Nova Scotia Utility and Review Board

IN THE MATTER OF Section 35A of *The Public Utilities Act*, R.S.N.S. 1989, c.380, as amended

- and -

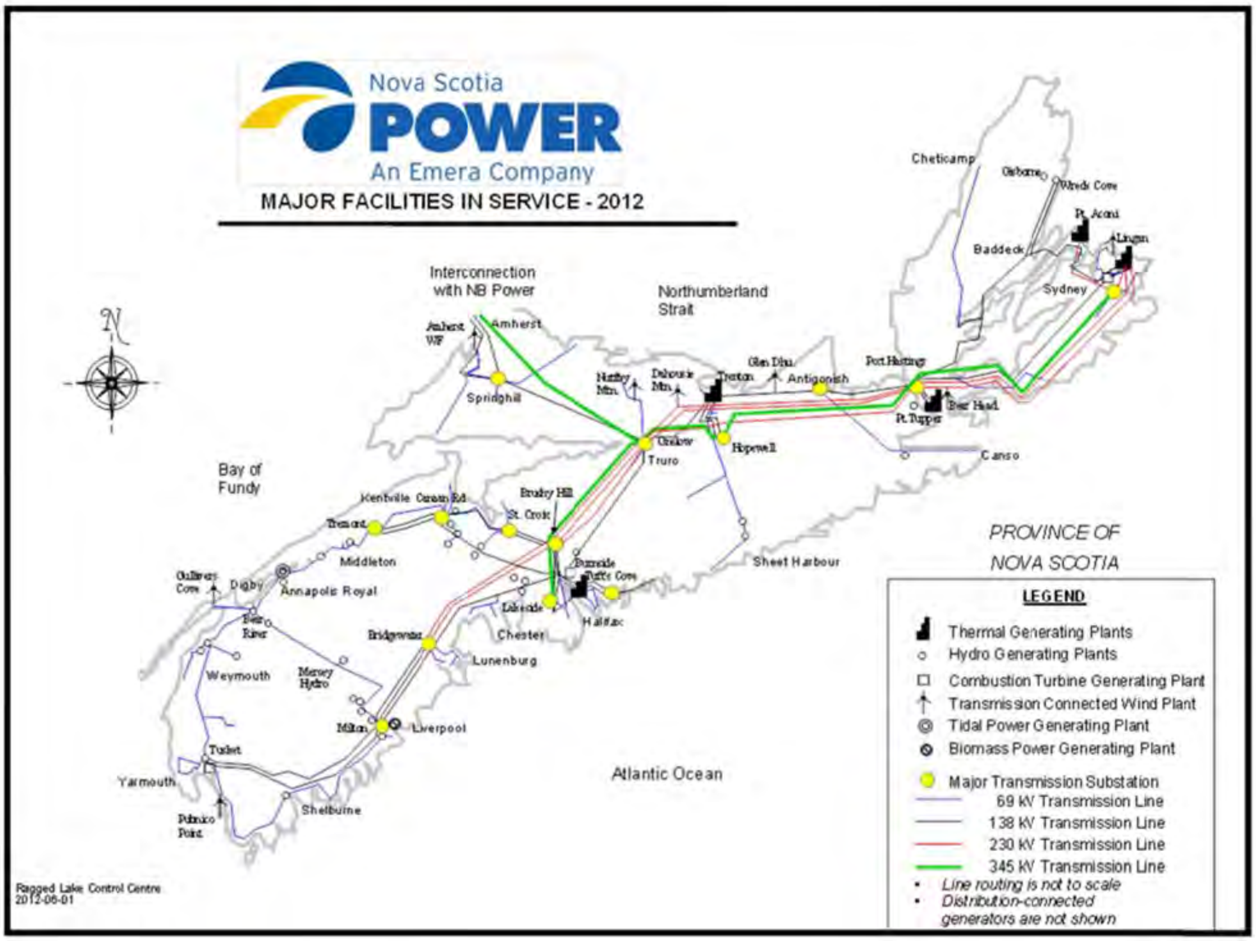
IN THE MATTER OF an Application by Nova Scotia Power Inc. for Approval of the **2013 Annual Capital Expenditure (ACE) Plan**

2013 ACE Plan

November 6, 2012

REDACTED

Nova Scotia Power Inc.
2013 Annual Capital Expenditure Plan



November 6, 2012

How the Annual Capital Expenditure Plan is Structured

The **Overview** section of this document provides the reader with a view of NS Power's overall capital expenditure plan.

Section 1 begins by providing a graph detailing the previous year's capital investments, projections for the current year and a forecast of the Company's capital spend for the next four years. It also includes a summary of the key assumptions used in the development and support for the capital projects included in the Plan. An outline of the Company's 2013 investment strategy by functional area is then presented.

A chart is provided in Section 1.4 to illustrate the breakdown of NS Power's 2013 Annual Capital Expenditure (ACE) Plan. The ACE Plan for 2013 is separated into the following components:

- Capital item approval sought through the ACE Plan 2013 process (including routine capital projects).
- Capital items to be submitted for approval later in 2013.
- Projects forecast for submission after the 2013 ACE Plan is submitted, but will be filed in 2012 (including the Q4 filing due in January 31, 2013).
- 2013 Carryover Projects. These are multi-year projects already approved in prior years with spending occurring in 2013.
- Capital Items Less Than $250,000. Pursuant to a legislative change to the Public Utilities Act effective May 11, 2010, capital expenditures with a value up to $250,000 may be made by a public utility, without formal approval of the Nova Scotia Utility and Review Board (UARB, Board) (Section 35 of the Public Utilities Act).
- Point Aconi Capital Items. Pursuant to Section 36 of the Public Utilities Act, investment in the Point Aconi Generating Station does not require Board approval.

Following the graphical summary of NS Power's ACE Plan, the Company provides lists of projects which are included in each of these sections.

Section 2 provides the Company's updates to the UARB's 2011 ACE Decision and responses to the 2012 ACE Decision directives.

The next four sections**, Generation, Transmission, Distribution** and **General Plant** provide the details of each capital project for which the Company is seeking Board approval in 2013.

Section 7 provides details regarding the Company's **Routine Capital** program within the Plan. NS Power's Routine Capital program is an annual allocation of capital to fund repetitive individual capital replacements. Routine Capital projects are included in the capital program in a pooled approach to reduce the administrative costs associated with identifying and approving individual Routine Capital projects and to provide NS Power with the flexibility required to effectively manage smaller, consistent scope projects from one year to the next. The overall Routine Capital Program is presented along with a breakdown of each project within the program and a multi-year overview of the program.

Appendices in Section 8 of the 2013 ACE Plan Include:

- 2013 Capital Spend by Justification Criteria
- A review of the categorization of capital
- A review of the functional areas within NS Power
- A 2013 Quick Reference Sheet that provides the reader with the Company's Allowance for Funds Used During Construction (AFUDC) and Overhead (AO) rates used in the development of the 2013 capital budget.
- NS Power's 2013 Depreciation Rates
- Glossary of Terms

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Annual Capital Expenditure Plan Foreword

The 2013 Annual Capital Expenditure Plan capital outlook is similar to the 2012 outlook. Our capital strategy reflects our long-term objective to transform our business to a cleaner generation mix in order to meet evolving emission standards, and to improve the reliability of the power system. Continuing to invest in our existing assets means better reliability, enhanced efficiency and improved customer service. Our customers will benefit from existing and future renewable generation that reduces our dependence on foreign solid fuels and saves customers money in the medium to long term. We recognize that transforming our power generation fleet to more renewable energy and investing in our transmission and distribution assets to improve reliability is a significant investment on behalf of our customers. In preparing and delivering this program, we are focused on safety, environmental regulations, cost control and operational excellence over the long term.

2013 capital investment highlights reflective of these objectives include:

- New wind projects awarded by the Renewable Electricity Administrator (REA) to our partners. These projects include the South Canoe and Sable wind projects.
- Preserving the current hydro generation fleet. This will serve to help achieve Renewable Electricity Standards (RES) requirements, as well as facilitate risk management associated with dam structures.
- The Port Hawkesbury Biomass Plant will be completed and in service in Q2 of 2013.
- Investment to support the Maritime Link project.
- The first phase of a seven year LED streetlight replacement plan.

Many of the initiatives will contribute to achieving RES compliance targets for 2015 and beyond, as well as provincial and federal greenhouse gas (GHG) regulations. These investments will be pursued in accordance with the government of Nova Scotia's outlook and vision for the province's green energy future. Per the Nova Scotia government's Renewable Electricity Plan:

> In the process of transitioning to a system that is cleaner, more diverse, more domestic, and more secure, this plan will support as much as $1.5 billion in green investment—creating good jobs and growing the economy. Specifically, the plan

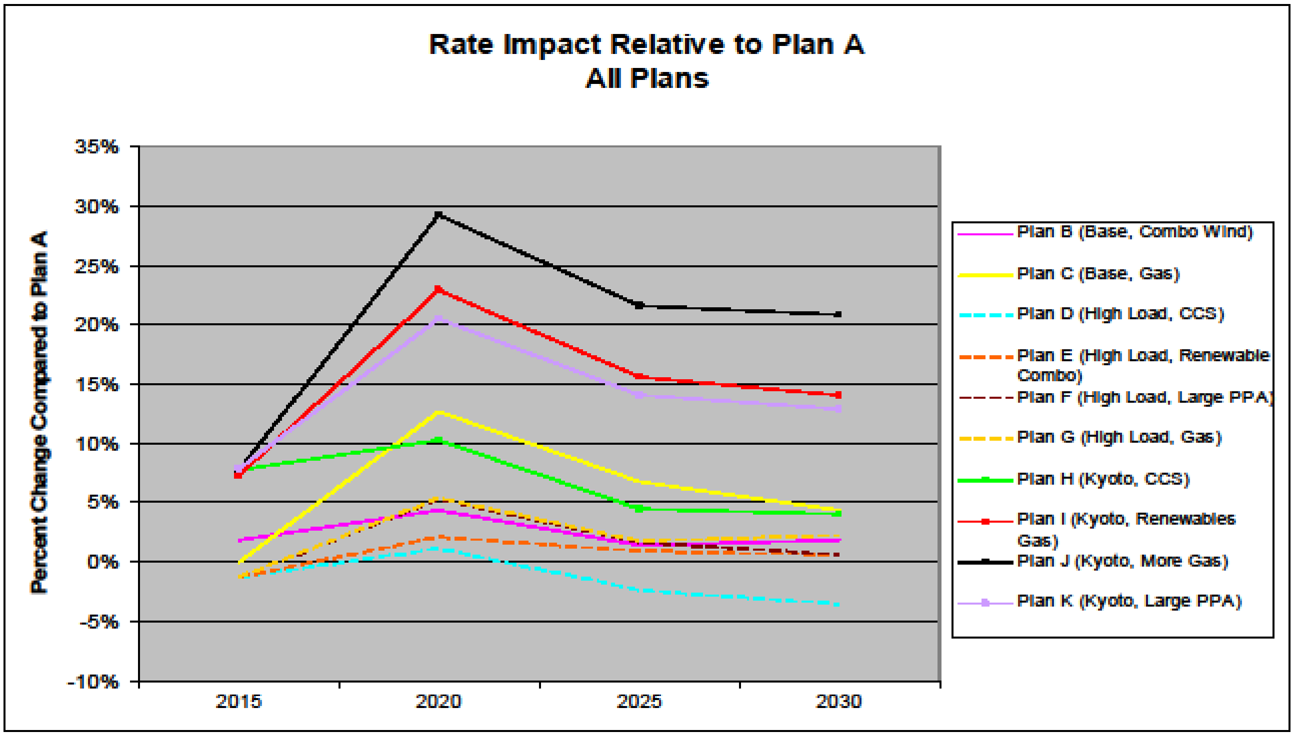
> will create jobs in construction, supply, manufacturing and maintenance, generating an estimated 5,000 to 7,500 person-years inside the province, with opportunities in both urban and rural areas. There are costs associated with moving in this direction—especially upfront. Adding renewables may add an average of one to two percent per year on electricity bills in the short term.
>
> But in the long run Nova Scotia will be far better off. Renewable electricity prices don't go up over time in the same way that carbon-based fuels will. Controlling our own supplies of energy gives us significant energy security. Moving towards local renewable sources will help stabilize fuel prices in the future—protecting consumers from both the volatility of fossil fuel pricing and the future costs of carbon.
>
> This plan takes a balanced approach to the challenging task of transforming our electricity system—a direction critical to the province's economic and environmental future—with opportunities for all Nova Scotians to participate.[1]

We understand what these investments mean to Nova Scotians and the issue of affordability. We wish to assure the Nova Scotia Utility and Review Board, our stakeholders and the public that measures are embedded within our capital program to ensure that capital investments are necessary and cost effective, offering value in the short term, long term, or both. This means that even under the constraints of necessary capital investments, we achieve value for our customers in the most cost effective manner possible. In this way, we provide customers the most affordable capital program we are capable of delivering today.

Despite significant costs associated with large capital investments, we pursue them in accordance with long term cost effectiveness and affordability. Our long-term approach to capital investment, as established in our Integrated Resource Plan (IRP) and its guiding principles, aims at achieving a balance between meeting future load growth and the introduction of renewable energy resources, while being as cost effective as possible.

The 2009 IRP Update resulted in a least cost Reference Plan, confirming the most cost effective approach for our customers. As shown in the table below (originally provided in our 2009 IRP report), our capital investment plan (Plan A) compares favourably to other more costly alternatives.

[1] Nova Scotia Department of Energy, *Renewable Electricity Plan*, April 2010, page 3, http://gov.ns.ca/energy/resources/EM/renewable/renewable-electricity-plan.pdf.



In addition to long term planning, we continue to pursue cost saving measures at all levels of our capital program. These cost savings are passed on to our customers.

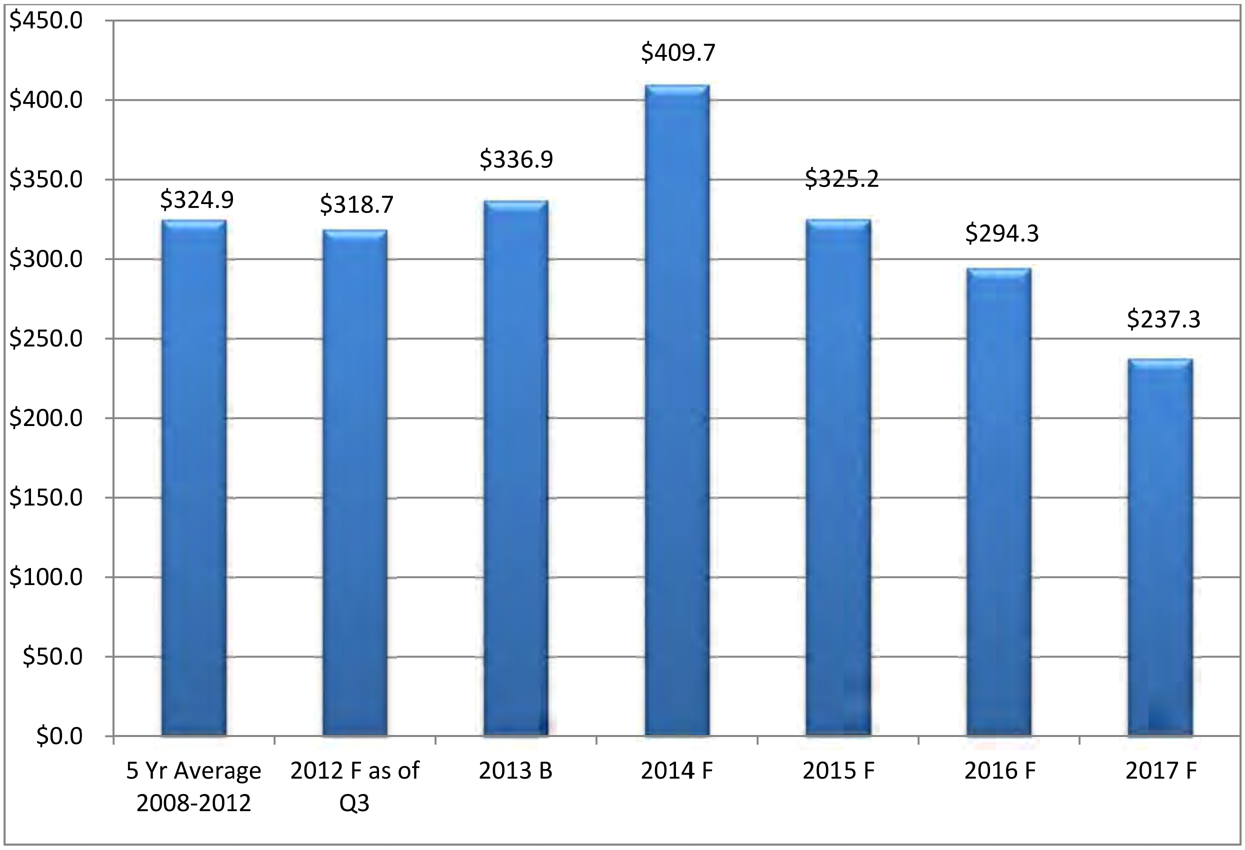
These measures include re-evaluating the need for capital investments based on changing circumstances. For example, NS Power load has decreased by 1400 GWh due primarily to the closure of the Bowater Mill and the partial shutdown of the New Page Mill. Because we are adding 115 MW of renewable energy through the South Canoe and Sable wind projects, investment in the Marshall Falls hydro system will not be pursued at this time. Moreover, with the renewable energy integration study work to be completed in late 2012, we will have a greater understanding of necessary capital investment for future fast acting generation and system upgrades.

NS Power delivers the most affordable capital program it can, even under the constraints of necessary investments. Many methods, many checks and balances, many evaluations and re-evaluations at every level of our capital program and beyond are practiced every day to achieve this result. NS Power's capital program is aimed at achieving the most cost effective solutions, providing long term value and stabilization of rates. We assess capital investments, not in isolation, but rather as part of Nova Scotia Power's overall delivery of cost effective service to customers – both capital and operating, guided by the long-term strategic planning of the IRP. It is through these rigorous processes that our capital costs are vetted, ensuring that what is spent provides the most cost efficient and affordable power system for all Nova Scotians.

1 Overview

1.1 Annual Capital Expenditure Plan for 2013-2017

(Millions of Dollars)



F = Forecast, B=Budget in above figure

Highlights of Nova Scotia Power's 2013 to 2017 capital plan:

- The proposed capital budget for 2013 is $336.9 million.
- The 2013 ACE Plan is comprised of new, carry-over and routine capital items. The ACE Plan includes capital items submitted for UARB approval through the ACE Plan proceeding, capital items previously approved by the Board, capital items that NS Power anticipates submitting for individual approval later in 2012 and 2013, and capital items that do not require UARB approval.

- 2013 capital spend for new capital items (including routines) submitted for UARB approval in this ACE Plan totals $173.3 million. The total capital investment for these capital items is $178.1 million. Detailed descriptions and justification for each new item requiring approval are included in this document, organized by capital function.

- Routine Capital spending represents $88.4 million of total spending in 2013 and is for "like-for-like" replacement of equipment additions to existing base equipment resulting from system growth and the addition of customers to the system. Excluding the costs of $0.6 million associated with Point Aconi Routines, NS Power is seeking approval of $87.8 million of Routine spending in 2013.

- The total investment for 2013 capital items that do not require UARB approval is $14.6 million. These investments include projects totaling less than $250,000 and capital investments in the Point Aconi Generating Station.

- Carryover projects comprise $46.1 million of total spending in 2013. The main projects contributing to this total include the Main Computer Centre Upgrade which constitutes $6.8 million, the Gaspereau Dam Safety project for $5.3 million, and the Port Hawkesbury Biomass Project represents approximately $4.8 million of the carryover spend.

- 2012 Projects totaling $27.2 million of spend in 2013 ($37 million Project Total Forecast) will be brought forward later in 2012 for separate approval.

- Projects totaling $75.7 million of spend in 2013 ($316.1 million Project Total Forecast) will be brought forward later in 2013 for separate approval.

Capital item justifications are based on the Capital Expenditure Justification Criteria (CEJC) as approved by the Board in 1995 with minor revisions per the 1997 filing. The CEJC provides the Board with assurance that NS Power is using sound economic, financial and technical criteria to ensure that its capital expenditures provide the maximum benefit to its customers. NS Power has worked with UARB staff throughout 2011 and 2012 to revise the CEJC and expects to file the updated version in early November.

NOTE: Figures presented in the ACE Plan document reflect rounding which may cause $0.1 million in rounding differences on some line items.

1.2 Key Assumptions & Clarifications

Economic Analysis Model

As in the past, NS Power uses the Economic Analysis Model (EAM) to calculate the economic value added of any project. The software takes capital costs, avoided costs, revenue and expenses into consideration to give a Net Present Value (NPV), Internal Rate of Return (IRR), and discounted payback period. The EAM continues to improve over time, with changes potentially leading to questions for reviewers. The capital investment for each project, generally shown on page 3 of the EAM in the "Capital" column, no longer includes Administrative Overhead (AO) and Allowance for Funds Used During Construction (AFUDC). AO and AFUDC are non-cash items and therefore not a part of Economic Value Add (EVA) and NPV analysis (these are cash based approaches to economic analysis).

The incremental replacement energy costs used in the EAM were derived using Strategist dispatch optimization software. The values used here are consistent with the most recent set of General Rate Application (GRA) assumptions. In addition, generating plant capacity factors have also been determined using Strategist software.

For example, within the 2013 ACE Plan, NS Power has provided an EAM which includes all projects on the Weymouth Hydro system. This EAM demonstrates that investment on the system provides economic benefit. In addition, for each economically-justified project included in that EAM, a second EAM has been provided to demonstrate the options NS Power considered before determining the path-forward for each project.

Labour Rates

Labour Rates used in the 2013 ACE Plan development include the assumptions used in the 2013 General Rate Application. All labour rates in the 2013 ACE Plan are considered forecasts and confidential due to the timing of labour negotiations.

Related Projects

The term "Related CIs" as noted on page 1 of each work order application generally refers to investments on the same asset within two years. NS Power continues to make efforts to improve the identification of related projects. In 2013, projects which are managed within one portfolio, pertaining to the same system or program, are categorized as related.

Preliminary Engineering

In some cases, in order to fully understand the scope and conceptual design of a project, NS Power must undertake preliminary engineering work. The projects which have preliminary engineering design work completed or underway, will be identified as having a start date prior to January 1, 2013.

1.3 Summary of 2013 Investment Strategy by Function

The following outlines NS Power's capital investment strategy, by function for 2013.

Steam Generation

As the amount of renewable energy on our system increases, coal-fired power plants, designed to be base-loaded, are required to operate in a more flexible manner. NS Power is looking for opportunities to increase efficiency at low loads, define new minimum loads, and to increase the rate at which units can be loaded. A number of investments in the 2013 ACE Plan are being pursued in response to this change in operation. These projects include 41226 – LIN Boiler Feed Pump Recirculation Piping and Valve Replacement, 43386 – POT Low and Variable Load Optimization, and 43041- POT Air Heater Steam Coils Replacement. The results of the wind integration study will inform further requirements of the units.

Lingan Generating Station

Lingan Unit 1 and Unit 2 are planned for seasonal operation in 2013 and as such NS Power anticipates minimal capital investment. Lingan Unit 3 has a major shutdown scheduled for 2013, based on the requirement to rewind the generator rotor (CI 43088). The total estimated investment on Unit 3 in 2013 is $6.6 million, $2.7 million of which is allotted to the rotor rewind project. As with all planned shutdowns, NS Power will take the opportunity to perform a number of inspections and tests on equipment. Lingan Unit 4 has a routine shutdown planned for 2013 and, as such, no significant work is planned.

Point Tupper Generating Station

The Point Tupper Generating Station has a short planned shutdown in 2013. Typical boiler capital investments are planned, as well as replacement of deteriorated equipment, including the air heater coils which are needed at lower loads (CI 43041). Several minor process improvements will be undertaken to improve variable operation reliability and efficiency.

Trenton Generating Station

As the Trenton Generating Station was shut down longer than planned in 2012, a number of projects, originally forecast for execution on Unit 5 in 2013, were advanced into 2012. In 2012, Trenton Unit 6 originally had a six week shutdown scheduled, but due to the extended shutdown on Unit 5, this shutdown was reduced in duration. As such, some of the projects originally planned for execution in 2012 could not be completed. These projects are shown as deferred or carry-over projects in the 2013 ACE Plan.

Tufts Cove Generating Station

No major outages are planned for the Tufts Cove Generating Station in 2013. The 2012 shutdown for Tufts Cove Unit 2 has been delayed due to the extended shutdown of Trenton Unit 5. This results in a number of projects being carried over into 2013 which were originally planned to be executed in 2012. A number of investments are planned for the circulating water system.

Tufts Cove Unit 6

This unit was put into service in February of 2012. Only one significant capital investment has been identified for this unit in 2013 – CI 42982 – TUC6 Gland Steam Supply. A study will be completed to develop the appropriate path forward to determine the optimal way to deliver gland steam to the unit.

Combustion Turbines

As more renewable energy is integrated into the provincial generation system, fast-acting generation, such as combustion turbines, becomes more critical to the system. NS Power is evaluating the long term investment strategy for its combustion turbine fleet. A number of projects have been incorporated into the plan to ensure the combustion turbine units in NS Power's fleet operate reliably and efficiently.

Point Aconi Generating Station

The Point Aconi generating station has a four week shutdown planned for 2013. Many of the projects are of a recurring nature such as CI 43111 – POA Refractory Replacement and CI 43150 – POA Boiler Arrowhead Replacement. There is no other significant capital investment forecast for the major components (turbine, generator or boiler) in 2013.

Hydro Generation

NS Power's hydro facilities cover 17 water systems and include 155 dams, 54 generating units in 33 power houses. Many of the assets are in excess of 50 years old and are at various condition states. On an annual basis, investment decisions pertaining to the fleet consider re-investment options, economics, risk management, timing, engineering investigations and operational optimization practices.

In the 2012 ACE Plan, NS Power requested approval for a number of projects on the St. Margaret's Bay Hydro System. A number of these projects are in progress and are carrying over into 2013. As a continuation of the dam safety work, refurbishment of Wright's Lake Dam in the St. Margaret's Bay hydro system is planned for 2013. This work is required to upgrade the dam to meet current industry standards.

Dam safety works are planned for the Black River hydro system in 2013. This consists of replacing the spillway and adjacent dam at Gaspereau Lake, and replacing the intake structure at Methals Generating Station to include headgates that are capable of closing under flow. This is an important safety feature that will eventually be incorporated into all of our intake structures.

A significant investment is being planned for the Nictaux Generating Station. This consists of installation of headgates capable of closing under flow, replacing the woodstave penstock, and replacing the headcover on the unit. This will ensure the continued safe and reliable operation of this important facility.

In the 2013 ACE Plan, NS Power is requesting approval for a number of projects in the Weymouth hydro system. The Weymouth system is the sixth largest hydro system in the province, and accounts for 5 percent of annual generation from hydro facilities. The total forecast expenditure on the Weymouth hydro system in 2013 is $10.9 million. This includes refurbishment of the surge tanks, replacement of the woodstave pipelines, replacement of electrical switchgear and the headcover on Unit 1. This is a reflection of the development of NS Power's asset management initiative across the generation fleet. This investment will extend the service life of the Weymouth Falls Generating Station for the foreseeable future.

Wind Investments

NS Power has partnered with three external proponents who were awarded three new wind projects by the Province's Renewable Electricity Administrator: Sable Wind and two separate projects comprising the South Canoe Wind Project. These projects will continue to support NS Power's strategy to comply with the Renewable Electricity Standard regulation for 2015 and 2020. In addition to these projects, there will also be a series of supporting projects brought forward to accommodate the distribution and transmission requirements of these new wind farms. All of these projects are listed as Subsequent Approval items.

Transmission & Distribution

All 2013 individual Transmission and Distribution investments are categorized within one of the following investment categories:

- Reliability (5 Year Plan & Incremental Reliability Investments)
- Load Growth
- Regulatory Compliance
- Renewable Infrastructure Development
- Sustaining Capital Investments

Reliability

2013 is year four of a five year (2010-2014) plan to improve reliability for NS Power's customers. The capital expenditures identified in this investment category serve to maintain and enhance the reliability of NS Power's electrical system. Investments in reliability are focused on aging assets and deteriorated equipment replacements, system performance improvements, technology improvements and storm hardening. Year four of the five year customer reliability investment plan for 2013 totals $18.3 million. Additional transmission system reliability investments not identified in the five year reliability plan total approximately $16 million in 2013.

Load Growth Capital Investments

Capital expenditures identified in this investment category are developed as a result of an increase in customer energy demand. Load growth generally occurs through increased economic activity, productivity or population growth in certain areas. The completion of the Harbour East Transmission Line Construction (and associated projects) in 2013 is an example of this type of investment.

Regulatory Compliance Capital Investments

In certain cases, capital investments are made in order to comply with recognized Canadian Standards Association (CSA) standards that are routinely incorporated into provincial regulations, internationally recognized reliability standards such as North American Electric Reliability Corporation/ Northeast Power Coordinating Council Inc. (NERC/NPCC), Environment Canada PCB regulations, etc. Examples of projects in this investment category include the Bulk System Protection Upgrades at Brushy Hill and Lakeside that are required to comply with North American Electric Reliability Corporation standards.

Renewable Infrastructure Development Investments

These capital investments are required to support the interconnection of renewable projects to NS Power's transmission and distribution systems. In 2013, projects will be initiated in support of the Sable and South Canoe Wind Farms, as well as the Maritime Link (contingent on UARB approval of the project). These projects are included in the 2013 ACE Plan as subsequent filings and are contingent on the main construction projects being brought forward and approved by the UARB.

Sustaining Capital Investments

On an annual basis, through planned inspections and performance monitoring, NS Power identifies deteriorating components on the electrical system. The capital expenditures identified in this investment category are required to ensure the continued reliable operation of these assets.

Generally, the construction of new Transmission and Distribution assets are planned and executed by the Technical and Construction Services (T&CS) group. To achieve the most effective execution of required work, the Work Management & Resource Allocation Department (WM&RA) is responsible for resource planning, scheduling and dispatch of work resources (NS Power and external contractors) for most Transmission and Distribution capital projects. Considerations incorporated into the capital planning and execution work plans include:

- Synergies with other operating or capital work.
- The nature of the work to be undertaken (e.g. transmission versus distribution, live line versus dead line).
- The availability and cost of NS Power's resources versus contracting options.
- The scope of the project (i.e. is the project better matched with NS Power Power crew availability/size or a contractor crew).
- Project location, duration and resource requirements.

1.4 Summary of ACE Plan Spending by Approval Category for 2013

The following table provides the proposed 2013 capital investment by approval category for NS Power's ACE Plan filing. This Application seeks UARB approval of the 2013 capital routines and other 2013 projects, which total $173.3 million of forecast spending in 2013. Certain items do not require UARB approval, but are included in the Company's annual capital plan for Stakeholders' information and transparency. The 2013 ACE Plan budget also includes spending on multi-year projects that were previously approved by the UARB.

2013 ACE Spend	2013 UARB Approval Request ($M)	UARB Approval Not Required ($M)	Capital Items Forecast for Later Filing & Approval in 2012/2013 ($M)	Capital Projects with 2013 Carryover ($M)	2013 ACE Plan ($M)
Capital Item Approval Sought through the 2013 ACE Process (Including Routine Capital Projects)	173.3				**173.3**
Capital Items Submitted for Approval Later in 2012			27.2		**27.2**
Capital Items Submitted for Later Approval in 2013			75.7		**75.7**
2013 Carryover Projects				46.1	**46.1**
Capital Items Less Than $250,000		10.3			**10.3**
Point Aconi Capital Spend		4.2			**4.2**
2013 ACE Plan	**$173.3**	**$14.6**	**$102.9**	**$46.1**	**$336.9**

NOTE: Figures presented in the ACE Plan document reflect rounding, which may cause $0.1 million in rounding differences on some line items.

1.5 2013 ACE Plan Capital Items Submitted for Approval

This table provides the list of Capital Items for which NS Power seeks UARB approval by this Application, totaling $173.3 million of spending in 2013, with a total forecast spending of $178.1 million.

Tab #	CI#	Project Title	2013 Budget	Project Total
Hydro				
Weymouth System				
G01	40308	HYD - Weymouth Falls Pipeline Replacement Unit 1&2	$6,583,387	$6,752,759
G02	43039	HYD - Weymouth Surge Tank	2,682,881	2,738,175
G03	17581	HYD - Weymouth Electrical Replacement	1,574,754	1,641,359
G04	43136	HYD - Weymouth Headcover Replacement	438,158	438,158
G05	20571	HYD - Weymouth Falls Tailrace Deck Refurbishment	371,469	371,469
Other Hydro Projects				
G06	31246	HYD Methals Intake Replacement	6,440,236	6,622,092
G07	20758	HYD - Nictaux Pipeline Replacement & Intake Refurbishment	4,168,556	4,379,301
G08	41806	HYD - Big Falls - Unit #6 Refurbishment	1,010,112	1,010,112
G09	27507	HYD - Sheet Harbour - Ruth Falls Penstock Butterfly Valve Replacements	733,528	733,528
G10	43127	HYD - 4th Lake Penstock Refurbishment	441,243	441,243
G11	43128	HYD - Gisborne Gearbox Replacement	360,731	360,731
Total New Hydro Spending			**$24,805,055**	**$25,488,927**
Steam				
G12	42806	LIN3 L-0 Blades Replacement	$3,553,933	$3,825,904
G13	43088	LIN3 Rotor Rewind	2,740,665	2,740,665
G14	41227	LIN3 Cond Large Bore Pipe and Valve Refurbishment	1,137,289	1,137,289
G15	41265	TUC - Oil Dock Piling Refurbishment	916,939	945,025
G16	41233	LIN 3 Boiler Refurbishment	809,680	809,680
G17	43094	LIN3 HT Fastener Replacement	779,269	779,269
G18	43006	TRE6 PLC Upgrades	728,309	728,309
G19	42729	POT - Replace economizer inlet header	626,028	626,028
G20	43053	POT - Waterwall Refurbishment 2013	623,050	623,050
G21	36603	LIN3-DAS Upgrades	567,748	567,748
G22	43166	LIN Mill Refurbishment	548,565	548,565
G23	41303	TRE6 - Waterwall Panel Replacements	545,409	545,409
G24	41511	TRE6 - Condenser Waterbox and Cooling Water (CW) Piping Refurbishment	394,545	394,545
G25	42978	TUC - CW Piping Refurbishment	387,840	387,840
G26	43424	TRE5 Analytical Panel	382,109	382,109
G27	43041	POT - Air Heater Steam Coils Replacement	331,766	331,766
G28	43097	LIN 3,4 Replace BFP Check Valve	331,572	331,572
G29	41159	LIN Reclaim Feeders Replacement	314,078	314,078
G30	41664	TRE5 Precip Refurbishment	306,057	306,057
G31	43008	TRE5 Turbine-Generator Fire Protection	305,402	305,402
G32	43567	TUC3 - CW travelling screens refurbishment	293,903	293,903
G33	41516	TRE6 - Stack Breaching Inlet Ductwork Refurbishment	289,376	289,376
G34	41506	TRE6 - 6B Cooling Water (CW) Pump Refurbishment	286,027	286,027
G35	42943	TUC2 - T-G Areas Fire Protection	283,088	283,088
G36	43056	POT - Cable spreading room fire protection	281,035	281,035
G37	38108	POT - AVR Refurbishment	266,205	266,276

Tab #	CI#	Project Title	2013 Budget	Project Total
G38	43169	LIN CW Screen Refurbishment	262,003	262,003
G39	43170	LIN4 AVR Replacement	227,346	874,245
Total New Steam Spending			**$18,519,236**	**$19,466,264**
Gas Turbine				
G40	43154	Critical Spares for LM6000 Combustion Turbines	$593,963	$593,963
G41	43157	Tusket Fuel Control & AVR	$332,606	$332,606
Total New Gas Turbine Spending			**$926,569**	**$926,569**
Total New Generation Spending			**$44,250,861**	**$45,881,760**
Transmission				
T01	43205	L5510 Insulator Replacements	2,953,689	2,953,689
T02	43293	Protection Upgrade Brushy Hill (138KV)	2,662,292	2,788,064
T03	43260	2013 Transmission Line Insulator Replacements	2,394,804	2,472,103
T04	43233	New Mobile Transformer 30+MVA (138-69kV -26,4-13_2kV)	2,152,435	2,152,435
T05	43226	2013 Transmission Switch & Breaker Replacements	1,969,767	1,969,767
T06	43237	2013 Substation Recloser Replacements	1,863,378	1,863,378
T07	43292	Protection Risk Reduction 120H-Brushy Hill 230KV	1,834,212	1,834,212
T08	43369	New Mobile Transformer 15MVA (138-69kV -26,4-13_2kV)	1,719,218	1,719,218
T09	43283	Additional Transformer 4C Lochaber Road	1,575,845	1,625,274
T10	43231	2013 Substation PCB Equipment Removal	1,496,626	1,496,626
T11	43490	2013 Steel Tower Painting	1,375,442	1,375,442
T12	43285	99W Bridgewater Add Capacitor Bank	1,057,741	1,097,853
T13	43672	82V-T1 Transformer Rewind	960,432	960,432
T14	43267	13V Gulch Hydro Replace 13V-GT1 and 13V-VR1	954,407	954,407
T15	43606	L5549 Upgrade	706,359	706,359
T16	43266	89S-ST2 Point Aconi Replace Station Service Transformer	681,377	681,377
T17	43200	Pole Retreatment 2013	678,882	678,882
T18	43426	78W-Martins Brook – Relocate Substation to Opposite Side of Road	455,700	455,700
T19	43261	6V-Hollow Bridge Hydro Replace 6V-GT1	435,537	435,537
T20	43486	89H-511 Add Battery, Battery Charging Set, RTU and Replace Breaker	421,477	421,477
T21	43204	L5503 Removal	402,387	402,387
T22	43268	9W-Tusket Replace 9W-B53 Structure	309,026	309,026
T23	43222	2013 Substation Insulator and Cut-Out Replacements	303,055	303,055
T24	43323	Tuft's Cove Line Swap	266,923	266,923
T25	43287	2C-Port Hastings- Retire 2C-T1 & T2 and the 69kV & 25kV Buses	266,691	266,691
T26	43487	Add Breaker Back-Up (BBU) Transfer Trip (TT) at 81V-Annapolis Hydro and 12V-Lequille Hydro	255,850	255,850
T27	43291	Protection Risk Reduction 67N-Onslow 230KV	117,460	2,416,341
Total New Transmission Spending			**$30,271,011**	**$32,862,504**
Distribution				
D01	43258	2013 Build-to-Roadside	$1,081,638	$1,081,638
D02	43126	13V-303 Bear River Targeted Feeder Replacements	798,977	798,977
D03	43201	2013 Halifax Underground Feeder Replacements	770,794	770,794
D04	43255	2013 Distribution Cutout Replacements	618,065	618,065
D05	43234	104S-313 Baddeck Re-build	593,045	593,045
D06	43217	24C-442G Hwy 16 Reconductor Phase 1	548,148	548,148
D07	41350	16W-301 Hebron Rebuild Phase 2	501,720	501,720
D08	43551	56N-401 Pictou Rebuild and Conversion	444,595	444,595
D09	41358	624V-311 Scotch Village Ph 3	422,957	422,957
D10	43219	93V-311 Saulnierville Reconductor Phase 2	418,888	418,888
D11	43282	2013 Distribution Feeder Ties	389,878	389,878
D12	43189	2013 Downline Recloser Additions	380,204	380,204
D13	43276	2013 Distribution Reliability Technologies	328,540	328,540

Tab #	CI#	Project Title	2013 Budget	Project Total
D14	43194	3S-303 North Sydney Targeted Replacements	308,730	308,730
D15	43177	103W-311 Gold River Reconductor Phase 3	306,410	306,410
D16	43218	88W-323HA – Tusket Islands Phase 3	287,196	287,196
D17	41346	82S-304 Whitney Pier Targeted Replacements	276,358	276,358
D18	43188	2013 Distribution Automation	274,349	274,349
Total New Distribution Spending			**$8,750,493**	**$8,750,493**
General Plant				
New Computers				
GP01	43346	IT - Service Hub Upgrade	$614,532	$614,532
GP02	43272	SCADA-EMS Hardware Replacement	497,250	497,250
Total New Computers Spending			**$1,111,782**	**$1,111,782**
Outage Performance				
GP03	43227	2013 RTU Replacements	$391,763	$682,211
GP04	43221	2013 New RTU Deployment	362,910	687,806
Total Outage Performance			**$754,673**	**$1,370,017**
Telecommunications				
GP05	43190	Replace Microwave Radio System 2013	$351,087	$351,087
Total New Telecommunications Spending			**$351,087**	**$351,087**
Total New General Plant Spending			**$2,217,543**	**$2,832,886**
Total Routine Capital Spending			**$87,819,054**	**$87,819,054**
Total Capital Items for which Approval is Sought			**$173,308,962**	**$178,146,697**

1.6 2012 Capital Items Pending Submission

The following table identifies outstanding 2012 projects included in the 2012 ACE Plan as items that would be submitted for subsequent approval but not yet submitted to the Board, and Unforeseen & Unbudgeted (U&U) capital work orders from 2012. These items are not yet ready for submission to the UARB and therefore not included in the 2013 ACE Plan for approval. However, NS Power anticipates these projects will be filed for approval in late 2012. These 2012 projects will carryover into 2013 and total $27.2 million of 2013 forecast spending on projects that are currently estimated at $37.0 million. These budget numbers are estimates at the time the 2013 ACE Plan was prepared and are subject to change when the scope and details of the projects are refined and provided for approval.

CI#	Project Title	2013 Budget	Project Total
Steam			
18448	TUC - Cooling Water System Biofouling Control *This project is for design and installation of a sodium hypochlorite system.*	$2,803,075	$3,619,424
41843	TUC2 U&U HP/IP Blade Replacement *The scope of this project includes replacement of the impulse blades in the High Pressure Turbine, replacement of Intermediate Pressure Blade rows 7, 8 and 9, as well as strip down inspection and refurbishment of related components.*	589,120	2,780,735
42728	LIN 1 & 2 U&U Seasonal Layup *Due to the seasonal operation of Lingan Units 1 and 2, work needs to be undertaken to preserve the assets and ensure they are ready to be placed in service when needed.*	55,408	225,930
	Total New Steam Spending for Subsequent Approval	**$3,447,603**	**$6,626,089**
Transmission			
41519	Harbour East 138 kV Transmission Line *This project includes the design and construction of a new 138kV transmission line from the existing Dartmouth East (113h) substation to a new substation required in the Eastern Passage area.*	$8,031,928	$8,427,500
41520	Harbour East Substation *The scope of this project is to design and construct a new 138kV substation in the Eastern Passage area.*	3,037,546	3,420,719
41522	138kV Line Terminal at Dartmouth East Substation *This project includes the design and construction of a 138kV line terminal at the existing Dartmouth East (113H) substation to connect to a new 138kV transmission line. The new line will be connected to a new substation in the Eastern Passage area.*	683,248	726,645
	Total New Transmission Spending for Subsequent Approval	**$11,752,722**	**$12,574,864**

CI#	Project Title	2013 Budget	Project Total
Distribution			
40320	LED Street Light Conversion Phase 1 *This project is Phase 1 of a program to convert all streetlights to Light Emitting Diode (LED) street lights. Phase 2 of this program will be filed in 2013. The total LED Program is currently forecast to cost approximately $56M.*	$6,117,302	$9,528,526
41534	2012 Reliability Technologies Distribution *The scope of this project includes the design, engineering, development and execution of a work plan for various covered conductor and insulating technologies.*	640,947	1,711,847
41541	U&U 141H Harbour East New Feeders *This project is for the design and installation of the necessary distribution feeder additions and upgrades to connect a new substation in Dartmouth to the existing system.*	176,125	176,125
	Total New Distribution Spending for Subsequent Approval	**$6,934,375**	**$11,416,498**
General Plant			
40278	OMS Upgrade 2011 *The scope of this project is to modify the existing Outage Management System (OMS) to provide enhancements, and maintain vendor support for this critical customer service application.*	$3,463,635	$3,746,742
40648	IT - Field Mobility System *The Field Mobility project will automate the work order management and time entry processes for Power Line Technicians (PLTs).*	1,401,619	1,664,954
43467	U&U Plant Wireless Infrastructure *This project is for installation of a wireless network within NS Power's thermal generating stations.*	186,030	926,165
	Total New General Plant Spending for Subsequent Approval	**$5,051,284**	**$6,337,861**
	Total Capital Items for Subsequent Approval	**$27,185,984**	**$36,955,311**

1.7 2013 ACE Plan Capital Items Forecast for Subsequent Approval

The following table identifies 2013 projects that are not yet ready for submission to the UARB, and that NS Power anticipates will be filed for approval in late 2012 and throughout 2013. NS Power estimates $72.4 million of spending in 2013 on these projects which are currently estimated for total spending $310.8 million. The budget numbers indicated below are estimates as NS Power requires additional time and effort to develop specific project budget proposals. This aspect of the Company's filing is designed to provide a general indication of anticipated 2013 projects, as requested by the Board.

CI#	Project Title	2013 Budget	Project Total
Hydro			
40283	HYD - Wrights Lake Dam Refurbishment *This project is for refurbishment of embankment dams and spillway at Wrights Lake.*	$2,344,643	$2,487,980
41130	HYD - Avon #2 Generator Stator Rewind *This project will install new stator coils in the Avon 2 generator.*	1,205,366	1,230,542
43607	HYD - Malay Falls Unit Overhaul *This project is to complete a detailed condition assessment of Malay Falls Units 5 and 6, and perform necessary repairs and replacements.*	540,892	692,652
42648	HYD - Harmony Fish Ladder *This project is to construct a new fish ladder adjacent to main dam.*	598,416	671,803
	Total New Hydro Spending for Subsequent Approval	**$4,689,318**	**$5,082,977**
Gas Turbine			
33142	CT- Burnside #4 Engine Restoration And Upgrade *This project provides for work required to bring the Burnside Unit 4 back in service.*	$591,370	$7,000,000
43747	TUC4 - LM #4 Hot Section Overhaul *OEM recommendations are to take Tufts Cove Unit 4 out of service after 25,000 hours for inspection and component replacement. The unit is expected to reach this number of operating hours in 2013.*	3,190,583	3,190,583
43155	CT's BGT#2 Air Intake Structure Refurbishment *This project will refurbish the Burnside Unit 2 air intake structure to prevent debris from entering the turbine intake.*	316,941	316,941
	Total New Gas Turbine Spending for Subsequent Approval	**$4,098,893**	**$10,507,524**

CI#	Project Title	2013 Budget	Project Total
Wind			
42127	South Canoe Wind Project *Construction of a 102MW Wind Farm.*	$29,924,344	$103,453,000
40785	Sable Wind Project *Construction of a 13MW Wind Farm.*	30,333	14,379,714
	Total New Wind Spending for Subsequent Approval	**$29,954,677**	**$117,832,714**
Steam			
30162	POT - Bunker C tank refurbishment *This project provides for the refurbishment of the Bunker C tank which has experienced wall thinning and corrosion.*	$1,079,465	$1,079,465
42982	TUC6 - Gland steam supply *This project provides for a gland steam supply for Unit 6.*	537,325	537,325
43035	POT - South BFP Refurbishment *The scope of this project is the overhaul of the Unit 2 South boiler feed pump, fluid coupling, and motor.*	505,535	505,535
43165	LIN4 Boiler Refurbish *This project will refurbish the boiler as required to ensure it is compliant with ASME specifications and NS Power standards.*	504,280	504,280
37885	POT - Lubrication and Chemical Storage *This project includes the construction of a storage building for lubricating oils, chemicals, salt for winter usage and auxiliary equipment such as hoses and storage containers.*	407,654	429,891
42966	TUC - Additional RO for WTP (or ion exchange) *This project is required to install additional Reverse Osmosis System in the Tufts Cove water treatment plant.*	290,784	290,784
	Total New Steam Spending for Subsequent Approval	**$3,325,043**	**$3,347,280**
	Total New Generation Spending for Subsequent Approval	**$42,067,931**	**$136,770,495**
Transmission			
43677	Woodbine Substation Expansion *This is a network upgrade project required to support the Maritime Link Investment.*	$297,000	$29,700,000
43324	L6513 Rebuild/upgrade line terminals *This work will address ground clearance issues on the L6513 line and is also work required to support the Maritime Link Investment.*	1,610,000	16,100,000
43678	Strait Crossing: Separate L-8004/L-7005 *This is a network upgrade project required to support the Maritime Link Investment.*	108,000	10,800,000
43682	South Canoe Line Upgrades(L-5535 and L-5541) *Interconnection and Network Upgrade work associated with the South Canoe Wind Farm*	276,600	7,437,544
43684	Interconnection Substation South Canoe Wind Project *Interconnection and Network Upgrade work associated with the South Canoe Wind Farm*	376,984	6,484,289

CI#	Project Title	2013 Budget	Project Total
43681	South Canoe Wind Project Substation Network Upgrades *Interconnection and Network Upgrade work associated with the South Canoe Wind Farm*	303,615	4,766,785
43683	South Canoe Wind Project Transmission Line *Interconnection and Network Upgrade work associated with the South Canoe Wind Farm*	63,974	4,430,958
43206	L6001 Overhead Ground Wire Replacement *This project includes replacing the overhead ground wires on L6001 which runs from Onslow to Burnside.*	3,342,636	3,342,636
43676	Interconnection Substation Sable Wind Project *Interconnection and Network Upgrade work associated with the Sable Wind Farm*	87,809	2,527,797
43679	L-7015 ROW Modifications *This is a network upgrade project required to support the Maritime Link Investment.*	500,000	2,500,000
43786	2013 L8002 Tower Refurbishments *This project is associated with the work required to replace grillages steel tower transmission structure on L8002. Grillages serve as the foundation of the guyed mast structures on this transmission line.*	2,129,708	2,129,708
43428	Remove 6S 4kV Switchgear Breakers *This project to convert the 6S substation from 4 kV to 12 kV.*	1,196,753	1,918,857
43726	Replace 3N-T51 Transformer *This project provides for the replacement of this transformer.*	1,297,791	1,297,791
43284	104H Kempt Rd Station Upgrades For Additional Transformer *The scope of this project is to modify the 104H-Kempt Rd. substation to accept installation of a fourth, T64 transformer.*	1,167,277	1,167,277
43674	Sable Wind Project Network Upgrades *Interconnection and Network Upgrade work associated with the Sable Wind Farm*	76,532	767,993
43427	62N-510 Breaker & Control Building Replacements *The scope of this project is to replace the 62N-510 circuit breaker and the associated hut containing the battery, battery charger and protection relays.*	574,142	574,142
43675	Sable Wind Project Interconnection *Interconnection and Network Upgrade work associated with the Sable Wind Farm*	16,393	281,516
	Total New Transmission Spending for Subsequent Approval	**$13,425,215**	**$96,227,294**
Distribution			
43468	LED Street Light Conversion Phase 2 *Phase 2 of the LED Streetlight deployment program.*	$2,263,293	$46,827,461
43286	6S Terrace Street Conversion Phase 1 *This project is to fund offloading of 4kV from 6S-T1, including replacement of older poles and conductor.*	743,269	743,269
43548	533S Mason Street Conversion *This project is for the conversion of 4kV load to 12kV.*	449,764	449,764
	Total New Distribution Spending for Subsequent Approval	**$3,456,326**	**$48,020,493**

CI#	Project Title	2013 Budget	Project Total
General Plant			
43202	Replace Mobile Radio System *This project provides for the replacement of NS Power's province wide Mobile Radio System.*	$2,453,617	$19,976,546
43191	Distribution Pole and Streetlight Data Management *This project provides for the purchase, installation and population of GIS databases to manage NS Power owned distribution pole and streetlight data.*	6,704,581	6,705,931
41766	Commercial AMI Pilot *This project provides for the deployment of AMI meters to commercial customers.*	3,671,238	3,927,927
41845	Residential AMI Pilot *This project provides for the deployment of AMI meters to residential customers.*	2,090,622	2,523,197
41705	Milton Hydro Office Renovation and Upgrade *This project provides for infrastructure repairs and improvements at the facilities at the Milton Hydro Office.*	815,730	894,680
40649	IT - PeopleSoft (Human Resource Mgt) *This project is to enable the functionality to define and centrally manage all positions within the organization.*	623,885	623,885
41424	IT - PeopleSoft Self Service Module *Enabling the employee self- service module will allow employees to manage a subset of their information within the PeopleSoft system and produce efficiencies.*	422,726	422,726
	Total New General Plant Spending for Subsequent Approval	**$16,782,399**	**$35,074,892**
	Total Capital Items for Subsequent Approval	**$75,731,870**	**$316,093,174**

1.8 2013 ACE Plan Capital Items with Estimated Total Project Cost of Less Than $250,000

This table includes capital items with a total project cost of less than $250,000. In accordance with Section 35 of the Public Utilities Act, these projects do not require UARB approval.

CI#	Project Title	2013 Budget	Project Total
Hydro			
43125	HYD - 4th Lake Butterfly Valve Actuator Replacement	$129,250	$129,250
	Total Hydro Items Less Than $250,000	**$129,250**	**$129,250**
Steam			
41226	LIN Boiler Feed Pump recirculation Piping and valve Replacement	$241,853	$241,853
43389	LIN3 Bentley Nevada Upgrade - System 1	240,956	240,956
43407	TRE5 Cable Rooms Fire Protection	238,743	238,743
43090	LIN3 Precipitator Access Door Replacement	237,878	237,878
42973	TUC - #1 and 2 WTP DCS upgrade	233,981	233,981
43051	POT - Selective superheater replacement 2013	230,452	230,452
43239	LIN4 BFP Proportional Recirculation Line Control	227,777	227,777
42964	TUC - Asbestos Abatement Program 2013	226,877	226,877
43207	LIN 4160 Motor Refurbishment	223,862	223,862
42941	TUC3 - DCS upgrade phase II	220,358	220,358
43052	POT - Selective Reheater Replacement 2013	216,785	216,785
42938	TUC - Unit 1 South BFP Refurbishment	208,236	208,236
41483	POT - 2013 Asbestos Abatement	198,561	198,561
43429	TRE5 Lube Oil Cooler Retube	183,832	183,832
42967	TUC - Replace Stack Rail Runner System	183,389	183,389
43100	POT - Selective ash cell capping	181,873	181,873
41564	POT - WTP Filter Replacement	176,410	176,410
42949	TRE Asbestos Abatement 2013	160,443	160,443
42937	TUC-LMs East Gas Compressor Overhaul	155,900	155,900
30163	POT - Control room and permit room upgrade	150,091	155,870
43666	TUC - Replace Hydrazine with DEHA	155,449	155,449
42979	TUC - HFO Line Support Refurbishment	154,269	154,269
43627	LIN Hydrazine Replacement	152,845	152,845
42939	TUC - Unit 2 Circulating Water Pump (North) Refurbishment	148,202	148,202
43213	LIN3 Battery Replacement	145,302	145,302
42962	TUC - Shoreline Lighting and Fencing	139,129	139,129
43409	TRE Ash Site Covering 2013	135,525	135,525
43032	POT - Auxiliary cooling water ACW strainer replacement	131,797	131,797
43054	POT - Backpass Refurbishment 2013	131,771	131,771
39777	TUC - Ferrous Sulphate System Upgrade	121,400	121,400
43626	TRE Hydrazine Replacement	120,710	120,710
43408	TRE 4kV Motor Refurbishments 2013	116,996	116,996
43386	POT - Low and Variable load optimization	113,840	113,840
42971	TUC1&2 - DCS Upgrade	111,547	111,547
43425	TRE5 HP Dosing Skid	95,455	95,455
37544	TRE5 - Coal MCC Transformer Replacement	92,141	92,141
30955	LIN Fire System Valve Upgrade	86,772	86,772
43412	TRE5 Breaker Refurbishments	86,217	86,217

CI#	Project Title	2013 Budget	Project Total
42965	TUC - Fire System Electrical Upgrade	82,412	82,412
42970	TUC - 4KV Motor Refurbishment Program 2013	80,587	80,587
42972	TUC - 4160 V / 600V Breaker Replacement 2013	77,404	77,404
41533	TRE6 - Boiler Thermoprobe Upgrade	75,225	75,225
30062	POT - Resin replacement for East and West Polishers	74,817	74,817
30862	TRE5 - Boiler Thermoprobe Upgrade	74,744	74,744
43413	TRE6 Breaker Refurbishments	73,961	73,961
42944	TUC3 - Boiler Drum North PSV Replacement	71,275	71,275
42953	TUC1- Replace closed cooling HX tube bundle	68,111	68,111
43212	LIN 4160 and 600V Breakers	52,985	52,985
43416	TRE5 WTP Resin Replacement	45,502	45,502
42969	TUC - WWTP Sludge Press Refurbishment	45,095	45,095
30043	POT - Replace Carbon Analyzer	44,970	44,970
	Total Steam Items Less Than $250,000	**$7,244,709**	**$7,250,488**
Gas Turbine			
43151	System 1 for LMs	$187,063	$187,063
43159	Burnside #1 & 2 and VJ Annunciation Units Upgrade to DAS	150,210	150,210
43766	CT - VJ 1&2 Annunciation Units Upgrade to DAS	144,224	144,224
43420	CTs - Burnside air dryer system upgrade	131,817	131,817
37982	CTs - BGT#3 AVR Replacement	77,403	77,403
43146	CTs - VJ Air Dryer System Upgrade	65,495	65,495
	Total Gas Turbine Items Less Than $250,000	**$756,211**	**$756,211**
	Total Generation Items Less Than $250,000	**$8,130,171**	**$8,135,950**
Transmission			
43488	7H Substation Retirement	$52,400	$52,400
43489	8H Substation Retirement	52,400	52,400
43223	101S-Woodbine Transfer Switch Replacement	48,768	48,768
	Total Transmission Items Less Than $250,000	**$153,568**	**$153,568**
Distribution			
43203	58C-405 Belle Cote Phase 1	$238,173	$238,173
43216	2013 Feeder Exit Cables	203,892	203,892
43278	Halifax 4kV Conversion Phase 1	155,921	155,921
43195	2013 Remote Communication on Reclosers	137,750	137,750
43198	77V-302 - Conway Targeted Feeder Replacements	127,080	127,080
43279	15N Load Balancing	67,785	67,785
	Total Distribution Items Less Than $250,000	**$930,601**	**$930,601**
General Plant			
43174	2013 Telecom Building Replacement Project Horton Lake	$206,455	$206,455
43368	Maximo Enhancements for System Maintenance	204,606	204,606
43355	IT Testing Environment and Standards	198,494	198,494
43388	IT - PI Software License True-up	156,988	156,988
43173	2013 Upgrade Multiplexer Group	136,651	136,651
43186	2013 Telecom 48VDC Battery & Charger Replacements	120,193	120,193
43238	E-Clipboard Project	110,476	110,476
	Total General Plant Items Less Than $250,000	**$1,133,862**	**$1,133,862**
	Total Capital Items Less Than $250,000	**$10,348,203**	**$10,353,982**

1.9 2013 ACE Plan Capital Items – Point Aconi Generating Station

This table provides the Point Aconi capital projects for 2013. These projects do not require UARB Approval.

CI#	Project Title	2013 Budget	Project Total
43111	POA - Boiler Refractory Replacement (2013)	$762,859	$762,859
43110	POA - Structural Steel Refurbishment Program	435,868	435,868
41051	POA - HV Bushing Capital Spare	226,128	226,128
43120	POA - UPS Chargers Replacement	200,922	200,922
43114	POA - Screw Cooler Trough Replacement	155,217	155,217
43244	POA - Stack Lighting	147,709	147,709
43150	POA - Boiler Arrowhead Replacement	144,013	144,013
43240	POA - HVAC Equipment Replacement	101,524	101,524
43256	POA - Acid Day Tank Replacement	98,479	98,479
43115	POA - 2013 Valve Refurbishment Program	94,367	94,367
43144	POA - Plant Access Improvements	93,222	93,222
43141	POA - "A" Circulating Water (CW) Screen Refurbishment	92,050	92,050
43241	POA - PLC Migration Program	91,624	91,624
43243	POA - Wellfield Communication	84,123	84,123
43247	POA - Adiabatic Bomb Calorimeter Replacement	79,155	79,155
43139	POA - Expansion Joint Upgrade	74,737	74,737
43147	POA - HP Blower Program	69,402	69,402
43245	POA - Plant Communication (PA & Radio)	66,556	66,556
43148	POA - 4KV Motor Refurbishment Program	64,059	64,059
43149	POA - 4KV / 600V Breaker Refurbishment	63,425	63,425
43242	POA - Plant Door Refurbishment	61,418	61,418
43118	POA - Plant Heating Upgrade	50,808	50,808
43152	POA - Hydrazine Replacement	47,155	47,155
	Total Point Aconi New Spending	**$3,304,819**	**$3,304,819**
	Point Aconi Carryover Spending	341,567	917,017
	Point Aconi Routine Spending (Included in overall Routine Program)		
	POA DCMS Equipment Replacement*	28,250	28,250
	POA Kelly Rock Limestone Quarry*	28,250	28,250
	POA Plant Tools & Equipment*	52,500	52,500
	POA - Routine Equipment Replacement	251,700	251,700
	POA Roofing Routine	169,258	169,258
	POA Heat Rate Routine	62,480	62,480
	Total Point Aconi Capital Spending	**$4,238,823**	**$4,814,274**

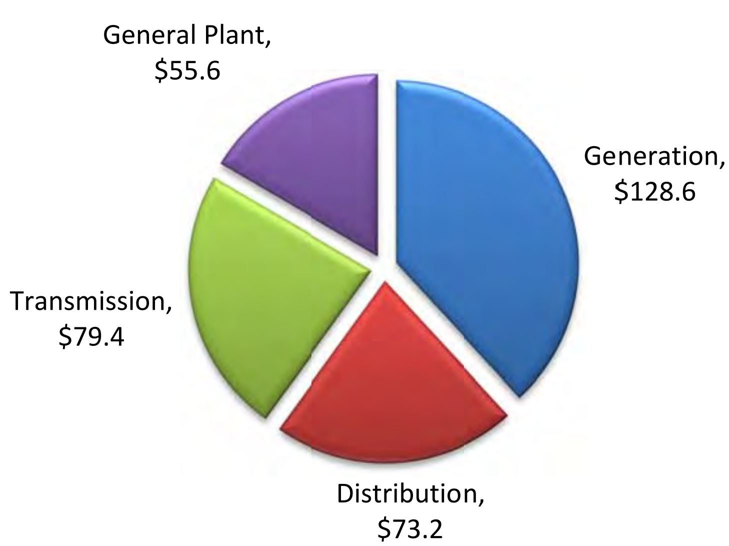
*General Plant Routines

1.10 Total Annual Capital Expenditures by Function

(Millions of Dollars)

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
	Actuals				Forecast as of Q3	ACE Plan	Forecast			
Generation	$78.5	$165.0	$385.0	$151.6	$153.2	$128.6	$213.2	$143.7	$122.9	$81.2
Transmission	18.0	22.7	45.1	58.4	56.4	79.4	74.9	78.8	67.0	50.0
Distribution	47.6	52.3	59.6	62.4	72.4	73.2	75.2	73.5	74.7	75.9
General Plant	23.2	39.6	54.0	42.5	36.8	55.6	46.4	29.2	29.7	30.2
Total	**$167.3**	**$279.7**	**$543.7**	**$315.0**	**$318.7**	**$336.9**	**$409.7**	**$325.2**	**$294.3**	**$237.3**

2013 Capital Spending by Function
(Millions of Dollars)



1.11 2012 ACE Capital Items Deferred / Cancelled

CI#	Project Title	2012 ACE Project Total	Cancelled/ Deferred
Generation			
38868	HYD Marshall Falls Hydro Station *Due to the Port Hawkesbury Biomass and REA energy anticipated Muskrat Falls generation addition to the system, NS Power does not need this project at this time to meet the Renewable Electricity Standards. The project will continue to be evaluated as new situations arise and fuel costs change.*	$18,233,184	Deferred
39566	LIN2 Steam Turbine Last Stage Blades *This project has been cancelled due to the seasonal operation mode of the Unit.*	$1,815,030	Cancelled
31583	LIN2 L-1 Steam Turbine Blading Replacement *This project has been cancelled due to the seasonal operation mode of the Unit.*	$1,077,882	Cancelled
40330	LIN2 HT Fastener Replacement *This project has been cancelled due to the seasonal operation mode of the Unit.*	$760,741	Cancelled
41233	LIN3 Boiler Refurbishment *A major shutdown for Unit 3 has been planned for 2013. This work has been deferred for execution during that outage.*	$755,711	Deferred
41595	POT - Sternson PLC Replacement *The front end of the water treatment plant requires updating prior to this upgrade. This upgrade may require replacement of the existing Sternson train. The project is deferred until the remaining water treatment plant work is defined.*	$596,976	Deferred
41303	TRE6 - Waterwall Panel Replacements *Due to the work required on Trenton Unit 5, the six week shutdown planned for Unit 6 was shortened. This project is deferred for execution in the six week outage planned for 2013.*	$584,225	Deferred
41806	HYD - Big Falls - #6 Refurbishment *Due to the Big Falls #5 issues, NS Power decided to keep Unit #6 in-service while repairs on Unit #5 were being completed (reference CI 41988 - Big Falls #5 Overhaul).*	$497,566	Deferred
41511	TRE6 -Condenser Waterbox and Cooling Water (CW) Piping Refurbishment *Due to the work required on Trenton Unit 5, the six week shutdown planned for Unit 6 was shortened. This project is deferred for execution in the six week outage planned for 2013.*	$447,687	Deferred
41516	TRE6 - Stack Breaching Inlet Ductwork Refurbishment *Due to the work required on Trenton Unit 5, the six week shutdown planned for Unit 6 was shortened. This project is deferred for execution in the six week outage planned for 2013.*	$252,948	Deferred
40032	POA - Boiler Feed Pump Refurbishment *Additional performance testing has concluded that this pump does not require refurbishment at this time.*	$220,641	Cancelled
41157	LIN4 Air Heater Baskets Replacement *Further evaluation has indicated replacement of the baskets with the same type as originally planned may not be the best option. NS Power is studying fouling of the air heater due to carbon injection pollution controls before new baskets can be specified, and the scope of the project confirmed.*	$173,236	Deferred

CI#	Project Title	2012 ACE Project Total	Cancelled/ Deferred
39950	TRE5 - 5-2 Cooling Water (CW) Screen Refurbishment *Due to reduced running time on Unit 5 in 2012, this project is being deferred. It is anticipated that the work will be required in 2014.*	$154,308	Deferred
38643	TRE6 - 6B Fly Ash Compressor Replacement *Further evaluation has indicated replacement of this compressor is not required at this time. Performance will continue to be monitored.*	$150,984	Deferred
41484	POT - Ash Cell Capping Cell D *Due to the extended shutdown of Point Tupper Unit 2 in 2011, and reduced load on coal-fired units, Ash cell D was not filled in 2011 as originally expected. The cell is not expected to be ready for capping until 2014.*	$143,979	Deferred
39953	TRE6 - Coal Feeder Valve Replacement *Further examination has determined that this project is not required.*	$136,516	Cancelled
41621	POA - Turbine Thrust Bearing Replacement *Further investigation has shown that the turbine thrust bearings do not require replacement.*	$136,159	Cancelled
39951	TRE5 - Coal Bunkerette Replacement *Due to reduced running time on Unit 5 in 2012 and completion of some repairs, this project is being deferred. It is anticipated that the work will be required in 2014.*	$135,329	Deferred
41568	POT - Electrostatic Precipitator Supervisory System Upgrade *Further investigation has determined that this item can be deferred until a transformer upgrade is performed in the next few years.*	$94,848	Deferred
41585	POT - Pulverizer Exhauster Lubrication Cooling System Upgrade *Testing is being completed to confirm the effectiveness of this upgrade. Until testing is finalized, execution of the project is deferred.*	$51,072	Deferred
Transmission			
41553	Dartmouth East Transformer Addition *This project is no longer required as it has been determined that the Harbour East Transmission Project will eliminate the need for this transformer.*	$2,307,615	Cancelled
41362	7H Beaufort Switchgear Retirement *This project is no longer required as the service areas' switchgear will be upgraded from 4kV to 25kV.*	$278,071	Cancelled
41395	8H Fairview Switchgear Retirement *This project is no longer required as the service areas' switchgear will be upgraded from 4kV to 25kV.*	$213,288	Cancelled
Distribution			
40219	2011 Recloser Control Replacements *Project is being cancelled as it was determined it is no longer required while substation recloser replacements are ongoing.*	$216,786	Cancelled

CI#	Project Title	2012 ACE Project Total	Cancelled/ Deferred
General Plant			
40299	Field Office Phone System Replacement *NS Power is investigating alternative methods of replacing the remote and rural telephone systems.*	$833,051	Deferred
41557	Streetlight & Area Management *Further evaluation of this project determined that the scope requires review. NS Power expects to bring a similar project forward in 2013 with a scope which includes distribution pole management. (CI 43191)*	$809,104	Cancelled
41766	Commercial AMI Pilot *Further evaluation of this project determined that the scope requires refinement. In 2013, NS Power expects to bring an AMI project forward for Board approval.*	$2,528,394	Deferred
41845	Residential AMI Pilot *Further evaluation of this project determined that the scope requires refinement. In 2013, NS Power expects to bring an AMI project forward for Board approval.*	$2,959,853	Deferred
41425	Cognos Upgrade *NS Power is in the process of developing a reporting strategy. Cognos is a tool which is integral to reporting within the business. Therefore, this project has been deferred so that the reporting strategy can be considered during implementation of this upgrade.*	$254,413	Deferred
40648	IT PeopleSoft (Human Resource Mgt) *NS Power continues to evaluate this solution.*	$633,487	Deferred
41424	IT PeopleSoft Self Service Module *NS Power continues to evaluate this solution.*	$413,859	Deferred

2 UARB ACE Plan Directives

NS Power received a number of Directives from the ACE Plan Decisions in 2011 and 2012. This information has been updated and provided below.

2011 ACE Plan Directives

Directive 7 – Approximate Impact of 2013 ACE Plan on Revenue Requirement

Per Directive 7 of the 2011 ACE Plan decision, and in accordance with Directive 12 of the 2012 ACE Plan decision, NS Power has endeavoured to improve the clarity of an estimate of the impact that the 2013 ACE Plan would have on revenue requirement over the five year time frame of 2013 - 2017.

The underlying principle in calculating the revenue requirement impact is that capital expenditures that equal NS Power's depreciation expense have no revenue requirement impact for customers. The premise is that rate base is not growing or declining if capital expenditures equal the rate of depreciation. The revenue requirement calculation below is determining the effect on rate base and the underlying effect on revenue requirement. To the extent depreciation expense equals capital expenditures in a given year, there is no effect on rate base or associated revenue requirement and therefore it is not included in the calculation. The revenue requirement impact factors the following inputs:

- Incremental capital expenditures over forecasted depreciation expense.
- Administrative overhead credit based on the prorated incremental capital to total capital expenditures.
- Depreciation expense based on a prorated incremental capital expenditures.
- Incremental Interest based on the cost of debt multiplied by the portion of debt to total capital of the incremental outstanding rate base.
- AFUDC based on a prorated calculation.
- Income taxes based on the resultant effects and prorated Capital Cost Allowance for tax purposes.

- Net earnings based on the rate of return multiplied by the portion of equity to total capital of the incremental outstanding rate base.

An important consideration is that this method does not address the revenue requirement impact should the capital projects not be completed. This includes avoided costs such as increased fuel costs, increased repair and maintenance expenses, and other risks or implications. The Economic Analysis Model used to decide whether an economically justified capital project is the best option for customers includes estimates of the avoided expenses, but these are not included in this revenue requirement calculation. Similarly, any resulting operating savings associated with a capital project is not incorporated. The revenue requirement calculation examines solely the incremental effects with rate base.

LONG-TERM CAPITAL PLANNING & REVENUE REQUIREMENT

NOVA SCOTIA POWER ($M)	**2013**	**2014**	**2015**	**2016**	**2017**
Capital Expenditures (Spend)	$336.9	$409.7	$325.2	$294.3	$237.3
Less: Depreciation of all assets	192.7	202.2	208.4	215.6	222.3
Incremental Spend over Depreciation (Growth)	144.2	207.5	116.8	78.7	15.1
Incremental Spend as a portion of Total Spend	42.8%	50.6%	35.9%	26.7%	6.4%
Annual incremental revenue requirement	($8.9)	$7.2	$20.2	$16.4	$10.2
Cumulative incremental revenue requirement	($8.9)	($1.7)	$18.5	$34.8	$45.1
Expenses					
Fuel	-	-	-	-	-
OM&G	-	-	-	-	-
Administrative Overhead	(18.2)	(21.4)	(16.0)	(11.0)	(2.3)
Depreciation	4.1	11.1	11.2	10.3	2.9
Interest	2.8	9.5	15.5	19.0	20.6
AFUDC	(3.4)	(4.3)	(1.9)	(1.1)	(0.2)
Earnings before tax	5.8	3.3	9.7	17.7	24.0
Income Tax	3.4	(4.7)	(3.5)	1.7	6.6
Net Earnings	$2.4	$8.0	$13.1	$16.1	$17.4
Average incremental NBV of projects in 5-year plan	70.0	238.3	389.3	476.3	516.6

Directive 9 – Summary of 2013 ACE Plan Capital Items Related to NERC and/or NPCC Standards

CI#	Project Title	2013 ACE Plan	Total Estimate	2013 ACE Category
43291	Protection Risk Reduction 67N-Onslow 230KV	$117,460	$2,416,341	2013 Project for Approval
43292	Protection Risk Reduction 120H-Brushy Hill 230KV	1,834,212	1,834,212	2013 Project for Approval
43293	Protection Upgrade Brushy Hill (138KV)	2,662,292	2,788,064	2013 Project for Approval
40231	2011 Protection Upgrades LAK	1,319,194	1,609,905	Carryover Project
NERC and/or NPCC Compliance Total		**$5,933,158**	**$8,648,523**	

Directive 11 – Annual Ranking/ Prioritization of Capital Projects

Overall

NS Power Capital Projects are generally ranked according to the following criteria:

- Health and Safety: Operating Permits, Personnel Safety
- Regulatory Compliance: Renewable Electricity Standards, GHG Regulations, Air, Emission Regulations, NERC/ NPCC Requirements
- Requirement to Serve
- Customer Reliability: SAIDI, SAIFI, CAIDI
- Business Sustainability (Economics): Based on Net Present Value of the Project, Levelized Cost Analysis, $/ Avoided Customer Hours of Interruption (ACHI)

Each year, the capital program includes those projects which are essential for health and safety objectives, regulatory compliance, and those which are required to provide service to an area. Projects which serve to improve customer reliability are evaluated based on factors related to performance targets (SAIDI, SAIFI, CAIDI, etc.).

Business sustainability initiatives are evaluated based on their economic ranking.

The following tables identify the projects included in the 2013 ACE Plan, their ranking category and ranking value where applicable.

Generation

Each capital project in Generation is ranked using the following criteria: Safety, Environment, Business Sustainability and Productivity/ Efficiency. The ranking process is completed first in the early stages of project development, and continues to be refined as the scope and estimated costs for the capital project are further defined. All rankings are reviewed by a centralized investment review team to ensure the projects are justified and appropriate for inclusion in the ACE Plan.

A lower ranking suggests a lower level of risk and urgency, but not always a lower level of priority. Lower ranking projects may be completed prior to higher ranking projects in certain cases. A planned outage would be one example of when a lower ranking project may be completed prior to a higher ranking project because there was an opportunity to complete the lower ranking project during the planned outage.

Hydro – 2013 ACE Plan Capital Item Rankings

CI#	Project Title	2013 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
40308	HYD - Weymouth Falls Pipeline Replacement Unit 1&2	6,583,387	New	Business Sustainability	8.00
31246	HYD - Methals Intake Replacement	6,440,236	New	Safety	9.00
20758	HYD - Nictaux Pipeline Replacement & Intake Refurbishment	4,168,556	New	Business Sustainability	7.00
43039	HYD - Weymouth Surge Tank	2,682,881	New	Business Sustainability	8.00
40283	HYD - Wrights Lake Dam Refurbishment	2,344,643	New	Safety	9.00
17581	HYD - Weymouth Electrical Replacement	1,574,754	New	Safety	9.00
41130	HYD - Avon #2 Generator Stator Rewind	1,205,366	New	Business Sustainability	8.00
41806	HYD - Big Falls - Unit #6 Refurbishment	1,010,112	New	Business Sustainability	8.00
27507	HYD - Sheet Harbour - Ruth Falls Penstock Butterfly Valve Replacements	733,528	New	Business Sustainability	7.00
43607	HYD - Malay Falls Unit Overhaul	540,892	New	Business Sustainability	8.00
42648	HYD - Harmony Fish Ladder	598,416	New	Environment	9.00
43127	HYD - 4th Lake Penstock Refurbishment	441,243	New	Safety	9.00
43136	HYD - Weymouth Headcover Replacement	438,158	New	Safety	9.00
20571	HYD - Weymouth Falls Tailrace Deck Refurbishment	371,469	New	Safety	9.00
43128	HYD - Gisborne Gearbox Replacement	360,731	New	Business Sustainability	8.00

CI#	Project Title	2013 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
43125	HYD - 4th Lake Butterfly Valve Actuator Replacement	129,250	New	Business Sustainability	6.00
20706	HYD - Security Improvements	783,213	Routine	Routine	9.00
11622	HYD - Equipment Replacement	757,372	Routine	Routine	9.00
35584	HYD - Gate Refurbishment Routine	418,391	Routine	Routine	9.00
35583	HYD - Oil Release Risk Assessment Remediation	283,580	Routine	Routine	9.00
27867	HYD - Roofing Routine	213,458	Routine	Routine	9.00
11611	HYD - Production Tools, Test Equipment	75,000	Routine	Routine	9.00

Steam – 2013 ACE Plan Capital Item Rankings

CI#	Project Title	2013 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
42806	LIN3 L-0 Blades Replacement	3,553,933	New	Business Sustainability	8.00
43088	LIN3 Rotor Rewind	2,740,665	New	Business Sustainability	7.50
41227	LIN3 Cond Large Bore Pipe and Valve Refurbishment	1,137,289	New	Business Sustainability	7.00
30162	POT - Bunker C tank refurbishment	1,079,465	New	Environment	9.00
41265	TUC - Oil Dock Piling Refurbishment	916,939	New	Safety	8.50
43170	LIN4 AVR Replacement	227,346	New	Business Sustainability	7.50
41233	LIN 3 Boiler Refurbishment	809,680	New	Business Sustainability	7.50
43094	LIN3 HT Fastener Replacement	779,269	New	Safety	8.00
43111	POA - Boiler Refractory Replacement (2013)	762,859	New	Business Sustainability	7.50
43006	TRE6 PLC Upgrades	728,309	New	Business Sustainability	7.50
42729	POT - Replace economizer inlet header	626,028	New	Business Sustainability	8.50
43053	POT - Waterwall Refurbishment 2013	623,050	New	Business Sustainability	8.00
36603	LIN3-DAS Upgrades	567,748	New	Business Sustainability	7.00
43166	LIN Mill Refurbishment	548,565	New	Business Sustainability	7.00
41303	TRE6 - Waterwall Panel Replacements	545,409	New	Business Sustainability	7.50
42982	TUC6 - Gland steam supply	537,325	New	Business Sustainability	8.00
43035	POT - South BFP Refurbishment	505,535	New	Business Sustainability	7.00
43165	LIN4 Boiler Refurbish	504,280	New	Business Sustainability	7.00
43110	POA - Structural Steel Refurbishment Program	435,868	New	Business Sustainability	8.50
37885	POT - Lubrication and Chemical Storage	407,654	New	Safety	8.00

CI#	Project Title	2013 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
41511	TRE6 - Condenser Waterbox and Cooling Water (CW) Piping Refurbishment	394,545	New	Business Sustainability	7.25
42978	TUC - CW Piping Refurbishment	387,840	New	Business Sustainability	7.25
43424	TRE5 Analytical Panel	382,109	New	Business Sustainability	8.00
43041	POT - Air Heater Steam Coils Replacement	331,766	New	Business Sustainability	8.25
43097	LIN 3,4 Replace BFP Check Valve	331,572	New	Business Sustainability	7.00
41159	LIN Reclaim Feeders Replacement	314,078	New	Business Sustainability	7.50
41664	TRE5 Precip Refurbishment	306,057	New	Environment	7.50
43008	TRE5 Turbine-Generator Fire Protection	305,402	New	Safety	9.00
43567	TUC3 - CW travelling screens refurbishment	293,903	New	Business Sustainability	7.00
42966	TUC - Additional RO for WTP (or ion exchange)	290,784	New	Business Sustainability	7.00
41516	TRE6 - Stack Breaching Inlet Ductwork Refurbishment	289,376	New	Business Sustainability	8.25
41506	TRE6 - 6B Cooling Water (CW) Pump Refurbishment	286,027	New	Business Sustainability	7.50
42943	TUC2 - T-G Areas Fire Protection	283,088	New	Safety	9.00
43056	POT - Cable spreading room fire protection	281,035	New	Safety	8.00
43169	LIN CW Screen Refurbishment	262,003	New	Business Sustainability	7.00
41226	LIN Boiler Feed Pump recirculation Piping and valve Replacement	241,853	New	Business Sustainability	7.50
43389	LIN3 Bentley Nevada Upgrade - System 1	240,956	New	Business Sustainability	7.00
43407	TRE5 Cable Rooms Fire Protection	238,743	New	Safety	8.00
43090	LIN3 Precipitator Access Door Replacement	237,878	New	Business Sustainability	7.00
42973	TUC - #1 and 2 WTP DCS upgrade	233,981	New	Business Sustainability	7.00
43051	POT - Selective superheater replacement 2013	230,452	New	Business Sustainability	7.50
43239	LIN4 BFP Proportional Recirculation Line Control	227,777	New	Business Sustainability	7.50
42964	TUC - Asbestos Abatement Program 2013	226,877	New	Safety	9.00
43207	LIN 4160 Motor Refurbishment	223,862	New	Business Sustainability	7.50
42941	TUC3 - DCS upgrade phase II	220,358	New	Business Sustainability	8.50
43052	POT - Selective Reheater Replacement 2013	216,785	New	Business Sustainability	7.50
42938	TUC - Unit 1 South BFP Refurbishment	208,236	New	Business Sustainability	7.00
43120	POA - UPS Chargers Replacement	200,922	New	Business Sustainability	8.25
41483	POT - 2013 Asbestos Abatement	198,561	New	Safety	9.00
43429	TRE5 Lube Oil Cooler Retube	183,832	New	Environment	7.00

CI#	Project Title	2013 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
42967	TUC - Replace Stack Rail Runner System	183,389	New	Safety	8.00
43100	POT - Selective ash cell capping	181,873	New	Environment	9.00
41564	POT - WTP Filter Replacement	176,410	New	Business Sustainability	8.25
42949	TRE Asbestos Abatement 2013	160,443	New	Safety	9.00
42937	TUC-LMs East Gas Compressor Overhaul	155,900	New	Business Sustainability	7.00
30163	POT - Control room and permit room upgrade	150,091	New	Safety	8.50
43666	TUC - Replace Hydrazine with DEHA	155,449	New	Environment	9.00
43114	POA - Screw Cooler Trough Replacement	155,217	New	Business Sustainability	8.50
42979	TUC - HFO Line Support Refurbishment	154,269	New	Environment	8.50
43627	LIN Hydrazine Replacement	152,845	New	Environment	9.00
42939	TUC - Unit 2 Circulating Water Pump (North) Refurbishment	148,202	New	Business Sustainability	7.25
43244	POA - Stack Lighting	147,709	New	Safety	9.00
43213	LIN3 Battery Replacement	145,302	New	Business Sustainability	7.00
43150	POA - Boiler Arrowhead Replacement	144,013	New	Business Sustainability	8.00
42962	TUC - Shoreline Lighting and Fencing	139,129	New	Safety	9.00
43409	TRE Ash Site Covering 2013	135,525	New	Environment	9.00
43032	POT - Auxiliary cooling water ACW strainer replacement	131,797	New	Business Sustainability	7.25
43054	POT - Backpass Refurbishment 2013	131,771	New	Business Sustainability	7.50
39777	TUC - Ferrous Sulphate System Upgrade	121,400	New	Business Sustainability	8.00
43626	TRE Hydrazine Replacement	120,710	New	Environment	9.00
43408	TRE 4kV Motor Refurbishments 2013	116,996	New	Business Sustainability	7.50
43386	POT - Low and Variable load optimization	113,840	New	Business Sustainability	7.00
42971	TUC1&2 - DCS Upgrade	111,547	New	Business Sustainability	8.50
43240	POA - HVAC Equipment Replacement	101,524	New	Business Sustainability	7.00
43256	POA - Acid Day Tank Replacement	98,479	New	Business Sustainability	7.50
43425	TRE5 HP Dosing Skid	95,455	New	Safety	7.50
43115	POA - 2013 Valve Refurbishment Program	94,367	New	Business Sustainability	7.50
43144	POA - Plant Access Improvements	93,222	New	Business Sustainability	8.00
37544	TRE5 - Coal MCC Transformer Replacement	92,141	New	Business Sustainability	7.50
43141	POA - "A" Circulating Water (CW) Screen Refurbishment	92,050	New	Business Sustainability	7.00
43241	POA - PLC Migration Program	91,624	New	Business Sustainability	8.00
30955	LIN Fire System Valve Upgrade	86,772	New	Safety	7.50

CI#	Project Title	2013 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
43412	TRE5 Breaker Refurbishments	86,217	New	Business Sustainability	7.25
43243	POA - Wellfield Communication	84,123	New	Business Sustainability	8.50
42965	TUC - Fire System Electrical Upgrade	82,412	New	Safety	9.00
42970	TUC - 4KV Motor Refurbishment Program 2013	80,587	New	Business Sustainability	7.50
43247	POA - Adiabatic Bomb Calorimeter Replacement	79,155	New	Business Sustainability	7.50
42972	TUC - 4160 V / 600V Breaker Replacement 2013	77,404	New	Business Sustainability	7.25
41533	TRE6 - Boiler Thermoprobe Upgrade	75,225	New	Business Sustainability	8.00
30062	POT - Resin replacement for East and West Polishers	74,817	New	Business Sustainability	7.50
30862	TRE5 - Boiler Thermoprobe Upgrade	74,744	New	Business Sustainability	8.00
43139	POA - Expansion Joint Upgrade	74,737	New	Business Sustainability	8.00
43413	TRE6 Breaker Refurbishments	73,961	New	Business Sustainability	7.25
42944	TUC3 - Boiler Drum North PSV Replacement	71,275	New	Safety	9.00
43147	POA - HP Blower Program	69,402	New	Business Sustainability	7.50
42953	TUC1- Replace closed cooling HX tube bundle	68,111	New	Business Sustainability	6.50
43245	POA - Plant Communication (PA & Radio)	66,556	New	Business Sustainability	8.00
43148	POA - 4KV Motor Refurbishment Program	64,059	New	Business Sustainability	7.50
43149	POA - 4KV / 600V Breaker Refurbishment	63,425	New	Business Sustainability	7.25
43242	POA - Plant Door Refurbishment	61,418	New	Safety	8.00
43212	LIN 4160 and 600V Breakers	52,985	New	Business Sustainability	7.25
43118	POA - Plant Heating Upgrade	50,808	New	Business Sustainability	7.50
43152	POA - Hydrazine Replacement	47,155	New	Environment	9.00
43416	TRE5 WTP Resin Replacement	45,502	New	Business Sustainability	7.50
42969	TUC - WWTP Sludge Press Refurbishment	45,095	New	Business Sustainability	7.00
30043	POT - Replace Carbon Analyzer	44,970	New	Business Sustainability	7.75
27856	TRE Roofing Routine	605,936	Routine	Routine	9.00
10621	TUC Routine Plant Spending	464,964	Routine	Routine	9.00
10626	LIN Routine Capital Program	461,196	Routine	Routine	9.00
43646	PH Biomass Routine Capital	398,265	Routine	Routine	9.00
10673	TRE Routine Capital	353,084	Routine	Routine	9.00
27855	POT Roofing Routine	319,140	Routine	Routine	9.00
10645	POT Routine Capital	276,060	Routine	Routine	9.00
27854	TUC Roofing Routine	175,470	Routine	Routine	9.00

CI#	Project Title	2013 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
27857	LIN Roofing Routine	112,760	Routine	Routine	9.00
43648	PH Biomass Tools and Equipment	104,247	Routine	Routine	9.00
33863	LIN Heat Rate Routine	103,211	Routine	Routine	9.00
33869	TRE Heat Rate Routine	85,104	Routine	Routine	9.00
33867	POT Heat Rate Routine	81,027	Routine	Routine	9.00
25646	TUC DCMS Equipment Replacement Routine	76,276	Routine	Routine	9.00
11648	LIN Plant Tools	75,000	Routine	Routine	9.00
33871	TUC Heat Rate Routine	70,574	Routine	Routine	9.00
11621	TRE Tools and Equipment	60,000	Routine	Routine	9.00
11627	POT Tools & Equipment	60,000	Routine	Routine	9.00
11589	TUC Plant Tools	58,000	Routine	Routine	9.00
25668	LIN DCMS Equipment Replacement Routine	50,000	Routine	Routine	9.00
25626	TRE DCMS Equipment Replacement Routine	41,627	Routine	Routine	9.00
25667	POT DCMS Equipment Replacement Routine	31,000	Routine	Routine	9.00

Combustion Turbine – 2013 ACE Plan Capital Item Rankings

CI#	Project Title	2013 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
43747	TUC4 - LM #4 Hot Section Overhaul	3,190,583	New	Business Sustainability	8.50
43154	Critical Spares for LM6000 Combustion Turbines	593,963	New	Business Sustainability	8.00
33142	CT- Burnside #4 Engine Restoration And Upgrade	591,370	New	Business Sustainability	8.50
43157	Tusket Fuel Control & AVR	332,606	New	Business Sustainability	7.50
43155	CTs - BGT#2 Air Intake Structure Refurbishment	316,941	New	Business Sustainability	8.00
43151	System 1 for LMs	187,063	New	Business Sustainability	7.00
43159	Burnside #1 & 2 and VJ Annunciation Units Upgrade to DAS	150,210	New	Business Sustainability	7.50
43766	CT - VJ 1&2 Annunciation Units Upgrade to DAS	144,224	New	Business Sustainability	7.50
43420	CTs - Burnside air dryer system upgrade	131,817	New	Business Sustainability	8.00
37982	CTs - BGT#3 AVR Replacement	77,403	New	Business Sustainability	7.50
43146	CTs - VJ Air Dryer System Upgrade	65,495	New	Business Sustainability	8.00
10634	CTs - Routine Spending	151,710	Routine	Routine	9.00
38899	CTs - Tooling Routine	28,000	Routine	Routine	9.00
28522	CTs - DCMS Routine	18,202	Routine	Routine	9.00

Transmission & Distribution

Customer Operations ranks capital projects according to three categories. The first is "Criteria". The Criteria category consists of Regulatory, Deteriorated Plant, System Reliability, Load Growth, Overloaded Equipment, Load Balancing and Customer Reliability. Each of these is assigned a ranking between 1.0 and 3.0.

The second is "Business Driver". The Business Driver category consists of Planning Study, Safety, Environment, Renewable Electricity Standard, Existing Issue, Pending Issue, and Regulatory Requirement. Each of these is assigned a ranking between 1.0 and 3.0.

The third is "Risk". The Risk category consists of high, medium and low. Each of these is assigned a ranking between 1.0 and 3.0. Each project is assigned a measure from each of the three categories and the sum of these rankings makes up the overall project ranking.

Each of the three categories has a top scale of 3.0 for a maximum project ranking of 9.0. All rankings are reviewed by a centralized investment review team to ensure the projects are justified and appropriate for inclusion in the ACE Plan. The lower ranking suggests a lower priority than a higher ranking.

Transmission and Distribution – 2013 ACE Plan Capital Item Rankings

CI#	Project Title	2013 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
Transmission Capital Items Included in 2013 ACE Plan					
43786	2013 L8002 Tower Refurbishments	2,129,708	New	System Reliability	8.5
43200	Pole Retreatment 2013	678,882	New	Regulatory	8.0
43204	L5503 Removal	402,387	New	System Reliability	7.0
43205	L5510 Insulator Replacements	2,953,689	New	System Reliability	6.5
43206	L6001 Overhead Ground Wire Replacement	3,342,636	New	System Reliability	9.0
43222	2013 Substation Insulator and Cut-Out Replacements	303,055	New	Customer Reliability	6.5
43226	2013 Transmission Switch & Breaker Replacements	1,969,767	New	Customer Reliability	7.0
43231	2013 Substation PCB Equipment Removal	1,496,626	New	Regulatory	9.0
43233	New Mobile Transformer 30+MVA (138-69kV -26,4-13_2kV)	2,152,435	New	System Reliability	9.0
43237	2013 Substation Recloser Replacements	1,863,378	New	Customer Reliability	7.0
43260	2013 Transmission Line Insulator Replacements	2,394,804	New	System Reliability	9.0
43261	6V-Hollow Bridge Hydro Replace 6V-GT1	435,537	New	System Reliability	7.0
43266	89S-ST2 Point Aconi Replace Station Service Transformer	681,377	New	System Reliability	6.5
43267	13V Gulch Hydro Replace 13V-GT1 and 13V-VR1	954,407	New	Overloaded Equipment	9.0
43268	9W-Tusket Replace 9W-B53 Structure	309,026	New	System Reliability	6.5
43283	Additional Transformer 4C Lochaber Road	1,575,845	New	System Reliability	8.0

CI#	Project Title	2013 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
43285	99W Bridgewater Add Capacitor Bank	1,057,741	New	System Reliability	7.0
43287	2C-Port Hastings- Retire 2C-T1 & T2 and the 69kV & 25kV Buses	266,691	New	System Reliability	8.5
43291	Protection Risk Reduction 67N-Onslow 230KV	117,460	New	Regulatory	9.0
43292	Protection Risk Reduction 120H-Brushy Hill 230KV	1,834,212	New	Regulatory	9.0
43293	Protection Upgrade Brushy Hill (138KV)	2,662,292	New	Regulatory	9.0
43323	Tuft's Cove Line Swap	266,923	New	Overloaded Equipment	8.0
43284	104H Kempt Rd Station Upgrades For Additional Transformer	1,167,277	New	Customer Reliability	6.5
43324	L6513 Rebuild/upgrade line terminals	1,610,000	New	Requirement to Serve	9.0
43427	62N-510 Breaker & Control Building Replacements	574,142	New	System Reliability	8.0
43369	New Mobile Transformer 15MVA (138-69kV -26,4-13_2kV)	1,719,218	New	System Reliability	9.0
43426	78W-Martins Brook – Relocate Substation to Opposite Side of Road	455,700	New	Deteriorated Plant	7.5
43486	89H-511 Add Battery, Battery Charging Set, RTU and Replace Breaker	421,477	New	System Reliability	8.0
43428	Remove 6S 4kV Switchgear Breakers	1,196,753	New	Load Growth	6.5
43487	Add Breaker Back-Up (BBU) Transfer Trip (TT) at 81V-Annapolis Hydro and 12V-Lequille Hydro	255,850	New	System Reliability	6.5
43490	2013 Steel Tower Painting	1,375,442	New	Deteriorated Plant	6.5
43606	L5549 Upgrade	706,359	New	System Reliability	8.0
43674	Sable Wind Project Network Upgrades	76,532	New	Requirement to Serve	9.0
43672	82V-T1 Transformer Rewind	960,432	New	System Reliability	8.0
43675	Sable Wind Project Interconnection	16,393	New	Requirement to Serve	9.0
43676	Interconnection Substation Sable Wind Project	87,809	New	Requirement to Serve	9.0
43677	Woodbine Substation Expansion	297,000	New	Requirement to Serve	9.0
43678	Strait Crossing/Separate L-8004/L-7005	108,000	New	Requirement to Serve	9.0
43679	L-7015 ROW Modifications	500,000	New	Requirement to Serve	9.0
43681	South Canoe Wind Project Substation Network Upgrades	303,615	New	Requirement to Serve	9.0
43682	South Canoe Line Upgrades(L-5535 and L-5541)	276,600	New	Requirement to Serve	9.0
43683	South Canoe Wind Project Transmission Line	63,974	New	Requirement to Serve	9.0
43684	Interconnection Substation South Canoe Wind Project	376,984	New	Requirement to Serve	9.0
43726	Replace 3N-T51 Transformer	1,297,791	New	Requirement to Serve	9.0
Distribution Capital Items Included in 2013 ACE Plan					
41346	82S-304 Whitney Pier Targeted Replacements	276,358	New	Customer Reliability	6.5
41350	16W-301 Hebron Rebuild Phase 2	501,720	New	System Reliability	7.0
41358	624V-311 Scotch Village Ph 3	422,957	New	System Reliability	7.0
43286	6S Terrace Street Conversion Phase 1	743,269	New	Load Growth	6.5
43126	13V-303 Bear River Targeted Feeder Replacements	798,977	New	Customer Reliability	6.5
43468	LED Street Light Conversion Phase 2	2,263,293	New	Regulatory	8.5
43177	103W-311 Gold River Reconductor Phase 3	306,410	New	System Reliability	7.5
43548	533S Mason Street Conversion	449,764	New	Load Growth	6.5
43188	2013 Distribution Automation	274,349	New	Customer Reliability	6.5
43189	2013 Downline Recloser Additions	380,204	New	Customer Reliability	8.0
43194	3S-303 North Sydney Targeted Replacements	308,730	New	Customer Reliability	6.5
43201	2013 Halifax Underground Feeder Replacements	770,794	New	Customer Reliability	6.5
43217	24C-442G Hwy 16 Reconductor Phase 1	548,148	New	System Reliability	6.5
43218	88W-323HA – Tusket Islands Phase 3	287,196	New	System Reliability	6.5
43219	93V-311 Saulnierville Reconductor Phase 2	418,888	New	System Reliability	7.0

CI#	Project Title	2013 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
43234	104S-313 Baddeck Re-build	593,045	New	System Reliability	8.0
43255	2013 Distribution Cutout Replacements	618,065	New	Customer Reliability	7.0
43258	2013 Build-to-Roadside	1,081,638	New	Customer Reliability	6.5
43276	2013 Distribution Reliability Technologies	328,540	New	Customer Reliability	8.0
43282	2013 Distribution Feeder Ties	389,878	New	Customer Reliability	7.0
43551	56N-401 Pictou Rebuild and Conversion	444,595	New	System Reliability	7.0
Routine Capital Items Included in 2013 ACE Plan					
14841	Protection Modifications and Replacements	598,865	Routine	Transmission	9.0
14973	Primary Equipment Spares	415,000	Routine	Transmission	9.0
23115	Provincial Transmission Line Replacements	839,657	Routine	Transmission	9.0
23118	Provincial - Planned Trans Line Replacements	5,821,899	Routine	Transmission	9.0
23120	Provincial-Trans Substation Primary Equipment Replacements	2,665,492	Routine	Transmission	9.0
23121	Provincial- Substation Additions & Modifications	1,362,787	Routine	Transmission	9.0
23135	D006 Regulatory Replacements - Provincially	1,415,763	Routine	Transmission	9.0
43281	Provincial Transmission ROW Widening	538,610	Routine	Transmission	9.0
23136	D007 Contractual Replacements (Joint Use) - Provincial	880,122	Routine	Distribution	9.0
23137	D055 - Planned Replacement Of Distribution Assets	8,206,749	Routine	Distribution	9.0
23158	D005 Unplanned Replace Deteriorated Plant	9,514,851	Routine	Distribution	9.0
23361	D008 Provincial Storm	2,504,578	Routine	Distribution	9.0
23511	Primary Equipment Spares - Distribution Plant	150,000	Routine	Distribution	9.0
26496	Meter Routine	2,578,179	Routine	Distribution	9.0
26716	New Customer Upgrades	7,187,286	Routine	Distribution	9.0
29038	System Performance Improvement Routine	440,176	Routine	Distribution	9.0
39766	New Customers - Residential	11,005,924	Routine	Distribution	9.0
39770	New Customers - Commercial	5,805,247	Routine	Distribution	9.0
23127	Provincial Distribution ROW Widening	2,539,685	Routine	Distribution	9.0

General Plant – Capital Item Rankings

The projects which are brought forward under General Plant primarily involve information technology, communications and facilities initiatives. These areas are too diverse to develop a comparable and useful ranking system across the groups, and therefore the determination of whether a project will proceed is based upon lifecycle or economic benefit.

Directive 12 - 2013 to 2015 Forecasted ACE Plan Expenditures by Functional Class and Spending Program

The Company does not anticipate a significant change in the investment level under $250,000, or the Routine program in 2014 and 2015. Justifications for projects determined as capital investments are scoped on an annual basis. Capital investment on the basis of health and safety, environmental compliance and requirement to serve remains non-discretionary. The table below identifies anticipated sustaining capital by function and specific strategic investments included in this ACE Plan. Investment levels from 2014-2017 are subject to change based on operating conditions, informed asset assessments and legislation.

Sustaining capital funding levels represent typical annual investment by function in a given year to sustain the integrity of existing assets. Strategic capital projections reflect specific multi-year program investments and asset growth.

(Millions of Dollars)

	2013 ACE	2014	2015	Project Totals
Sustaining Capital Investments				
Thermal Generation	$52.7	$42.5	$43.3	
Hydro Generation	18.9	19.9	20.2	
Wind Generation	0.1	0.1	0.1	
Transmission	24.6	22.8	23.2	
Distribution	55.3	58.5	59.7	
General Property	24.1	23.8	24.2	
Strategic Capital Investments				
General Plant:				
IT - Field Mobility System	1.4			1.7
Dist. Pole and Streetlight Data Mgt	6.7			6.7
OMS Upgrade	3.5			3.7
Main Comupter Centre Upgrade	6.8			8.3
Replace Mobile Radio System	2.5	17.5		20.0
AMI Investment	5.8	4.9	5.0	25.5
CEF Load Control Project	1.2	0.2		4.1
Power Production Asset & Work Management	0.5			5.8
Harbour East Land Purchase	1.6			2.5
5 Year Reliability Investment General Plant	1.5			1.5
Distribution:				
5 Year Reliability Investment Distribution	9.4	9.1	5.0	23.5
LED Lighting Replacement	8.4	7.6	8.8	56.3
Harbour East New Feeders	0.2			0.2
Transmission:				
5 Year Reliability Investment Transmission	7.3	5.7	5.0	18.0
NSPI Network Upgrades	2.5	21.5	30.6	73.7
Transmission Reliability	16.1	10.0	5.0	31.1
Transmission Reinforcement	15.9	15.0	15.0	45.9
Harbour East 138kV Transmission	11.8			11.8
Wind:				
South Canoe and Sable Wind Farms *(Includes Interconnection Projects)*	31.2	109.4		144.5

	2013 ACE	2014	2015	Project Totals
Hydro:				
Hydro Infrastructural Renewal		15.0	20.0	35.0
Weymouth System	11.7			11.7
Nictaux System	4.5			4.5
Gaspereau Dam Safety	5.3			5.3
Steam and Gas Power Production:				
Burnside	0.6	6.4		7.0
Fast Acting Generation #1		20.0	40.0	60.0
Fast Acting Generation #2			20.0	60.0
Port Hawkesbury 60 MW Biomass Project	4.8			208.0
Total Annual Capital Investment	**$336.9**	**$409.7**	**$325.2**	

2012 ACE Plan Directives

Directive 3: A redefinition of capital expenditures that would reduce the current difference between what is capitalized for regulatory purposes and tax purposes.

> The Board directs NSPI to propose a redefinition of capital expenditures that would reduce the current difference between what is capitalized for regulatory purposes and tax purposes. In addition, NSPI is to estimate the total of the 2013 capital budget that would be considered as maintenance under the proposed definition, and calculate the potential effect on present and future rates. The Utility is directed to submit this information as part of the 2013 ACE Plan.[2]

There are differences in what NS Power capitalizes for regulatory accounting purposes and tax purposes based on the fact these are two different environments. Accounting standards are based on Generally Accepted Accounting Principles (GAAP). There are specific guidelines regarding the capitalization of costs that are further defined in NS Power's Accounting Policies and Procedures. Tax standards are generally defined by the Canadian Revenue Agency (CRA) and specifically guided by case law. Accounting standards are based on matching the useful life of an asset with rate recovery from customers. The application of tax is based on maximizing benefits for customers based on appropriate accelerated tax deductions. A cost that has a useful life beyond one year is capitalized for accounting purposes and depreciated over its useful life, but for tax purposes may be deducted as an expense based on specific case

[2] NS Power 2012 Annual Capital Expenditure Plan, UARB Decision, NSUARB-NSPI-P-128.12, May 4, 2012, paragraph 97.

law that supports this position. NS Power utilizes this position to benefit customers in minimizing rate impacts.

There are further differences between accounting and tax in depreciation rates applied to capital. For example, the tax depreciation of generation assets for tax purposes are generally at a rate of 8 percent relative to an average depreciation rate for accounting purposes of 3 percent. These differences arise because there are fundamental differences in underlying principles. Tax depreciation rates are established by the Federal Government and are motivated to stimulate investment while balancing a reasonable rate of tax depreciation based on useful lives. Accounting depreciation rates are based on useful life and for regulated purposes involve extensive consultation and expert advice to determine useful service life. These differences are further magnified by the recent investments with renewable energy. A typical wind farm will be depreciated for tax purposes over three years, where for accounting purposes it depreciated over 25 years. It would seem misdirected to recover a wind farm asset from customers over three years if tax principles were aligned with accounting guidelines. NS Power's investment in wind farms has kept electricity rates lower than otherwise would have been.

A redefinition of capital expenditures to remove the accelerated tax treatment would increase the revenue requirement in 2013 by $38 million as customers would receive the tax benefits over the tax depreciation period rather than the current year. This would result in a higher revenue requirement in the early years. NS Power does not recommend this redefinition as it is advantageous for customers to receive the benefits of accelerated tax deductions. A redefinition would require a fundamental change in NS Power's Accounting Policies and Procedures. There would further be a dramatic difference with accounting depreciation that would misalign the cost recovery with the customer benefit. Alternatively, a change in tax practices to align with accounting would forgo for customers the current benefit of accelerated tax deductions. Any redefinition would be required to be implemented during a general rate application given the rate impacts and cost recovery differences.

NS Power sought out opportunities to minimize current taxes to the benefit of customers. The resultant effect of expensing certain costs for tax purposes in a current period while capitalizing the same costs for accounting purposes derives a benefit for customers in the current period. The deduction for tax purposes presents a lower revenue requirement in the current period. The effects are simply timing related. Had the expense been capitalized for tax purposes it would be depreciated over time based on the applicable tax capital cost allowance rate. However, the net present value for customers is better based on the tax expense treatment of certain costs for tax purposes as the tax benefit is realized earlier in the life of the investment.

Directive 5: A Review of the Accounting Treatment for Large Inventory Items.

NS Power purchases spare parts to be available, on short notice, when needed. These are referred to as capital spares. Larger items that meet UARB approved materiality thresholds are capitalized.

The spare parts are capitalized and depreciated with the main capital item. The practice below provides NS Power's Accounting Practice for spare parts which documents the procedures and application of spare parts inventory. As part of the 2013 ACE Plan submission, NS Power is seeking UARB acceptance of this accounting practice.

NS Power Capital Spares – Accounting Practice

Background

As part of the operation of the utility, critical spare parts are required to be on hand to ensure the safe, effective and reliable provision of service to customers. The use of spares is applicable to areas of the business which have a discrete asset system with finite life assumptions that are established as part of a formal depreciation study.

Definition

Capital assets include identifiable assets such as property, plant and equipment or intangible assets that are held for use in the production or supply of goods and services. They are intended for use on a continuing basis and are not intended for sale in the ordinary course of business.

A critical capital spare must meet each of the following three guidelines:

1. The part or component must be intended for use or utilization for periods greater than one year;

2. The part or component meets the materiality threshold. This may include multiple parts that form one critical component. The materiality policy must be considered in the capital versus operating decision, since there are administrative costs associated with capitalizing and carrying an asset in the accounting records. Please refer to NSPI's Accounting Policy & Procedures Manual Section 1560A for the current materiality guidelines with respect to capitalization; and
3. The part or component is critical to the safe, reliable and effective operation of the system and is required to mitigate an assessed risk of asset failure.

Practice

If a spare part or component meets the definition of a critical capital spare above, the cost of the spare part is capitalized as part of the capital project to which it relates, and depreciated with the asset. If the criteria are not met, the cost is recorded as an operating expense.

The spare part is recorded in the inventory system to allow for proper tracking of the spare through the course of its life. The preference will be to purchase critical capital spare parts upon the original provisioning of the asset. However, if circumstances or situations change and the risk to the business is substantial enough, procuring critical capital spares after original provisioning will be permissible. This requirement will be evaluated as part of the standard capital review process.

The cost of refurbishing or replacing the spare part with similar parts that only maintain the current asset will be expensed to operating as maintenance costs in the year the refurbishment or replacement occurs. Critical capital spares that are no longer required are retired from the asset system in accordance with NSPI's Accounting Policy & Procedures Manual Section 6420 on the retirement and disposal of capital assets.

3 Generation

(Millions of Dollars)

F = Forecast, B=Budget in above figure

3.1 Generation – Five Year Plan and Highlights

The focus for Generation capital investments in 2013 is renewable generation expansion, hydro infrastructure renewal and sustaining the current asset base. The Generation capital investment plan for 2013 is comprised of the following:

i	New 2013 capital spending for projects with total estimated project spend greater than $250,000 and for which approval is sought. (As provided in Section 3.3)	$44.3
ii	2012 Subsequent Approval Projects to be filed by Q4 2012. (As provided in Section 1.6)	3.4
iii	New 2013 capital spending for projects with total estimated project spend greater than $250,000 for subsequent approval. (As provided in Section 1.7)	42.1
iv	New capital spending for projects with total estimated spend less than $250,000 for which approval is not sought. (As provided in Section 1.8)	8.1
v	Point Aconi Generating Station Capital Spending.[3] (As provided in Section 1.9)	4.1
vi	Carry-over capital spending. (As provided in Section 3.2)	21.0
vii	Routine capital spending. (As provided in Section 7)	5.6
	Total 2013 Generation Capital Investment Plan	**$128.6 M**
	Request for ACE Approval (Items i + vii)	**$49.8M**

[3] There are 2 Point Aconi routine projects that are included under General Plant.

3.2 Generation – Carry-over Capital Spending Summary

Project Number	CI#	Project Title	Start Date	Final Date	Previous Expenditure	2013 Budget	Subsequent Spending	Total Estimate
Hydro Generation Plant								
H517	16374	HYD Gaspereau Dam Safety Remedial Works	2007/04	2013/12	$4,892,995	$5,341,918	$0	$10,234,914
H638	23125	HYD - Sissiboo Falls - Electrical Equipment Replacement	2011/12	2013/09	115,618	771,826	0	887,444
H579	39042	HYD - Sheet Harbour - Ten Mile Lake Dam Decommissioning	2009/12	2013/10	230,478	693,628	0	924,105
H653	41145**	HYD - Mersey - Upper Lake Falls Rip Rap Replacement	2012/05	2013/08	63,973	541,130	0	605,103
H624	41126	HYD Annapolis - Sluiceway and Powerhouse Stop Log Refurbishment	2011/08	2013/05	591,841	500,234	0	1,092,075
H629	12079	HYD - SHH - RUF 1&2 Runner Replacement	2011/10	2013/04	376,794	481,711	0	858,505
	41127	HYD - Nictaux - Headcover Replacement	2012/08	2013/10	8,095	368,135	0	376,231
	41138	HYD-Hollow Bridge Surge Tank	2012/04	2013/08	500,766	186,384	0	687,150
H665	43193	HYD - Malay Falls Rubber Dam Repairs U&U	2012/09	2013/11	0	123,726	0	123,726
H648	42709	HYD - U&U PLC Upgrades	2012/04	2013/10	28,067	114,129	0	142,196
	Total Hydro Generation Plant				**$6,808,627**	**$9,122,821**	**$0**	**$15,931,448**
Steam Generation Plant								
S661	39029	Port Hawkesbury Biomass Project	2010/11	2013/11	$203,956,505	$4,844,655	$0	$208,801,159
S613	30954	LIN3-ESP Gas Flow Modification	2010/06	2013/12	201,494	1,423,807	0	1,625,301
S901	35083	LIN 2011 Ash Site Sealing and Capping	2011/11	2013/09	155,140	852,531	0	1,007,671
S925	37611	LIN3 - Generator Excitation & AVR System Replacement	2012/02	2013/08	39,394	779,421	0	818,814
S931	28674	TRE6 - Human Machine Interface (HMI) Upgrade	2012/03	2013/09	206,870	701,162	0	908,031
SA70	41441	TRE - Siding Replacement	2012/06	2013/11	7,850	588,749	0	596,599
	40363	LIN3 High Voltage Bushing Refurbishment	2012/09	2013/06	86,727	483,805	0	570,533
SA14	41507	TRE6 - Air Heater Refurbishment	2012/07	2013/08	206,435	357,496	0	563,931
S920	41503	TRE6 - Steam Turbine Control Valve Refurbishment	2012/07	2013/08	69,528	300,217	0	369,745
S821	39952	TRE6 - Coal Bunkerette Replacement	2011/07	2013/09	2,793	140,209	0	143,003
S782	40334	POT - Refurbish Underground Valves & Hydrants	2011/04	2013/10	2,797	108,528	0	111,325
S795	28645	TRE6 - Turbine Controls Power Supplies Replacement	2012/03	2013/08	222,097	104,636	0	326,733
	41121	LIN - Cooling Water (CW) Pump Refurbishment	2012/09	2013/04	283,469	85,828	0	369,297
SA05	41525*	TRE5 - 5-1 Pulverizer Refurbishment	2012/03	2013/07	73,474	75,632	0	149,107
SA18	39923	TUC2 - Generator Excitation and AVR System Replacement	2012/04	2013/08	683,810	66,246	0	750,057
SA86	41584	POT Vacuum Pump Replacement	2012/05	2013/12	166,972	55,375	0	222,348
	39982	TRE - Gauge Replacements	2012/06	2013/09	26,521	48,715	0	75,236
	41250	TUC2- South Boiler Feed Pump (BFP) Refurbishment	2012/07	2013/04	107,947	47,232	0	155,179
	41591	POT - Induced Draft (ID) Fan Bearings Cooling System Upgrade	2013/03	2014/08	0	31,939	0	31,939
SA93	41278	TUC2- Condensate Extraction Pump Refurbishment	2012/08	2013/03	75,321	27,917	0	103,237
SA91	41245	TUC2 - Cooling Water (CW) Pump Refurbishment	2012/07	2013/04	120,146	20,777	0	140,923
	43089	POT – U&U Safety Eyewash and Shower Refurbishment	2012/09	2013/12	249,493	16,382	0	265,875
SA85	41260	TUC2- H2 Dryer Replacement	2012/06	2013/02	125,535	9,870	0	135,404
S907	41946	TUC2 U&U CW Screens Refurbishment	2011/11	2013/03	296,658	9,436	0	306,094
S842	26472	TRE - 6A Cooling Water Pump Refurbishment	2011/12	2013/03	226,364	-60,000	0	166,364
	Total Steam Generation Plant				**$207,593,341**	**$11,120,564**	**$0**	**$218,713,905**

Project Number	CI#	Project Title	Start Date	Final Date	Previous Expenditure	2013 Budget	Subsequent Spending	Total Estimate
Gas Turbine Generation Plant								
G157	42907	CT- U&U Burnside Free Turbine Overhaul	2012/05	2013/03	$1,686,329	$771,424	$0	$2,457,753
		Total Gas Turbine Generation Plant			**$1,686,329**	**$771,424**	**$0**	**$2,457,753**
Total Generation Carry Over Spending					**$216,088,297**	**$21,014,809**	**$0**	**$237,103,106**

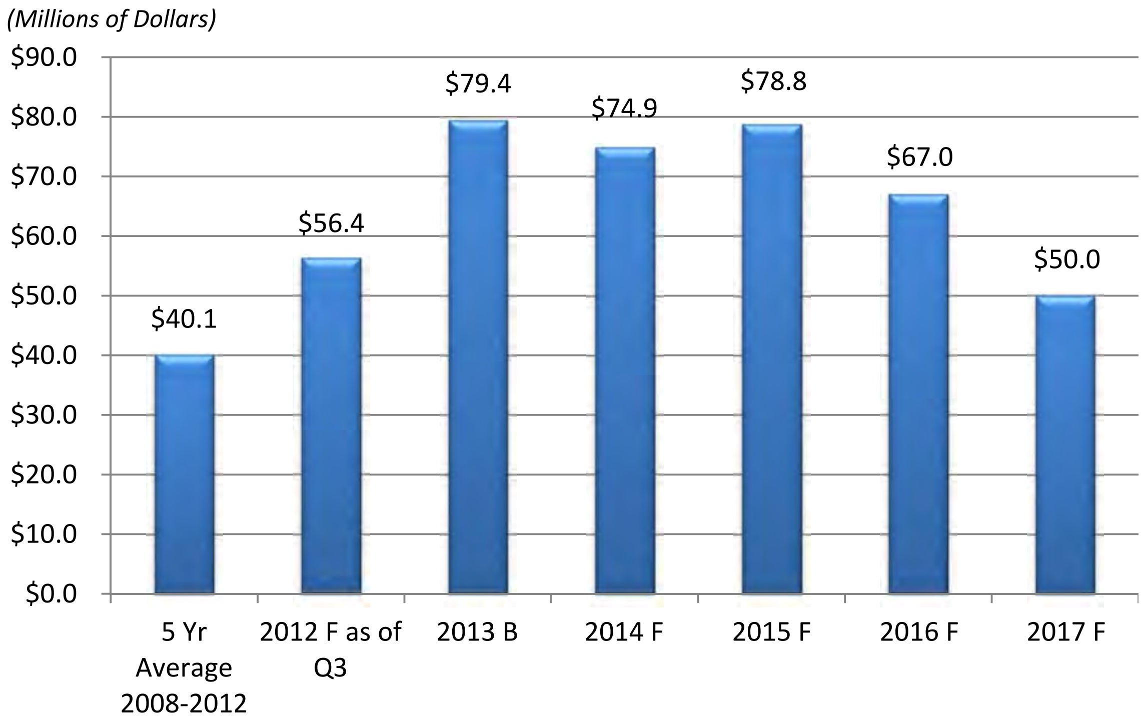
*CI 41525 was incorrectly listed as deferred in the 2012 Q1 Quarterly filing. The project had already been activated in Q1 2012.
**CI 41145 was incorrectly listed as deferred in the 2012 Q2 Quarterly filing. While construction will take place in 2013, Engineering work has been initiated in Q2 2012.

3.3 Generation – New 2013 Capital Items for ACE Approval

Tab #	CI#	Project Title	2013 Budget	Project Total
		Hydro Generation Plant		
		Weymouth System		
G01	40308	HYD - Weymouth Falls Pipeline Replacement Unit 1&2	$6,583,387	$6,752,759
G02	43039	HYD - Weymouth Surge Tank	2,682,881	2,738,175
G03	17581	HYD - Weymouth Electrical Replacement	1,574,754	1,641,359
G04	43136	HYD - Weymouth Headcover Replacement	438,158	438,158
G05	20571	HYD - Weymouth Falls Tailrace Deck Refurbishment	371,469	371,469
		Other Hydro Projects		
G06	31246	HYD Methals Intake Replacement	6,440,236	6,622,092
G07	20758	HYD - Nictaux Pipeline Replacement & Intake Refurbishment	4,168,556	4,379,301
G08	41806	HYD - Big Falls - Unit #6 Refurbishment	1,010,112	1,010,112
G09	27507	HYD - Sheet Harbour - Ruth Falls Penstock Butterfly Valve Replacements	733,528	733,528
G10	43127	HYD - 4th Lake Penstock Refurbishment	441,243	441,243
G11	43128	HYD - Gisborne Gearbox Replacement	360,731	360,731
		Total Hydro Generation Plant	**$24,805,055**	**$25,488,927**
		Steam Generation Plant		
G12	42806	LIN3 L-0 Blades Replacement	$3,553,933	$3,825,904
G13	43088	LIN3 Rotor Rewind	2,740,665	2,740,665
G14	41227	LIN3 Cond Large Bore Pipe and Valve Refurbishment	1,137,289	1,137,289
G15	41265	TUC - Oil Dock Piling Refurbishment	916,939	945,025
G16	41233	LIN 3 Boiler Refurbishment	809,680	809,680
G17	43094	LIN3 HT Fastener Replacement	779,269	779,269
G18	43006	TRE6 PLC Upgrades	728,309	728,309
G19	42729	POT - Replace economizer inlet header	626,028	626,028
G20	43053	POT - Waterwall Refurbishment 2013	623,050	623,050
G21	36603	LIN3-DAS Upgrades	567,748	567,748
G22	43166	LIN Mill Refurbishment	548,565	548,565
G23	41303	TRE6 - Waterwall Panel Replacements	545,409	545,409
G24	41511	TRE6 - Condenser Waterbox and Cooling Water (CW) Piping Refurbishment	394,545	394,545
G25	42978	TUC - CW Piping Refurbishment	387,840	387,840
G26	43424	TRE5 Analytical Panel	382,109	382,109
G27	43041	POT - Air Heater Steam Coils Replacement	331,766	331,766
G28	43097	LIN 3,4 Replace BFP Check Valve	331,572	331,572
G29	41159	LIN Reclaim Feeders Replacement	314,078	314,078
G30	41664	TRE5 Precip Refurbishment	306,057	306,057
G31	43008	TRE5 Turbine-Generator Fire Protection	305,402	305,402
G32	43567	TUC3 - CW travelling screens refurbishment	293,903	293,903
G33	41516	TRE6 - Stack Breaching Inlet Ductwork Refurbishment	289,376	289,376
G34	41506	TRE6 - 6B Cooling Water (CW) Pump Refurbishment	286,027	286,027
G35	42943	TUC2 - T-G Areas Fire Protection	283,088	283,088
G36	43056	POT - Cable spreading room fire protection	281,035	281,035
G37	38108	POT - AVR Refurbishment	266,205	266,276
G38	43169	LIN CW Screen Refurbishment	262,003	262,003
G39	43170	LIN4 AVR Replacement	227,346	874,245
		Total Steam Generation Plant	**$18,519,236**	**$19,466,264**

Tab #	CI#	Project Title	2013 Budget	Project Total
	Gas Turbine Generation Plant			
G40	43154	Critical Spares for LM6000 Combustion Turbines	$593,963	$593,963
G41	43157	Tusket Fuel Control & AVR	$332,606	$332,606
		Total Gas Turbine Generation Plant	**$926,569**	**$926,569**
	Total Generation New Spending		**$44,250,861**	**$45,881,760**

4 Transmission



F = Forecast, B=Budget in above figure

4.1 Transmission – Five-year Plan and Highlights

The focus for Transmission capital investments in 2013 continues to reflect localized customer load growth, customer and system reliability. The $79.4 million Transmission capital investment plan for 2013 is comprised of the following:

i	New 2013 capital spending for projects with total estimated project spend greater than $250,000 and for which approval is sought. (As provided in Section 4.3)	$30.3
ii	2012 Subsequent Approval Projects to be filed by Q4 2012. (As provided in Section 1.6)	11.8
iii	New 2013 capital spending for projects with total estimated project spend greater than $250,000 for subsequent approval. (As provided in Section 1.7)	13.4
iv	New capital spending for projects with total estimated spend less than $250,000 for which approval is not sought. (As provided in Section 1.8)	0.2
v	Carry-over capital spending. (As provided in Section 4.2)	11.6
vi	Routine capital spending. (As provided in Section 7)	12.2
	Total 2013 Transmission Capital Investment Plan	**$79.4M**
	Request for ACE Approval (Items i + vi)	**$42.5M**

4.2 Transmission – Carry-over Capital Spending Summary

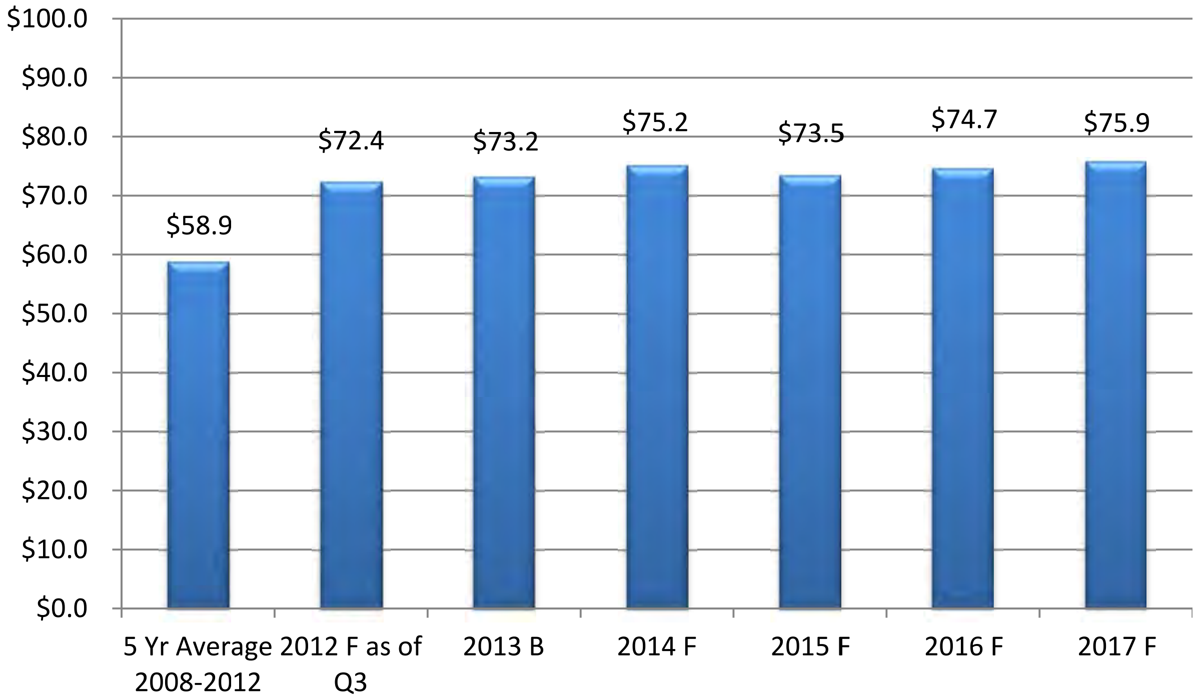
Project Number	CI#	Project Title	Start Date	Final Date	Previous Expenditure	2013 Budget	Subsequent Spending	Total Estimate
Transmission Plant								
T639	33624	Spare Generator Transformer	2010/06	2013/10	$31,733	$3,353,021	$0	$3,384,754
T703	40317	Additional Water Street Transformer & Low Side 25 kV Breakers	2011/06	2013/09	2,005,480	1,911,774	0	3,917,254
T713	41432	L7009 Lidar Upgrades & Maintenance	2012/03	2013/12	1,884,303	1,722,617	0	3,606,919
T688	40231	2011 Protection Upgrades LAK	2011/07	2013/06	290,711	1,319,194	0	1,609,905
T737	41434	Purchase New 42 MVA Spare Transformer	2012/06	2013/06	238	841,903	0	842,141
T738	41555	Spare Wind Farm Generator Transformer	2012/06	2013/06	3,952	815,903	0	819,855
T739	41437	10H-T62 Kempt Road Transformer Rewind	2012/06	2013/03	436,764	447,613	0	884,377
	41438	85S Cable Termination Replacement - Wreck Cove	2012/06	2013/04	46,276	281,095	0	327,372
T699	41536	2012 Reliability Technologies Transmission	2011/08	2013/06	163,836	277,641	0	441,477
T744	41390	7V Methals Hydro Transformer Replacement	2012/06	2013/04	467	235,742	0	236,209
T712	41439	Mobile Refurbishments 5P & 6P	2012/02	2013/05	231,230	165,264	0	396,493
	40310	15N Willow Lane Circuit Switcher Additions	2012/07	2013/03	266,052	100,811	0	366,862
	41551	Glentosh Substation Footing Remediation	2012/04	2013/03	420,404	78,189	0	498,593
T732	41592	88W New Recloser and Relocate 88W-322	2012/04	2013/03	91,696	34,925	0	126,620
	Total Transmission Plant				**$5,873,140**	**$11,585,691**	**$0**	**$17,458,831**
Total Transmission Carry Over Spending					**$5,873,140**	**$11,585,691**	**$0**	**$17,458,831**

4.3 Transmission – New 2013 Capital items for ACE Approval

Tab #	CI#	Project Title	2013 Budget	Project Total
	Transmission Plant			
T01	43205	L5510 Insulator Replacements	$2,953,689	$2,953,689
T02	43293	Protection Upgrade Brushy Hill (138KV)	2,662,292	2,788,064
T03	43260	2013 Transmission Line Insulator Replacements	2,394,804	2,472,103
T04	43233	New Mobile Transformer 30+MVA (138-69kV -26,4-13_2kV)	2,152,435	2,152,435
T05	43226	2013 Transmission Switch & Breaker Replacements	1,969,767	1,969,767
T06	43237	2013 Substation Recloser Replacements	1,863,378	1,863,378
T07	43292	Protection Risk Reduction 120H-Brushy Hill 230KV	1,834,212	1,834,212
T08	43369	New Mobile Transformer 15MVA (138-69kV -26,4-13_2kV)	1,719,218	1,719,218
T09	43283	Additional Transformer 4C Lochaber Road	1,575,845	1,625,274
T10	43231	2013 Substation PCB Equipment Removal	1,496,626	1,496,626
T11	43490	2013 Steel Tower Painting	1,375,442	1,375,442
T12	43285	99W Bridgewater Add Capacitor Bank	1,057,741	1,097,853
T13	43672	82V-T1 Transformer Rewind	960,432	960,432
T14	43267	13V Gulch Hydro Replace 13V-GT1 and 13V-VR1	954,407	954,407
T15	43606	L5549 Upgrade	706,359	706,359
T16	43266	89S-ST2 Point Aconi Replace Station Service Transformer	681,377	681,377
T17	43200	Pole Retreatment 2013	678,882	678,882
T18	43426	78W-Martins Brook – Relocate Substation to Opposite Side of Road	455,700	455,700
T19	43261	6V-Hollow Bridge Hydro Replace 6V-GT1	435,537	435,537
T20	43486	89H-511 Add Battery, Battery Charging Set, RTU and Replace Breaker	421,477	421,477
T21	43204	L5503 Removal	402,387	402,387
T22	43268	9W-Tusket Replace 9W-B53 Structure	309,026	309,026
T23	43222	2013 Substation Insulator and Cut-Out Replacements	303,055	303,055
T24	43323	Tuft's Cove Line Swap	266,923	266,923
T25	43287	2C-Port Hastings- Retire 2C-T1 & T2 and the 69kV & 25kV Buses	266,691	266,691
T26	43487	Add Breaker Back-Up (BBU) Transfer Trip (TT) at 81V-Annapolis Hydro and 12V-Lequille Hydro	255,850	255,850
T27	43291	Protection Risk Reduction 67N-Onslow 230KV	117,460	2,416,341
		Total Transmission Plant	**$30,271,011**	**$32,862,504**
	Total Transmission New Spending		**$30,271,011**	**$32,862,504**

5 Distribution

(Millions of Dollars)



F = Forecast, B=Budget in above figure

5.1 Distribution – Five-year Plan and Highlights

The focus for Distribution capital investments in 2013 continues to reflect localized customer load growth and customer reliability. The $73.2 million Distribution capital investment plan for 2013 is comprised of the following:

i	New 2013 capital spending for projects with total estimated project spend greater than $250,000 and for which approval is sought. (As provided in Section 5.3)	$8.8
ii	2012 Subsequent Approval Projects to be filed by Q4 2012. (As provided in Section 1.6)	6.9
iii	New 2013 capital spending for projects with total estimated project spend greater than $250,000 for subsequent approval. (As provided in Section 1.7)	3.5
iv	New capital spending for projects with total estimated spend less than $250,000 for which approval is not sought. (As provided in Section 1.8)	0.9
v	Carry-over capital spending. (As provided in Section 5.2)	0.9
vi	Routine capital spending. (As provided in Section 7)	52.2
	Total 2013 Distribution Capital Investment Plan	**$73.2M**
	Request for ACE Approval (Items i + vi)	**$61.0M**

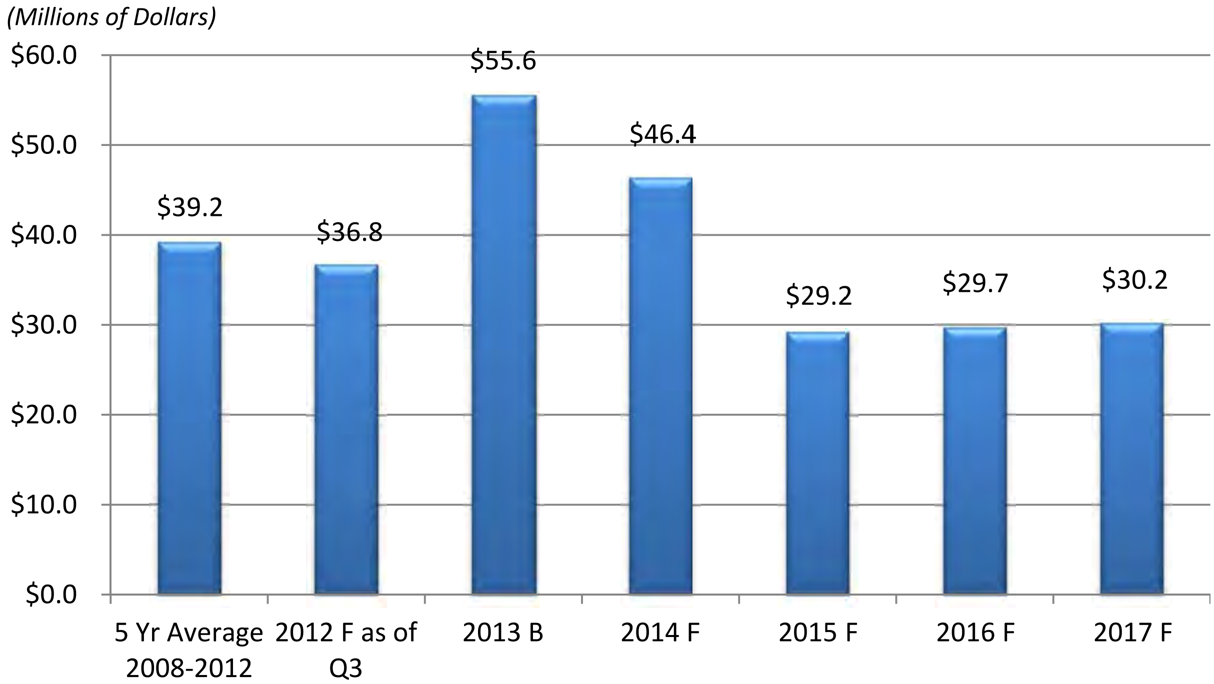
5.2 Distribution – Carry-over Capital Spending Summary

Project Number	CI#	Project Title	Start Date	Final Date	Previous Expenditure	2013 Budget	Subsequent Spending	Total Estimate
Distribution Plant								
D442	41349	2012 Off Road To Roadside	2012/06	2013/05	$1,458,062	$478,016	$0	$1,936,077
D388	41672	Morris St/Water St Underground U&U	2011/09	2013/03	474,062	254,358	0	728,420
D423	41540	99V Highbury Rd New Feeders	2012/06	2013/02	969,342	138,889	0	1,108,231
D435	41355	2012 Remote Communication on Reclosers	2012/04	2013/05	181,243	76,798	0	258,041
	Total Distribution Plant				**$3,082,709**	**$948,060**	**$0**	**$4,030,769**
Total Distribution Carry Over Spending					**$3,082,709**	**$948,060**	**$0**	**$4,030,769**

5.3 Distribution – New 2013 Capital Items for ACE Approval

Tab #	CI#	Project Title	2013 Budget	Project Total
	Distribution Plant			
D01	43258	2013 Build-to-Roadside	$1,081,638	$1,081,638
D02	43126	13V-303 Bear River Targeted Feeder Replacements	798,977	798,977
D03	43201	2013 Halifax Underground Feeder Replacements	770,794	770,794
D04	43255	2013 Distribution Cutout Replacements	618,065	618,065
D05	43234	104S-313 Baddeck Re-build	593,045	593,045
D06	43217	24C-442G Hwy 16 Reconductor Phase 1	548,148	548,148
D07	41350	16W-301 Hebron Rebuild Phase 2	501,702	501,702
D08	43551	56N-401 Pictou Rebuild and Conversion	444,595	444,595
D09	41358	624V-311 Scotch Village Ph 3	422,957	422,957
D10	43219	93V-311 Saulnierville Reconductor Phase 2	418,888	418,888
D11	43282	2013 Distribution Feeder Ties	389,878	389,878
D12	43189	2013 Downline Recloser Additions	380,204	380,204
D13	43276	2013 Distribution Reliability Technologies	328,540	328,540
D14	43194	3S-303 North Sydney Targeted Replacements	308,730	308,730
D15	43177	103W-311 Gold River Reconductor Phase 3	306,410	306,410
D16	43218	88W-323HA – Tusket Islands Phase 3	287,196	287,196
D17	41346	82S-304 Whitney Pier Targeted Replacements	276,358	276,358
D18	43188	2013 Distribution Automation	274,349	274,349
		Total Distribution Plant	**$8,750,493**	**$8,750,493**
	Total Distribution New Spending		**$8,750,493**	**$8,750,493**

6 General Plant



F = Forecast, B=Budget in above figure

6.1 General Plant – Five-year Plan and Highlights

General Plant capital investment in 2013 focuses largely on Information Technology related projects and vehicle purchases.

i	New 2013 capital spending for projects with total estimated project spend greater than $250,000 and for which approval is sought. (As provided in Section 6.3)	$2.2
ii	2012 Subsequent Approval Projects to be filed by Q4 2012. (As provided in Section 1.6)	5.1
iii	New 2013 capital spending for projects with total estimated project spend greater than $250,000 for subsequent approval. (As provided in Section 1.7)	16.8
iv	New capital spending for projects with total estimated spend less than $250,000 for which approval is not sought. (As provided in Section 1.8)	1.1
v	Point Aconi Generating Station Capital Spending. (As provided in Section 1.9)	0.1
vi	Carry-over capital spending. (As provided in Section 6.2)	12.5
vii	Routine capital Spending. (As provided in Section 7)	17.8
	Total 2013 General Plant Capital Investment Plan	**$55.6M**
	Request for ACE Approval (Items i + vii)	**$20.0 M**

6.2 General Plant – Carry-over Capital Spending Summary

Project Number	CI#	Project Title	Start Date	Final Date	Previous Expenditure	2013 Budget	Subsequent Spending	Total Estimate
Telecommunications								
P894	41419	2012 Replace Microwave Radio System	2012/02	2013/06	$470,174	$149,609	$0	$619,782
P888	41420	Upgrade Multiplexer Network Manager	2012/03	2013/04	122,213	105,559	0	227,771
P885	41404	Multiplexer Group Replacement	2012/03	2013/01	53,373	89,966	0	143,339
P893	41421	Telecom 48VDC Battery&Charger Repl.	2012/02	2013/03	68,944	50,551	0	119,495
P850	40261	Newtonville Radio Sys. Replacement	2011/02	2013/02	307,099	17,809	0	324,908
P844	40251	Mersey Radio System Replacement	2011/02	2013/01	153,626	5,739	0	159,365
	Total Telecommunications				**$1,175,429**	**$419,232**	**$0**	**$1,594,661**
Computers								
P856	40314	Main Computer Centre Upgrade	2011/05	2013/09	$1,471,868	$6,833,445	$0	$8,305,313
P845	40743	IT - NSPI Intranet	2011/03	2013/03	551,605	186,406	0	738,012
P884	40365	IT - MS Sharepoint Platform Upgrade	2012/01	2013/04	663,138	139,763	0	802,901
	41403	GIS Enterprise License Agreement	2012/08	2016/12	90,643	87,500	192,500	370,643
	41795	IT - Maximo Interface Fixes	2012/07	2013/02	142,742	45,254	0	187,996
	41443	IT - Web Filtering Security	2012/06	2013/07	72,098	26,835	0	98,933
	41442	IT - Advanced Laptop Security	2012/03	2013/02	84,903	9,501	0	94,404
P862	40367	IT - SAC Office Network Redundancy	2011/06	2013/02	134,850	3,751	0	138,601
	40651	IT - Fuelworx (Fuel Management)	2012/07	2013/03	210,973	1,364	0	212,337
	Total Computers				**$3,422,820**	**$7,333,819**	**$192,500**	**$10,949,139**
Equipment Replacement								
P897	41433	2012 New RTU Deployment	2012/06	2013/06	$269,295	$740,601	$0	$1,009,896
P860	40229	Protective Equip Test Center Upgrade	2011/04	2013/01	861,668	29,000	0	890,668
	Total Equipment Replacement				**$1,130,963**	**$769,601**	**$0**	**$1,900,564**
Overloaded Equipment								
P883	42230	U&U Harbour East Land Purchase & ROW	2012/02	2013/03	$906,707	$1,631,059	$0	$2,537,766
	Total Overloaded Equipment				**$906,707**	**$1,631,059**	**$0**	**$2,537,766**
Other General Property								
	40103	U&U Load Control Demo	2010/10	2014/10	$2,455,815	$1,242,400	$673,600	$4,371,815
P833	33562	FAC Land Registration Act	2010/10	2014/12	682,278	604,991	457,962	1,745,232
P834	40403	Work & Asset Management	2011/07	2013/03	5,287,071	517,847	0	5,804,918
	Total Other General Property				**$8,425,165**	**$2,365,238**	**$1,131,562**	**$11,921,965**
Total General Plant Carry Over Spending					**$15,061,084**	**$12,518,948**	**$1,324,062**	**$28,904,095**

6.3 General Plant – New 2013 Capital Items for ACE Approval

Tab #	CI#	Project Title	2013 Budget	Project Total
General Plant				
GP01	43346	IT - Service Hub Upgrade	$614,532	$614,532
GP02	43272	SCADA-EMS Hardware Replacement	497,250	497,250
Total New Computers Spending			**$1,111,782**	**$1,111,782**
Equipment Replacement				
GP03	43227	2013 RTU Replacements	$391,763	$682,211
GP04	43221	2013 New RTU Deployment	362,910	687,806
Total Equipment Replacement			**$754,673**	**$1,370,017**
Telecommunications				
GP05	43190	Replace Microwave Radio System 2013	$351,087	$351,087
Total New Telecommunications Spending			**$351,087**	**$351,087**
Total New General Plant Spending			**$2,217,543**	**$2,832,886**

7 Routine Capital Program

This category includes recurring annual expenditures for replacement of equipment (like-for-like replacement), additions to existing equipment base resulting from system growth and addition of customers to the system.

2013 Routine Capital Spending by Function

Generation	
Generation Equipment Replacements**	$4,554,160
Generation Other Hydro	701,971
Generation Other Thermal	339,916
	5,596,047
Transmission	
Transmission Substation Replacement, Additions/Modifications	4,028,279
Primary Equipment Spares	415,000
Protection Modification & Replacement	598,865
Transmission Line Replacement, Additions/Modifications	6,661,557
Transmission Right-of-Way Widening***	538,610
	12,242,310
Distribution	
Meters	2,578,179
Distribution Upgrades and Replacement	22,082,118
New Customers	24,148,457
Joint Use	880,122
Distribution Right-of-Way Widening***	2,539,685
	52,228,562
General Plant	
Work Vehicles	6,392,625
Tools and Test Equipment	1,453,886
Telecommunications	888,448
Computing Asset Management	3,448,963
Property Improvements and Furniture	3,855,001
Other	1,713,213
	17,752,136
Total 2013 Routine Capital Spending*	**$ 87,819,054**

***** The entire Routine program totals $88.4 million. The totals presented above and in the following information do not include Point Aconi Routines.

** For 2013, NS Power has included a new project S001 Equipment Replacements in the Generation Equipment Replacement Routine for the Port Hawkesbury Biomass Facility. This project will address any like-for-like equipment replacements required for the facility. Additionally, a P016 Tools and Test Equipment project for the same facility has also been added.

*** NS Power has created a new transmission right of way project which distinguishes funding between transmission and distribution right-of-way routines.

7.1 Routine Capital Spending by Function Yr/Yr

	2011 Actual	2012 Budget	2012 Forecast	2013 ACE Plan
Generation				
Generation Equipment Replacements	$4,023,770	$4,768,978	$4,757,498	$4,554,160
Generation Other Hydro	528,179	670,000	659,286	701,971
Generation Other Thermal	243,344	435,474	303,897	339,916
	4,795,293	5,874,452	5,720,681	5,596,047
Transmission				
Transmission Substation Replacement, Additions, Modifications	3,059,648	3,811,365	4,048,353	4,028,279
Primary Equipment Spares	264,292	300,000	300,000	415,000
Protection Modification & Replacement	378,584	699,194	624,181	598,865
Transmission Line Replacement, Additions, Modifications	5,458,592	6,270,513	5,933,808	6,661,557
Transmission Right-of-Way Widening				538,610
	9,161,116	11,081,072	10,906,342	12,242,310
Distribution				
Meters	2,361,132	2,857,014	2,202,518	2,578,179
Distribution Upgrades and Replacement	22,870,102	20,132,197	20,324,602	22,082,118
New Customers	22,231,459	23,134,635	23,406,418	24,148,457
Joint Use	1,690,093	906,693	1,075,175	880,122
Distribution Right-of-Way Widening	939,223	969,058	969,058	2,539,685
	50,092,008	47,999,597	47,977,772	52,228,562
General Plant				
Work Vehicles	6,531,413	6,806,696	6,457,314	6,392,625
Tools and Test Equipment	1,666,667	1,328,447	1,339,805	1,453,886
Telecommunications	872,018	880,597	886,717	888,448
Computing Asset Management	1,846,367	2,699,455	2,144,513	3,448,963
Property Improvements and Furniture	2,130,429	2,585,000	2,585,001	3,855,001
Other	1,323,787	1,783,500	1,675,202	1,713,213
	14,370,682	16,083,694	15,143,210	17,752,136
Total Routine Capital Spending	**$78,419,099**	**$81,038,815**	**$79,693,348**	**$87,819,054**

7.2 Routine Capital Spending Project Breakdown Yr/Yr

Prjct #	CI #	Project Title	2011 Actual	2012 Budget	2012 Forecast	2013 ACE Plan
G001	10634	CT'S - Routine Spending	$117,776	$137,630	$254,295	$151,710
H001	11622	HYD - Equipment Replacement	707,360	750,000	748,265	757,372
H004	27867	HYD-Roofing Routine	296,266	200,000	198,604	213,458
S001	23428	GS - Routine Capital	96,904	135,000	134,197	135,000
	10645	POT - Routine Capital	242,643	259,586	252,327	276,060
	10673	TRE - Routine Capital	326,871	333,799	330,396	353,084
	43646	PH Biomass- Routine Capital	0	0	0	398,265
	10621	TUC - Routine Plant Spending	344,355	560,648	488,052	464,964
	10626	LIN - Routine Capital Program	530,450	566,267	564,915	461,196
S004	27856	TRE-Roofing Routine	479,810	298,201	278,823	605,936
	27855	POT-Roofing Routine	243	290,743	180,417	319,140
	27854	TUC-Roofing Routine	471,646	151,630	158,988	175,470
	27857	LIN-Roofing Routine	356,005	960,476	1,115,788	112,760
G008	38899	CTs Tooling Routine	53,441	25,000	19,487	28,000
W001	41830	Wind - Routine Equipment Replacement	0	100,000	32,946	101,745
		Generation Equipment Replacements Total	**$4,023,770**	**$4,768,978**	**$4,757,498**	**$4,554,160**
H005	35583	HYD - Oil Release Risk Assessment	279,308	270,000	268,472	283,580
H006	35584	HYD - Gate Refurbishment	248,871	400,000	390,814	418,391
		Generation Hydro Total	**$528,179**	**$670,000**	**$659,286**	**$701,971**
S005	33871	TUC-Heat Rate Routine	463	66,194	49,526	70,574
	33867	POT-Heat Rate Routine	71,559	75,570	74,822	81,027
	33869	TRE-Heat Rate Routine	37,170	87,237	76,239	85,104
	33863	LIN-Heat Rate Routine	134,152	206,473	103,310	103,211
		Generation Thermal Total	**$243,344**	**$435,474**	**$303,897**	**$339,916**
T003	23120	Provincial-Trans Substation Primary Equipment Replacements	2,744,313	2,575,000	2,561,042	2,665,492
T004	23121	Provincial - Substation Additions & Modifications	315,335	1,236,366	1,487,311	1,362,787
		Transmission Subs Replace, Adds/Mods Total	**$3,059,648**	**$3,811,365**	**$4,048,353**	**$4,028,279**
T018	14973	Primary Equipment Spares	264,292	300,000	300,000	415,000
		Primary Equipment Spares Total	**$264,292**	**$300,000**	**$300,000**	**$415,000**
T016	14841	Protection Modification & Replacement	378,584	699,194	624,181	598,865
		Protection Modification & Replacement Total	**$378,584**	**$699,194**	**$624,181**	**$598,865**
T001	23115	Provincial Transmission Line Replace	1,203,200	755,000	755,000	839,657
T011	23118	Provincial - Planned Trans Line Replacement	4,255,392	5,515,513	5,178,808	5,821,899
		Transmission Line Replacements Total	**$5,458,592**	**$6,270,513**	**$5,933,808**	**$6,661,557**
T010		Transmission Right-of-Way Widening	0	0	0	538,610
		Transmission Right-of-Way Widening Total	**$0**	**$0**	**$0**	**$538,610**

Prjct #	CI #	Project Title	2011 Actual	2012 Budget	2012 Forecast	2013 ACE Plan
D009	26496	Meter Routine	2,361,132	2,857,014	2,202,518	2,578,179
		Meters Total	**$2,361,132**	**$2,857,014**	**$2,202,518**	**$2,578,179**
D005	23158	Unplanned Replace Deteriorated	9,033,728	8,000,000	8,880,126	9,514,851
D006	23135	Regulatory Replacements - Province	1,216,979	1,699,100	1,022,027	1,415,763
D008	23361	Provincial Storm	4,060,133	2,371,335	2,369,441	2,504,578
D051	29038	System Performance Improvement Routine	601,458	458,585	461,636	440,176
D055	23137	Planned Replacement Of Distr	7,957,803	7,603,178	7,591,373	8,206,749
		Distribution Upgrades and Replacement Total	**$22,870,102**	**$20,132,197**	**$20,324,602**	**$22,082,118**
D002	26715	New Primary Services	(10,557)	0	0	0
D004	26716	New Customer Upgrades	5,637,919	5,858,803	7,704,892	7,187,286
D016	26717	New Customers - Unmetered Services	0	0	0	0
D017	26718	New Customers - Metered Services	(23,625)	0	0	0
D018	23511	Primary Equipment Spares - Distribution	177,545	150,000	150,000	150,000
D021	26719	New Customers - Line Extensions	(58,865)	0	0	0
D022	26720	New Customers - Underground Service	(35,275)	0	0	0
D061	39766	New Customers - Residential	10,425,434	11,401,508	10,121,923	11,005,924
D062	39770	New Customers - Commercial	6,118,883	5,724,324	5,429,603	5,805,247
		New Customers Total	**$22,231,459**	**$23,134,635**	**$23,406,418**	**$24,148,457**
D007	23136	Contractual Replacements (Joint Use)	1,690,093	906,693	1,075,175	880,122
		Joint Use Total	**$1,690,093**	**$906,693**	**$1,075,175**	**$880,122**
D010	23127	Provincially Widening	939,223	969,058	969,058	2,539,685
		Right of Way Widening Total	**$939,223**	**$969,058**	**$969,058**	**$2,539,685**
P006	20945	Replacement and Additional Work Vehicles	110,421	151,081	140,908	199,485
P009	16192	Mobile Transformer & Track Routine	155,414	387,225	108,610	98,337
P063	39304	Class 3 Work Vehicle Replacements	769,172	446,173	450,482	289,308
P062	39305	Work Vehicle Replacements	3,670,521	4,051,173	3,947,520	4,046,691
P061	40236	Transportation Vehicle Replacements	1,825,884	1,771,044	1,809,793	1,758,805
		Work Vehicles Total	**$6,531,413**	**$6,806,696**	**$6,457,314**	**$6,392,625**
P002/P016		Tools and Equipment	1,608,068	1,253,447	1,264,523	1,378,886
P015	11611	Hydro Production Tools, Test Equipment	58,599	75,000	75,282	75,000
		Tools and Test Equipment Total	**$1,666,667**	**$1,328,447**	**$1,339,805**	**$1,453,886**
P025	16365	Mobile Radio Routine	76,459	87,953	88,987	82,018
P027	16551	Telecommunication Radio and Fibre Optics	133,575	159,370	163,132	159,224
P028	16550	Telecommunication Systems Replace & Modifications	497,968	453,024	454,310	470,506
P814	38243	Telecommunications Spares	164,017	180,250	180,288	176,700
		Telecommunications Total	**$872,018**	**$880,597**	**$886,717**	**$888,448**
P010	16073	SCADA Improvements Routine	107,774	129,747	129,448	151,996
P020	10632	NSPI/CGI Infrastructure	679,266	0	0	0
P031	29114	NSPI Non-CGI Infrastructure	955,473	2,340,865	1,808,871	3,079,862
P040	28522	CTs DCMS Routine	475	17,340	11,897	18,202
	25667	POT - DCMS Equipment Replacement Routine	0	30,000	26,538	31,000
	25626	TRE - DCMS Equipment Replacement Routine	38,879	59,103	55,026	41,627
	25646	TUC - DCMS Equipment Replacement Routine	52,587	71,400	63,222	76,276
	25668	LIN - DCMS Equipment Replacement Routine	11,914	51,000	49,510	50,000
		Computing Asset Management Total	**$1,846,367**	**$2,699,455**	**$2,144,513**	**$3,448,963**

Prjct #	CI #	Project Title	2011 Actual	2012 Budget	2012 Forecast	2013 ACE Plan
P001/P030		Property Improvement and Furniture	2,130,429	2,585,000	2,585,001	3,855,001
		Property Improvement and Furniture Total	**$2,130,429**	**$2,585,000**	**$2,585,001**	**$3,855,001**
P012/P041		Other (HYD - Security Improvement & FAC - Land Acquisition)	396,824	900,000	809,716	933,213
P816	38897	FAC Enviro Property Remed Routine	568,542	304,000	299,560	297,000
P815	38896	FAC Environment Site Assess Routine	180,524	179,500	162,696	183,000
P032	38848	Purchasing Equip & Warehouse Routine	177,896	400,000	403,230	300,000
		Other Total	**$1,323,787**	**$1,783,500**	**$1,675,202**	**$1,713,213**
Routine Capital Spending			**$78,419,099**	**$81,038,815**	**$79,693,348**	**$87,819,054**

*POA amounts have been removed to represent the spend amount that requires UARB approval.

7.3 Routine Capital Spending Variances

Routine Function	ACE 2012 $M	ACE 2013 $M	Variance Inc / (Dec)
Generation	$5.9	$5.6	($0.3)
Transmission	11.1	12.2	1.2
Distribution	48.0	52.2	4.2
General Plant	16.1	17.8	1.7
Total	$81.0	$87.8	$6.8

Routine Function	Inc / (Dec) $M	Area of Variance
Generation	$(0.8)	Roofing Routine: Lingan
	0.4	Roofing Routine: Trenton, Point Tupper, Tufts Cove & Hydro
	0.3	Equipment Replacements: All Plants & Hydro
	(0.1)	Heat Rate Routine: All Plants
	(0.3)	
Transmission	0.4	Transmission Line Replacements (T001 & T011)
	0.2	Transmission Substation Replacements
	(0.1)	Protection Modifications
	0.1	Primary Equipment
	0.5	Transmission ROW Widening
	1.2	
Distribution	1.0	New Customers
	1.9	Distribution Upgrades and Replacements (D006)
	1.6	Right of Way Widening
	(0.3)	Meters
	4.2	
General Property	0.1	Tools & Test Equipment
	(0.1)	Purchasing Equipment and Warehouse
	1.3	Property Improvement & Furniture
	(0.4)	Work Vehicles
	0.7	Computing Asset Management
	1.7	
Total	**$6.8**	

7.4 2013 Routine Capital Spending Project Details

Generation

Project #	Project Title	ACE 2013 Forecast
Generation Equipment Replacements		
G001	CTs - Routine Equipment Replacement	$151,710
H001	HYD - Routine Equipment Replacement	757,372
H004	HYD-Roofing Routine	213,458
	GS - Routine Capital	135,000
	POT - Routine Equipment Replacement	276,060
	TRE - Routine Equipment Replacement	353,084
	TUC - Routine Equipment Replacement	464,964
	PH Biomass- Routine Equipment Replacement	398,265
	LIN - Routine Equipment Replacement	461,196
S004	TRE-Roofing Routine	605,936
	POT-Roofing Routine	319,140
	TUC-Roofing Routine	175,470
	LIN-Roofing Routine	112,760
G008	CTs Tooling Routine	28,000
W001	Wind - Routine Equipment Replacement	101,745
	Generation Equipment Replacements Total	**$4,554,160**
Generation Hydro		
H005	HYD Oil Release Risk Assessment	$283,580
H006	HYD - Gate Refurbishment Routine	418,391
	Generation Hydro Total	**$701,971**
Generation Thermal		
S005	TUC-Heat Rate Routine	$70,574
	POT-Heat Rate Routine	81,027
	TRE-Heat Rate Routine	85,104
	LIN-Heat Rate Routine	103,211
	Generation Thermal Total	**$339,916**
	Generation Total	**$5,596,047**

Transmission

Transmission Substation Replacements, Additions and Modifications

T003 Provincial: Transmission Substation Primary Equipment Replacements	ACE 2013 Forecast
Unplanned failures	$1,064,492
Replace oil filled reclosers at 92H	216,000
2 new breakers at 10H	190,000
New charger for 2S	18,000
Bus PTs for 2S, 1C, 2C, 67C	216,000
3 New CTs for 20V	40,000
3S PTs on 69kV at 3S	42,000
3S-T5 new bushing on high side	29,000
4S Fence Repairs	14,000
New rads for 81S-T2, 83S-GT1/GT2, 91H-GT1	240,000
Gravel for 85S, 50N, 7N, 62N, 67N, 74N, 19C, 24C, 57C	125,000
SF6 bus repairs at 88S	30,000
101S - Station Svc xfer switch	37,000
New batteries at 1N	19,000
New oil containment pits 2x	93,000
3x transformer refurbishment	96,000
80W batteries	19,000
420W battery charger	18,000
Fence work at 78W, 46W, 75W, 50N, 7N, 62N, 67N, 74N, 19C, 24C, 57C	159,000
Total T003 Provincial: Transmission Substation Primary Equipment	**$2,665,492**
T004 Provincial- Substation Additions & Modifications	
Unknown additions	$228,787
48V and 129V A scheme chargers at 79N	38,000
3 x larger regulators for 20v	110,000
Air Conditioning Projects	420,000
Install On-line Oil Filtration units	93,000
Install On-line Gas Monitors	173,000
Install On-line Transformer Monitoring	200,000
Wildlife insulation protective cover-up (Sites TBD)	100,000
Total T004 Provincial- Substation Additions & Modifications	**$1,362,787**
Total Transmission Substation Replacements, Additions and Modifications	**$4,028,279**

Primary Equipment Spares

T018 Primary Equipment Spares	ACE 2013 Forecast
Spare 138 kV breaker	$130,000
Spare 69 kV breaker	75,000
Spare 25 kV, 15 kV, 6 kV lightning arresters	90,000
Various Spare Bushings	120,000
Total Primary Equipment Spares	**$415,000**

Protection Modification & Replacement

T016 Protection Modification & Replacement	ACE 2013 Forecast
L-5537 Pilot Wire Replacement	$50,000
Replace LFCB on L-6048	91,000
L-5563/L-5560 Add Fault Location at 2S	31,500
L-7003 Relay Replacement at 3C	44,500
L-7005 Relay Replacement at 3C	44,500
L-7011 Relay Replacement at 3C	44,500
L-7012 Relay Replacement at 3C	44,500
Replace A SPS at 88S Lingan	66,000
Replace A SPS at 67N Onslow	43,040
Replace A SPS at 79N Hopewell	43,025
L-6020 & L-6021 Add Perm & TT	20,000
Unplanned Relay Replacement	76,300
Total Protection Modification & Replacement	**$598,865**

Transmission Line Replacement, Additions / Modifications

T001 Provincial Transmission Line Replacement (Unplanned)	ACE 2013 Forecast
The forecast funding for T001 has been increased by 10% over 2012 budget levels. This increase reflects increases to contract and material assumptions. Activity in this routine varies depending on storm response.	**$839,657**

T011 Provincial- Planned Transmission Line Replacement		**ACE 2013 Forecast**
LINE #	**Description**	
5003	Farrell St. to Sackville	$140,300
5010	Imperial Oil to Imperial Oil	21,600
5014	St Croix to Upper Burlington	51,800
5021	Canaan Rd to Klondike	5,900
5028	Onslow to Stewiake @ Lafarge	155,800
5026	Gulch to Paradise	113,600
5029	Maccan to Springhill	153,600
5036	Berwick tap to Berwick	2,200
5040	Onslow to Tatamagouche	789,700
5050	Sissiboo to Fourth Lake	65,700
5055	Tap to East Kemptvill Tin Mine	30,600
5056	Tap to 81V Anapolis Royal	3,500
5500	VJ to Lingan	22,900
5502	Trenton to Bridge Ave	163,800
5524	Trenton to Abercrombie	59,900
5532	4C Lochaber Rd to 57C Salmon river	87,200
5535	13V Gulch to 3W Big Falls	213,900
5541	Tusket to Sissiboo	41,100
5551	Milton to Big Falls	28,900
5565	Lunenburg to Riverport	25,800
6002	VJ to Lingan	719,500
6015	Sackville to Bridgewater	178,400
6020	Cannan Rd to Tremont	58,600
6050	Milton to Souriquois	6,100
6503	6001 Tap to Aerotec Park	738,000
6516	Onslow to Trenton	510,700
6518	Hastings to VJ	84,600
6531	Hastings to Stora	150,100
6533	Milton to Bridgewater	19,200
6540	VJ to Sysco South	25,800
5536A	Tusket to Plesant St.	63,300
5536B	Plesant st. to Hebron	88,000
7004	Dalhousie Mountain to Hastings	655,600
7015	Pt. Aconi to Woodbine	1,800
7019	Onslow to Dalhousie Mountain	126,600
8004	Hopewell to Woodbine	217,800
T011 Provincial- Planned Transmission Line Replacement		**$5,821,899**
Transmission Line Replacement Total		**$6,661,557**

T010 Provincial Transmission Right of Way Widening

In 2013, this routine was created to properly differentiate the costs associated with transmission rights of way widening from those on the distribution system. This forecast is developed based on an identified level of widening in the current year.

Line	Current Line Height	Dominant Tree Height	Tree Density	Slope	Current Clear Width	Increased Width	Spans	Distribution Substations	Customer Impact	Tree Contact Duration (Hrs)	Interruption Frequency	ACHI	2013 ACE Plan
L-5025	10.4	18.5	1840	8	10.8	4.2	86	65V	4,064	2	0.1	740	$ 196,000
L-5531	7.3	19.8	1567	0	11	5	124	77V, 13V	6,373	6	0.5	17207	209,000
											Subtotal	17947	405,000
											Total		$ 538,610

Overall $/ACHI	$ 30.01

Transmission Total	**$12,242,310**

Distribution

Meters

Item#	Prg#	Meter Type	Meter Style	Description	2013 Forecast	Current Unit Cost	Capital for meters
1.0 Element, 120-240 volt							
1	294	I-210+	GE	240V, 10A, 2W, 4 Jaw, 4 dial	200	80.68	$16,136.00
2	220	kV2c	GE	T/R, 2W, 4Jaw, TOU (KWH) c/w L.C. (ETS)	100	173.25	$17,325.00
3	230	I-210+c	GE	T/R, 2W, 4Jaw, KW/KVA dmd	140	127.00	$17,780.00
4	39	kV2c	GE	T/R, 2W, 4Jaw, TOU(KWH) c/w modem, L.P,L.C. (ETS)	4	384.85	$1,539.40
5	40	kV2c	GE	T/R, 2W, 4Jaw, KW/KVA dmd, c/w modem, L.P.	4	351.80	$1,407.20
1.5 Element, 120-240 volt				**Description**	**2013 Forecast**		
	N/A	C1S	Centron	240V, 200A, 3W,4 Jaw, 5 dial	20000	26.50	$530,000.00
6	219	SS1S1T	Sentinel	S/C, 3W, 4Jaw, TOU(KWH) c/w L.C. (ETS)	1000	155.25	$155,250.00
7	231	SS1S2D	Sentinel	S/C, 3W, 4Jaw, KW/KVA dmd	240	143.75	$34,500.00
8	232	SS1S2D	Sentinel	T/R, 3W, 4Jaw, KW/KVA dmd	60	155.25	$9,315.00
	236	SS1S1L	Sentinel	S/C, 3W, 4Jaw, (KWH) c/w modem & L.P.	10	373.75	$3,737.50
2.0 Element, 120-480 volt				**Description**	**2013 Forecast**		
9	N/A	CN1S	Centron	120V,200A,3W,5Jaw(9o,clock pos:), 5 dial	1000	83.00	$83,000.00
10	226	SS2S2D	Sentinel	S/C, 3W, 5Jaw(9 o,clock pos:) KW/KVA dmd,(Mult: 25)	100	143.75	$14,375.00
	227	SS3S2D	Sentinel	T/R, 3W, 8Jaw, KW/KVA dmd, c/w KYZ pulses	10	230.00	$2,300.00
11	233	SS2S1T	Sentinel	S/C, 3W, 5Jaw(9 o,clock pos:)TOU(KWH) c/w L.C.(ETS)	100	155.25	$15,525.00
12	235	SS3S3L	Sentinel	T/R, 3W, 8Jaw, KW/KVA dmd, c/w modem, L.P.	4	373.75	$1,495.00
13	272	SS3S3L	Sentinel	T/R , 3W, 8Jaw, kW/kVA dwd, Modem, LP (5-min int) KYZ	4	414.00	$1,656.00
27	297	SS3S2D	Sentinel	T/R, 3W, 8Jaw, KW/KVA dmd	250	143.75	$35,937.50
2.5 Element, 120-347 volt				**Description**	**2013 Forecast**		
14	281	SS5S0	Sentinal	T/R,4W, 13Jaw, 120-480V, 0.1-10A (KWH)	40	121.00	$4,840.00
15	228	SS2S2D	Sentinel	T/R, 4W, 13Jaw, KW/KVA dmd	200	121.00	$24,200.00
16	229	SS5S2D	Sentinel	T/R, 4W, 13Jaw, KW/KVA dmd, c/w KYZ	20	155.25	$3,105.00
17	234	SS5S3L	Sentinel	T/R,4W, 13Jaw, KW/KVA dmd c/w modem, L.P.	20	373.75	$7,475.00
18	273	SS5S3L	Sentinel	T/R, 4W, 13 Jaw, kW/kVA dmd, modem, LP (5 min int)	4	414.00	$1,656.00
19	274	SS5S3L	Sentinel	T/R, 4W, 13 Jaw, kW/kVA dmd, modem, LP (5 min int), KYZ	4	414.00	$1,656.00
3.0 Element, 120-347 volt				**Description**	**2013 Forecast**		
20	247	SS4S0D	Sentinel	S/C, 4 W, 7Jaw, (KWH)	500	121.00	$60,500.00
21	248	SS4S0	Sentinel	T/R, 4W, 13Jaw, (KWH)	20	121.00	$2,420.00
22	218	SS4S3L	Sentinal	T/R, 4W, 13Jaw, KW/KVA dmd, c/w modem, L.P.	20	373.75	$7,475.00
23	222	SS4S2D	Sentinel	S/C, 4W, 7Jaw, KW/KVA dmd, (Mult 25)	800	121.00	$96,800.00
24	223	SS4S2D	Sentinel	T/R, 4W, 13Jaw, KW/KVA dmd	400	121.00	$48,400.00
	225	SS4S2D	Sentinel	T/R,4W, 13Jaw, KW/KVA dmd, c/w KYZ	10	155.25	$1,552.50
25	275	SS4S3L	Sentinel	T/R, 4W, 13 Jaw, kW/kVA dmd, modem, LP (5 min int)	4	373.75	$1,495.00
26	276	SS4S3L	Sentinel	T/R, 4W, 13 Jaw, kW/kVA dmd, modem, LP (5 min int), KYZ	4	414.00	$1,656.00
	243	SS4S3L	Sentinel	T/R, 4W, 13Jaw, KW/KVA, dmd, c/w modem, L.P, KYZ	20	414.00	$8,280.00
				TWACS Modules	500	72.00	$36,000.00
				Total Meters	**25792**		**1,248,789**
				Misc Meters "ION"	5	5,000.00	**$25,000**
				CT and PT requirements			**150,000**
				Wire Adapters and switches			**87,443**
				Total Materials			**1,511,232**
				Applied Overhead			**563,219**
				Labour			**503,729**
				D009 Meters Total			**2,578,179**

Distribution Upgrades and Replacement

		ACE 2013 Forecast
D005 Unplanned Replacement Deteriorated Equipment		
	The forecast was developed based on an estimated 3,800 person days of work at a unit cost of $2,504/person day	**$9,514,851**
D006 Regulatory Replacements		
	The forecast is developed based on past experiences or information from various government agencies. This amount could vary based on current year decisions by these agencies.	**$1,415,763**
D008 Provincial Storm		
	This forecast is developed based on past experience. There can be significant variation in this amount based on yearly storm activity.	**$2,504,578**
D051 System Performance Improvement		
	Relocate switch D472-020 into substation and add 3 phase gang operation capability. This switch parallels feeders 85S-401 and 402.	$75,000
	New single phase reclosers at 6 locations	200,000
	Transfer Scheme between Lawrence Blvd and MacGregor Ave.	165,176
Total D051 System Performance Improvement		**$440,176**
D055 Planned Replacement of Distribution Equipment		
	Bin Work (Work resulting from NSPI's distribution line inspection program that has been identified as requiring follow up within one year)	$2,246,488
	Streetlight/service removal (This funding is to support system upgrades required for street light installations. This includes transformer installs, service upgrades and/or new pole installations)	600,000
	Padmount replacement	750,000
	Field Driven Work	600,000
	Voltage Regulator Replacement	110,000
	3S-403 - Reinsulate and relocate to roadside	262,921
	14C-211 Petit de Grat Rebuild Phase 2	228,000
	500N-311 Caribou Island Reconductor	338,000
	Convert 534S-212 to 12kV	80,000
	81S-306 The hub insulator replacement	67,500
	16W-301 MacCormack Road Rebuild	164,478
	77V-302 Beachwood Lane Rebuild	74,161
	89W-302 Dayspring Reconductor	283,363
	1N-402 Truro Back Road Rebuild	71,777
	11S- 302/303 Keltic Drive retired 12kV Removals/Clean-up	200,000
	62N-413 - Fall Brook Rd Rebuild	84,000
	79S-T41 - replace stepdown	71,000
	57C-426 Sherbrooke Village Rebuild	125,000
	50W-412 East Berlin Rebuild	54,000
	Replacement program open air switches with submersible switches	200,000

	ACE 2013 Forecast
4kV Vault Replacement	250,000
63V-313 Aylesford Reconductor - Ph 1	364,593
545W-311 Dagley Rd. - Deteriorated Plant	137,728
63V-313 Aylesford Reconductor - Ph2	466,552
88W-312 Bunker Island Removal	92,763
76W-301 Albany New replace Deteriorate poles	80,000
16W-301 Port Maitland Reconductor	72,000
93V-313 Mardiagras Rd replace poles	132,425
Total D055 Planned Replacement of Distribution Equipment	**$8,206,749**
Distribution Upgrades and Replacement Total	**$22,082,117**

New Customers

	ACE 2013 Forecast
D004 New Customer Upgrades	
This forecast is developed as a % of D061 and D062 net of capital contributions. In 2013 this is estimated to be 43%.	**$7,187,286**
D018 Primary Equipment Spares Distribution	
This forecast is developed based on the probable amount of distribution spare equipment required during the year.	**$150,000**
D061 New Customers- Residential	
This forecast is for the costs associated with new residential customers net of capital contributions. Costs include metered services, unmetered services, line extensions and underground services.	**$11,005,924**
D062 New Customers- Commercial	
This forecast is for the costs associated with new commercial customers net of capital contributions. Costs include metered services, unmetered services, line extensions and underground services.	**$5,805,247**
Total New Customers	**$24,148,457**

	ACE 2013 Forecast
Joint Use Total	
This forecast is developed from discussions with communication utilities and may vary depending on their level of activity	**$880,122**

D010 Provincial Distribution Right of Way Widening

This forecast is developed based on an identified level of widening in the current year. Recent field reviews conducted by the NS Power Forestry department in conjunction with consultant Ecological Solutions Inc., determined that NS Power distribution rights-of-way typically have a clear width of 2-4 m from centerline, rather than the specified 6.1 m. While a distribution standard of 6.1m is specified, the majority of newly established rights-of-way observed during the field review were also found to have a clear width of only 2-4 m. The increase in this routine reflects the work that will be required to widen the following rights of way to standard.

Line	Current Line Height	Dominant Tree Height	Tree Density	Slope	Current Clear Width	Increased Width	Line Security Improvement	Average Storm Tree Contacts CHI	ACHI	Spans	Tree Work	Costs
1N-405	11	12	975	0	3	3	95	6,542	6,215	140	1-side	$ 140,190
1V-443	11	18	889	3	3	3	47	26,140	12,286	275	1-side	275,372
20H-301	11	11	918	1	3	3	95	11,319	10,753	55	1-side	55,074
20V-311	11	20	925	1	5	1	17	10,533	1,791	278	1-side	278,377
22C-404GA	9	16	1450	0	5	1	23	8,278	1,904	40	1-side	40,054
104S-313	9	18	2175	0	5	1	19	7,788	1,480	110	2-side	178,992
50N-410G	8.1	16	1880	0	5.64	0.36	22	11,662	2,566	247	1-side	247,334
50N-415	7	17	1550	0	5	1	19	3,061	582	100	2-side	162,720
516N-311	10.5	16	2225	0	0	6	79	1,306	1,032	182	1-side	182,246
57C-422GAA	10.5	16.3	2017	4	0	6	77	6,044	4,654	400	1-side	400,542
73W-411H	10.9	15.4	1286	0	3.1	2.9	58	14,571	8,451	578	1-side	578,783
								Totals	**51,712**	**2405**		**$ 2,539,685**

Overall $/ACHI	**$ 49.11**

Distribution Total	**$52,228,562**

General Plant

Work Vehicles

P006 Replacement and Additional Work Vehicles	Quantity	Unit Price	ACE 2013 Forecast
Reel and Pole Trailers	5	$39,897	$199,485
Total P006 Replacement and Additional Work Vehicles			**$199,485**
P009 Mobile Transformer & Track			
This forecast is developed based on estimated repairs or modifications to track machines or the mobile transformers.			**$98,337**
P061 Transportation Vehicle Replacements	60	$29,313	**$1,758,805**
P062 Work Vehicle Replacements	16	$252,918	**$4,046,691**
P063 Class 3 Work Vehicle Replacements	3	$96,436	**$289,308**
	Total Work Vehicles		**$6,392,625**

Tools and Equipment

Description	Quantity	Estimated Unit Cost	ACE 2013 Forecast
Meter Shop Tools and Equipment			**$45,000**
Provincial Line Tools & Equipment			
Western Territory			
Hydraulic Stick Saws	10	$1,900	$19,000
Gator Tail rope and reel	4	3,900	15,600
Pole boss	4	1,100	4,400
Ground Sets	9	1,300	11,700
Phase Identifier	1	8,000	8,000
Fiberglass Step	1	1,500	1,500
Hydraulic cutters	4	1,800	7,200
Smart Board	1	3,000	3,000
Phasing Sticks	3	2,600	7,800
Western Territory Total			**$78,200**
Eastern Territory			
Meter Base recorder	1	$6,000	$6,000
Fork Ammeter (3-SYD, 2- spares)	5	1,800	9,000
UG termination Kit (1-ANT, 1-SYD)	2	2,000	4,000
Gator ropes (3 reels / pole boss) (1-SYD , 1-STE)	1	3,700	3,700
12 ton press (2-STE, 1-PHA)	3	6,000	18,000
6 ton press (2-PHA, 2-STE)	4	2,000	8,000
Live Line Conductor Pulling Equipment Set	1	29,379	29,379
Eastern Territory Total			**$78,079**
Central Territory			
Hydraulic drill	6	$1,300	$7,800
2/0 grounding sets	6	1,200	7,200
6 ton press	12	2,200	26,400
12 ton press	6	4,000	24,000
sets of dies for y-35 press for new sleeves	6	1,500	9,000
3 phase patten jumper sets - 15' - 2/0	6	2,200	13,200
Hydraulic Chain saw	4	1,500	6,000
Y46 press; cutter head for y46 press	1	3,000	3,000
Dewalt battery powered tools (6 piece set)	2	1,200	2,400
cable locator kit	1	8,500	8,500
live line phasing sticks	2	2,000	4,000
Cable locating sonde fish tape	1	2,500	2,500
Box locator	2	2,000	4,000
Hydraulic Cutters	2	3,000	6,000
Battery powered cable cutters	6	2,600	15,600

Description	Quantity	Estimated Unit Cost	ACE 2013 Forecast
TTR - Transformer Tested 3/0	1	2,500	2,500
Man hole Retractor	2	3,000	6,000
Inverter	1	1,000	1,000
AMP Probe with universal attachment	2	1,500	3,000
Set of 3 DRA's for engineering	1	6,000	6,000
Candura Power Pro	1	8,000	8,000
Fluke Scope	1	8,000	8,000
Air Monitors	2	2,000	4,000
Tri-pod for man hole	1	5,000	5,000
Central Territory Total			**$183,100**
T&D Asset			
Breakdown Allowance	1	$75,000	$75,000
Handheld Data Collection Units - PETC	4	2,500	10,000
Portable Ground Sets	100	1,300	130,000
Rope Tester	4	2,918	11,672
Dielectric Rope	4	2,200	8,800
69kV Cover Up Sets	4	5,520	22,080
Specialty Tools for Hendrix Cable Installation	1	25,000	25,000
Live Line Conductor Pulling Equipment Set	2	29,379	58,758
T&D Asset Total			**$341,310**
Telecom			
Electromagnetic Interference Detector	2	$4,500	$9,000
T1 Communication Test Set, with cables and set-up	1	27,500	27,500
Communication Tool kits	15	1,600	24,000
Communication System installation and testing RF cable sets.	1	2,500	2,500
Telecom Total			**$63,000**
System Maintenance			
2 Suparule Height measurers	2	$1,200	$2,400
2 sets of built in ATV ramps (retract a Jack)	2	2,000	4,000
2 sets of high powered stabalizing binoculars	2	1,500	3,000
1 twin rotored camera equipped mini helicopter for tower inspecting	1	1,250	1,250
Battery operated Press (for PHA)	1	2,000	2,000
Moisture Analyzer	1	2,000	2,000
Phasing Sticks	1	2,000	2,000
Battery operated Cable cutter (for PHA)	1	2,000	2,000
Meggers 1000Volt	4	1,000	4,000
Hand crank TTR	1	2,000	2,000

Description	Quantity	Estimated Unit Cost	ACE 2013 Forecast
Breaker Analizer (PHA)	1	2,000	2,000
New Winding Resistance set	1	8,000	8,000
AC high voltage test set	1	8,000	8,000
Battery load test set (Torqal or equiv.)	1	12,000	12,000
Kelman tester	1	50,000	50,000
Vanguard CT tester	1	20,000	20,000
70 kV DC Hi-Pot set	1	18,000	18,000
ABB test plugs 3 & 3	1	4,800	4,800
Megger SDVRKER 760	1	10,000	10,000
Megger DLRO200-115	1	7,500	7,500
Digital Hydrometer	1	7,000	7,000
CT test set	1	10,000	10,000
Cable locator	1	8,000	8,000
10kv meggars	3	6,000	18,000
2kw generator	1	2,000	2,000
TTR - 3 phase	1	7,000	7,000
Battery operated y-35 and dies	2	8,000	16,000
System Maintenance Total			**$232,950**
P002 Tools and Equipment Total			**$1,021,639**
P015 Hydro Production Tools & Test Equipment			**$75,000**
P016 Thermal Production Tools & Test Equipment			
POT Tools & Equipment			$60,000
TUC Tools & Equipment			58,000
TRE Tools & Equipment			60,000
LIN Tools & Equipment			75,000
PH Biomass Tools & Equipment			104,247
P016 Thermal Production Tools & Test Equipment Total			**$357,247**
Tools and Test Equipment Total			**$1,453,886**

Telecommunications

P025 Mobile Radio	**ACE 2013 Forecast**
Spare parts - Hutton	$16,057
Spare parts - Nova	16,057
Replacement Radio Equipment Hardware and Upgrades	30,445
Test MTR2000 repeater spares	5,962
Equipment repairs- Nova	13,497
P025 Mobile Radio Total	**$82,018**

P027 Telecommunication Radio & Fibre Ops	
HVAC Replacement - 2 sites	$111,073
Radio Site repairs	14,525
Generator Upgrades	14,726
Engineering for As Built Drawings	0
Reconfigure Generator Alarms at Sites	4,842
Misc. repairs	14,058
P027 Telecommunication Radio & Fibre Ops Total	**$159,224**

P028 Telecommunication Systems Replace & Modifications	
Replace Bayly & Marconi Multiplex Equipment	$29,870
Upgrade site access (7705) equipment	60,257
Install Newbridge Shelves @ RAL and Move Circuits	17,483
Remove old Bayly Mux Equipment	3,078
12 Volt Deep Cycle Batteries	16,579
Misc. Power Supplies	5,239
UPS Repairs/Replacements	5,239
Replace Ethernet Spread Spectrum Radios	20,453
Newbridge CPSS Audit Work	2,955
Upgrade Network Access to Sites	15,246
Misc. Alcatel equipment	16,765
Misc. Telecom eqpt.	13,098
Cable & Entrance Protection	15,717
Switched Communications (SOPS, etc)	5,239
Misc. Fibre Optics (Replace NEC/ADC eqpt.)	32,935
Fibre Link (Substation to Radio Site)	21,941
Network Monitoring - replace net dogs	39,790
TMON Installation and Alarm Commissioning	12,312
Review and Update System Drawings	41,807
Upgrade MDR8000 to Frequency Diversity	32,293
MDR8000 Ethernet Upgrades	6,402
Install Net Guardians at various sites	25,632
LED Tower Lighting Upgrades (Communication Towers not Roadway Lighting)	30,177
P028 Telecommunication Systems Replace & Modifications Total	**$470,506**

P814 Telecommunications Spares	ACE 2013 Forecast
Alcatel-Lucent MDR8000 Microwave Radio	$60,000
Net Guardian Alarm Monitoring Equipment	24,000
Ethernet and SSR Spares	40,000
MDS SD9, Transnet, INet	7,200
SEL 2505, 2506 Spares	8,000
Battery Charger Spare	20,000
Misc. spares	17,500
P814 Telecommunications Spares Total	**$176,700**
Telecommunications Total	**$888,448**

Computing and Asset Management

P010 SCADA Improvements		ACE 2013 Forecast
	This forecast is developed based on SCADA equipment/operator interfaces failures or modifications	**$151,996**

P031 NSPI IT Infrastructure

Infrastructure Component	Asset Management Plan	Volume to be Refreshed	
Voice and Data Network	Network equipment that has or will reach seven (7) years old. (Measured in number of network ports)		$450,000
Servers	Servers that have or will reach six (6) years old	12	454,000
Laptop and Desktop Computers	Computers that have or will reach four (4) years old*	850	1,733,162
	New laptop or desktop computers	100	280,700
	New software licenses	50	28,000
Monitors	Part of laptop/desktop refresh	300	69,000
Accessories			65,000
P031 NSPI IT Infrastructure Total			**$3,079,862**

* Note: Some of these have been deferred from 2012.

P040 DCMS Equipment Replacement	**ACE 2013 Forecast**
CTs DCMS Equipment Replacement	$18,202
LIN DCMS Equipment Replacement	50,000
POT DCMS Equipment Replacement	31,000
TRE DCMS Equipment Replacement	41,627
TUC DCMS Equipment Replacement	76,276
	$217,105
Computing and Asset Management Total	**$3,448,963**

Property Improvement and Furniture

	ACE 2013 Forecast
P001 FAC - Property Improvements	$3,680,001

Year over year increases in this routine reflect an 8% increase in sustaining capital investment for NS Power facility assets. Additionally, new sustaining capital investment is required to maintain the LWS Head Office facility. In 2013, there are also some one time, smaller, individual investments included in this approval request, reflecting projects that are planned to be managed with the same approach as other work traditionally included in the routine.

P030 FAC - Lower Water Street	175,000
Property Improvement and Furniture Total	**$3,855,001**

Other

	ACE 2013 Forecast
P012 HYD - Security Improvement	$783,213
P041 FAC - Land Acquisition Routine	150,000
P816 FAC - Environment Property Remediation	297,000
P815 FAC - Environment Site Assessment	183,000
P032 FAC - Equipment & Warehouse	300,000
Other Total	**$1,713,213**
General Plant Total	**$17,752,136**

8 Appendices

8.1 2013 Capital Spending by Justification Criteria

Items in the 2013 ACE Plan have been developed using the Capital Expenditure Justification Criteria documents of 1995 and 1997. Definitions of the various criteria referenced in the following table are included in these documents.

(Millions of Dollars)

Justification Criteria	**2013 Budget**	**Individual Project Approval**	**Routine Spend**	**Less than $250K**	**Items for Later Filing 2013**	**Items for Later Filing 2012**	**Carryover**	**Pt. Aconi**
Distribution System*	$70.7	$8.8	$49.7	$0.9	$3.5	$6.9	$0.9	$0.0
Thermal	46.5	16.6	3.8	5.2	6.3	3.6	6.9	4.0
Work Support*	43.2	2.2	16.2	1.1	10.2	4.9	8.5	0
Hydro	28.9	15.5	2.5	0.1	1.7	0	9.0	0
Health and Safety	17.1	11.8	0.0	1.6	3.2	0	0.2	0.2
Transmission Plant	79.4	30.3	12.2	0.2	13.4	11.8	11.6	0
Environmental	38.7	0.3	0.7	1.1	31.6	0	4.8	0
Metering Equipment	9.6	0.0	2.6	0	5.8	0	1.2	0
System Design	0.5	0	0	0	0	0	0.5	0
Facilities/Land and Right-of-Way	2.4	0	0.2	0	0	0	2.2	0
Total	**$336.9**	**$85.5****	**$87.8****	**$10.3**	**$75.7**	**$27.2**	**$46.1**	**$4.2**

* Details of justification sub-criteria are provided on the following page.
** Total ACE Approval request of $173.3 million

8.1.1 2013 Capital Spending by Justification Sub-Criteria

(Millions of Dollars)

Justification Sub-Criteria	2013 Budget	Individual Project Approval	Routine Spend	Less than $250K	Items for Later Filing 2013	Items for Later Filing 2012	Carryover
Distribution System							
Requirement to Serve	$30.7	$0.7	$29.4	$0.0	$0.0	$0.2	$0.4
Pole Strength	8.4	0	8.2	0.2	0	0	0
Joint Use	0.9	0	0.9	0.0	0	0	0
Deteriorated Conductor	3.0	2.8	0	0.2	0	0	0
Equipment Replacement	9.4	0.9	0	0.2	2.3	6.1	0.0
Outage Performance	7.8	3.8	2.5	0.3	0	0.6	0.6
Overloaded Equipment	0.1	0	0	0.1	0	0	0
System Protection	0	0	0	0	0	0	0
Other Distribution System	10.2	0.4	8.6	0	1.2	0	0
Total	**$70.7**	**$8.8**	**$49.7**	**$0.9**	**$3.5**	**$6.9**	**$0.9**
Work Support							
Buildings	$4.4	0.0	4.2	0.2	0.0	0.0	0.0
Furniture & Fixtures	0.4	0.0	0.0	0.0	0.0	0.0	0.0
Telecommunications	9.2	0.4	0.9	0.3	2.5	4.9	0.4
Computers / IT	20.2	1.1	3.3	0.7	7.8	0.0	7.3
Tools & Equipment	1.4	0.0	1.4	0.0	0.0	0.0	0.0
Vehicles	6.4	0.0	6.4	0.0	0.0	0.0	0.0
Equipment Replacement	1.5	0.8	0.0	0.0	0.0	0.0	0.8
Other	0.1	0.0	0.1	0.0	0.0	0.0	0.0
Total	**$43.2**	**$2.2**	**$16.2**	**$1.1**	**$10.2**	**$4.9**	**$8.5**

8.2 Capital Categories

NS Power classifies capital expenditures by Function and/or Justification Criteria. NS Power also classifies capital expenditures by Category: New Items, Carryover Items, and Routine Capital Items. For further clarification, each of these latter categories is divided into sub-categories.

1. <u>New Items</u>

   This category includes new, non-routine capital items.

   (a) New Items with 2013 Completion - This category includes all new, non-routine capital items scheduled to start in 2013 and finish in 2013.
   (b) New Items with Subsequent Completion - This category includes all new, non-routine capital items scheduled to start in 2013, but which will be completed beyond 2013.

2. <u>Carryover Items</u>

   This category includes items that have been previously approved by the UARB.

   (a) Carryover Items with 2013 Completion - Includes items that will be completed during 2013.
   (b) Carryover Items with Subsequent Completion - Includes items that will be completed beyond 2013.

3. <u>Routine Capital Items</u>

   This category is for recurring annual capital expenditures.

   (a) Replacement equipment (like-for-like replacement).
   (b) Additions to existing equipment base resulting from power system growth.
   (c) The addition of customers to the power system.

8.3 Capital Functions

Capital expenditures are categorized into functions for accounting and depreciation purposes.

Generation Generation includes all items for NS Power's generation facilities. This includes replacements and additions to Thermal, Hydro, Wind, Tidal, Gas Turbine and Biomass plants.

Transmission Transmission includes items for replacement, reinforcement or expansion of the transmission system, which transmits electrical energy from the generation plants, the NB/NS Power interconnection and throughout the province. Transmission includes energy transmitted at 69 kV level or higher.

Distribution Distribution includes replacement of and additions to equipment for delivering electric energy from points on the transmission system to customers served at voltages below 69 kV.

General Plant General Plant includes computer infrastructure and communication equipment, which comprise the majority of capital expenditures incurred under this function. Other items such as furniture, office equipment and capital tools are also included under this function.

The General Plant function also includes vehicles. That is, replacement and additions to transportation and work vehicles, and construction equipment.

The General Plant function also includes all buildings except generating and substation facilities. It primarily pertains to customer service, work depot and head office facilities.

8.4 NS Power 2013 Quick Reference Sheet

2013 AFUDC Rate 7.76%

2013 O/H Rates

Generation		**Customer Operations**		**Shared Services**	
PP Regular	26.60%	Regular	73.05%	IT	50.04%
Hydro	19.36%	Contract	32.99%	T&CS	31.24%
Contractor	12.76%	Vehicle	41.23%		

8.5 2013 Depreciation Rates

	2013
Steam Production Plant	
Lingan	
Lingan 1-2	4.12%
Lingan 3-4	2.28%
Lingan - Common	4.48%
Total Lingan	3.35%
Point Aconi 1	2.27%
Point Tupper	
Point Tupper 1	3.97%
Point Tupper 2	2.82%
Total Point Tupper	2.89%
Trenton	
Trenton 5	3.10%
Trenton 6	2.34%
Trenton - Common	0.47%
Total Trenton	2.47%
Tufts Cove	
Tufts Cove 1	4.24%
Tufts Cove 2	3.68%
Tufts Cove 3	2.33%
Tufts Cove - Common	3.44%
Total Tufts Cove	3.27%
Point Tupper Marine Terminal	4.06%
General	2.82%
Total Steam Production Plant	**2.82%**

	2013
Hydraulic Production Plant	
Avon	3.02%
Bear River	1.80%
Black River	2.04%
Dickie Brook	3.16%
Fall River	1.82%
Harmony	4.55%
Lequille System	2.33%
Roseway	2.29%
St. Margaret's	2.85%
Sheet Harbour	3.38%
Tusket	2.64%
Wreck Cove System	1.67%
Annapolis Tidal	2.32%
General	2.10%
Total Hydraulic Production	**2.10%**
Other Production - Gas Turbines	
Burnside	2.40%
Tusket	6.42%
Victoria Junction	3.17%
Tufts Cove Unit 4	2.55%
Tufts Cove Unit 5	2.77%
Tufts Cove Unit 6	3.03%
Wind Turbines	
Pre 2009 Wind	5.52%
Post 2009 Wind	4.0%
Transmission Plant	
Land Rights - Easements	1.26%
Station Equipment	2.14%
Towers & Fixtures	1.26%
Poles & Fixtures	4.32%
Overhead Conductors & Devices	1.96%
Underground Conduit	1.53%
Underground Conductors & Devices	2.61%
Roads, Trails & Bridges	1.74%
Total Transmission Plant	**2.35%**

	2013
Distribution Plant	
Land Rights - Easements, Surveys & Clearing	1.56%
Structures & Improvements	5.31%
Station Equipment	1.28%
SCADA Equipment	9.68%
Remote Monitoring Equipment	10.32%
Station Equipment - Miscellaneous	12.49%
Poles, Towers & Fixtures	3.79%
Overhead Conductors & Devices	3.33%
Underground Conduit	1.51%
Underground Conductors & Devices	3.17%
Line Transformers	4.09%
Services	5.33%
Meters	6.87%
Street Lighting & Signal Systems	5.33%
Total Distribution Plant	**3.89%**
General Plant	
Land Rights - General Plant	1.93%
Structures & improvements	2.85%
Office Furniture & Equipment	9.26%
Office Furniture & Equip - Comp Hardware	20.00%
Office Furniture & Equip - Comp Software	10.00%
Transportation Equipment	9.55%
Stores Equipment	14.97%
Communication Equipment	4.38%
Communication Equipment - SCADA Eq	1.33%
Remote Monitoring Equipment	10.27%
Miscellaneous Equipment	5.02%
Roads, Bridges & Traps (Kelly Rock)	2.58%
Mining Equipment (Kelly Rock)	2.92%
Total General Plant	**8.16%**

8.6 Glossary of Terms

Capacitor	A device used by electrical utilities to maintain voltage on a distribution or a transmission line.
Capacity	The load for which a generating unit, generating station, or other electrical apparatus is rated. Several capacity values may be identified as follows: Maximum: the maximum output that can be achieved Nameplate: the maximum output specified by the manufacturer Dependable: the maximum output that can be reliably supplied during peak load months (December, January, and February) Firm: based on dependable capacity, unit availability and system characteristics
Cogeneration	The generation of electricity in conjunction with the production of useful heat, usually steam.
Conductor	One or more wires, usually aluminum or copper, connected together and designed to carry an electrical current. These wires may be bare or insulated.
Demand	The rate at which electric energy is delivered at a given instant or averaged over some designated period of time, expressed in kilowatts, megawatts, and other larger units. Also called “load” or “power”.
Distribution System	The facilities (i.e. lines, transformers, switches and sub-stations) used to distribute electricity over short distances from the transmission system to the customer, generally at voltages below 69 kV.
Energy Terms	kWh is a measure of energy equal to 1000 watts, over a period of one hour. MWh is a measure of energy equal to 1000 kilowatt hours. GWh is a measure of energy equal to 1000 megawatt hours.

Electrical Generation	The process of transforming other forms of energy into electrical energy. At Nova Scotia Power, this means using coal, oil, natural gas, diesel fuel, water or wind as fuel for the process to create electrical energy.
Feeder	An electric line for supplying electrical energy within an electric service area or subarea.
Heat Rate	A measure of the thermal efficiency of a generation station, generally expressed as Btu per net kWh. The lower the heat rate (the fewer Btu's required to produce a kilowatt hour of electricity), the more efficient the generating unit.
Line	A term used to describe a section of either distribution or transmission conductor, and its supporting hardware towers and insulators.
Load	See Demand.
Load Factor	The ratio of energy supplied during a given period to the maximum that could have been supplied had the peak load in that period been maintained in all hours.
Recloser	A heavy duty power switch capable of detecting abnormal power flows, then automatically opening and closing according to preset instructions.
Relay	A piece of equipment used to monitor quantities such as current, pressure, liquid levels, voltage or temperature and take action when these quantities are outside prescribed limits.
Substation	A facility for switching circuits and/or transforming electrical energy from one voltage to another.
Three Phase	Three separate conductors, each at the same nominal voltage, used to supply power primarily to large customers.
Transformer	An electromagnetic device for changing voltage from one level to another.
Transmission System	The facilities (i.e. lines, transformers, switches and substations) used to transmit electrical energy from the generating stations throughout the province and NB Power/NSPI interconnection to various parts of the transmission system, generally at voltages of 69 kV and higher.

Generation

ACE 2013 Weymouth Projects

There are five projects related to the Weymouth Generating Station. They are as follows:

- CI 40308 - Pipeline Replacement for $ 6,752,759
- CI 43039 - Surge Tank Refurbishment for $ 2,738,175
- CI 17582 - Electrical Refurbishment for $ 1,641,359
- CI 43136 - Headcover Replacement for $ 438,158
- CI 20571 - Tailrace Deck Refurbishment for $ 371,469

NS Power intends to invest in the Weymouth Generating Station to ensure its reliability in the long-term. An Economic Analysis Model (EAM) is provided for the "suite" of projects to demonstrate that it is economically beneficial to invest in this system, versus decommissioning.

For each project that is economically-justified within this suite, namely CI 43039 – Surge Tank Refurbishment and CI 40308 – Pipeline Replacement, a project specific EAM is provided to quantify the benefits of each project, and demonstrate NS Power's evaluation of options.

HYD Weymouth System Projects
Summary of Alternatives

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Hydro	**CI Number:**	17581
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Complete Weymouth Capital Work	6.48%	8,925,373	1	14.76%	10.2 years
B	Decommission Weymouth	6.48%	-2,715,267	4	-7.01%	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

This EAM has been developed for the suite of projects proposed for the Weymouth system in 2013. Project specific EAMs are provided for each project within this suite that are economically justified.
It is recommended that the capital work at Weymouth be completed.

Notes/Comments :

Complete Weymouth Capital Work

The capital work at Weymouth includes CI 17582 - Electrical Refurbishment for approx. $1,641K, CI 20571 - Tailrace Deck Refurbishment for approx $350K, CI 43136 - Headcover Replacement for $411K, CI 43039 - Surge Tank Refurbishment for $2,363K and CI 40308 - Pipeline Replacement for $6,292K. All values noted here include AO and AFUDC.

Decommission Weymouth

This option considers decommissioning the Weymouth unit and not completing any of the planned 2013 capital work.

Test 3

Test 4

HYD Weymouth System Projects
Avoided Cost Calculations

Division :	Production	**Date :**	**31-Oct-12**
Department :	Hydro	**CI Number:**	17581
Originator :		**Project No. :**	

Complete Weymouth Capital Work

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**1**	**1**	**1**	**1**		
Probability of Occurance (%)	**100%**	**100%**	**100%**	**100%**		
Capacity Factor (%)	**100%**	**100%**				
Energy Replaced (MW)	[redacted]					
Duration (Hours)	**0.50**	**1.00**				
Totals	**$925,200**	**$1,855,200**	**$0**	**$0**	**$925,200**	**$1,855,200**
Total Capital Cost of Alternative						**$11,941,991**

Decommission Weymouth

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	**100%**	**100%**				
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$3,285,903**

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	**100%**	**100%**				
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

Test 4

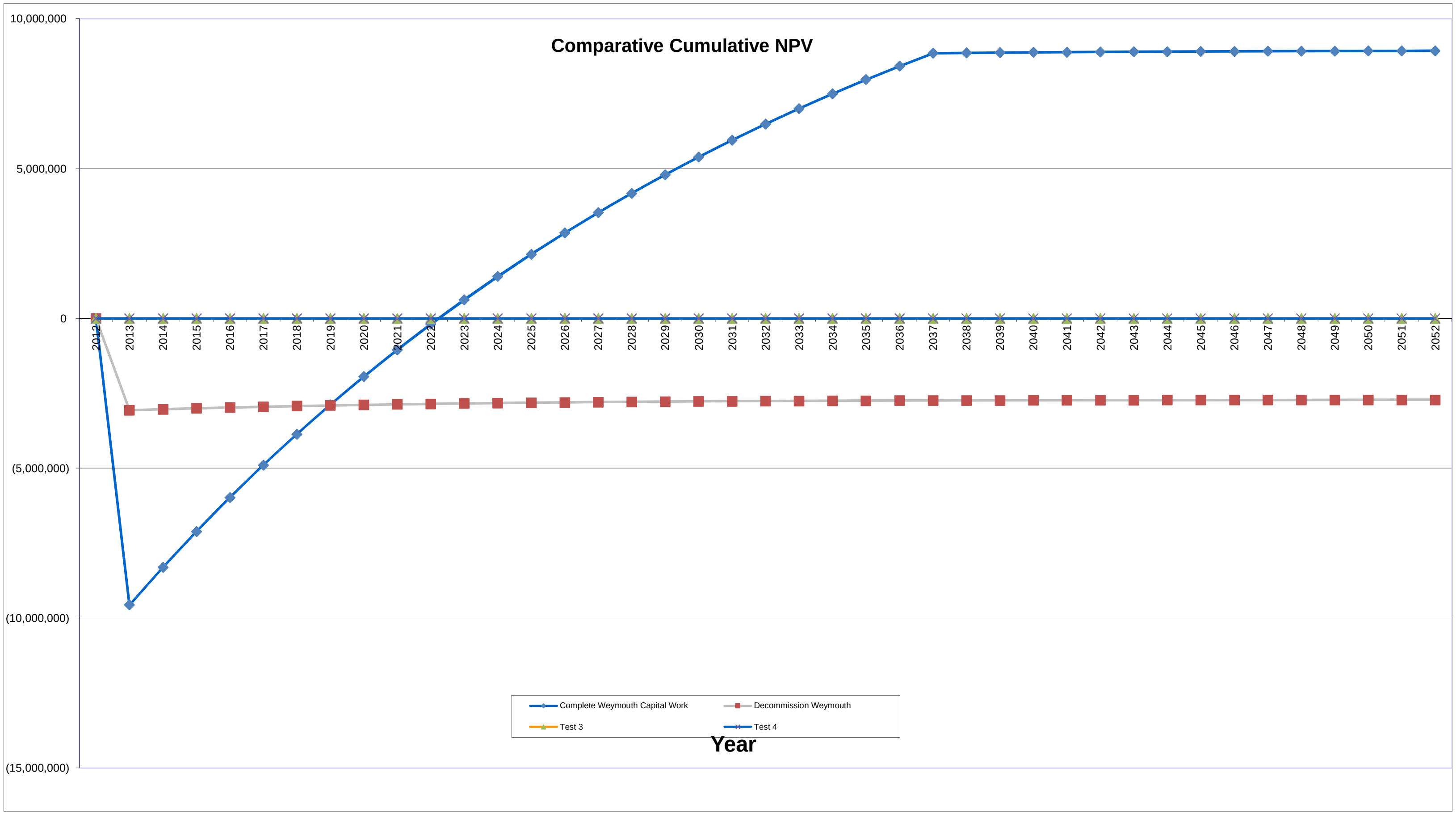
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	**100%**	**100%**				
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

HYD Weymouth System Projects
Complete Weymouth Capital Work

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	925,200.0	(10,882,847.0)	230,746.5	10,886,856.9	(9,957,647.0)	(215,280.6)	(10,172,927.6)	(9,553,838.822)	0.9	(9,553,838.8)
2014	-	1,855,200.0	-	451,598.5	10,435,258.4	1,855,200.0	(435,116.5)	1,420,083.5	1,252,500.196	0.9	(8,301,338.6)
2015	-	1,892,304.0	-	432,257.9	10,003,000.5	1,892,304.0	(452,614.3)	1,439,689.7	1,192,517.543	0.8	(7,108,821.1)
2016	-	1,930,150.1	-	413,792.6	9,589,207.8	1,930,150.1	(470,070.8)	1,460,079.3	1,135,806.277	0.8	(5,973,014.8)
2017	-	1,968,753.1	-	396,159.4	9,193,048.5	1,968,753.1	(487,504.0)	1,481,249.0	1,082,151.008	0.7	(4,890,863.8)
2018	-	2,008,128.1	-	379,317.5	8,813,731.0	2,008,128.1	(504,931.3)	1,503,196.8	1,031,353.625	0.7	(3,859,510.2)
2019	-	2,048,290.7	-	363,228.4	8,450,502.5	2,048,290.7	(522,369.3)	1,525,921.4	983,231.686	0.6	(2,876,278.5)
2020	-	2,089,256.5	-	347,855.8	8,102,646.8	2,089,256.5	(539,834.2)	1,549,422.3	937,616.968	0.6	(1,938,661.5)
2021	-	2,131,041.7	-	333,165.0	7,769,481.7	2,131,041.7	(557,341.7)	1,573,699.9	894,354.168	0.6	(1,044,307.4)
2022	-	2,173,662.5	-	319,123.6	7,450,358.1	2,173,662.5	(574,907.0)	1,598,755.4	853,299.735	0.5	(191,007.6)
2023	-	2,217,135.7	-	305,700.7	7,144,657.5	2,217,135.7	(592,544.9)	1,624,590.9	814,320.820	0.5	623,313.2
2024	-	2,261,478.4	-	292,866.8	6,851,790.6	2,261,478.4	(610,269.6)	1,651,208.9	777,294.328	0.5	1,400,607.5
2025	-	2,306,708.0	-	280,594.5	6,571,196.1	2,306,708.0	(628,095.2)	1,678,612.8	742,106.069	0.4	2,142,713.6
2026	-	2,352,842.2	-	268,857.2	6,302,338.9	2,352,842.2	(646,035.3)	1,706,806.8	708,649.985	0.4	2,851,363.6
2027	-	2,399,899.0	-	257,630.2	6,044,708.6	2,399,899.0	(664,103.3)	1,735,795.7	676,827.461	0.4	3,528,191.0
2028	-	2,447,897.0	-	246,889.8	5,797,818.8	2,447,897.0	(682,312.2)	1,765,584.8	646,546.692	0.4	4,174,737.7
2029	-	2,496,854.9	-	236,613.5	5,561,205.4	2,496,854.9	(700,674.9)	1,796,180.1	617,722.122	0.3	4,792,459.9
2030	-	2,546,792.0	-	226,779.9	5,334,425.4	2,546,792.0	(719,203.7)	1,827,588.3	590,273.930	0.3	5,382,733.8
2031	-	2,597,727.9	-	217,369.0	5,117,056.4	2,597,727.9	(737,911.3)	1,859,816.6	564,127.562	0.3	5,946,861.4
2032	-	2,649,682.4	-	208,361.4	4,908,695.1	2,649,682.4	(756,809.5)	1,892,872.9	539,213.313	0.3	6,486,074.7
2033	-	2,702,676.1	-	199,738.8	4,708,956.2	2,702,676.1	(775,910.6)	1,926,765.5	515,465.944	0.3	7,001,540.6
2034	-	2,756,729.6	-	191,484.0	4,517,472.3	2,756,729.6	(795,226.2)	1,961,503.5	492,824.334	0.3	7,494,364.9
2035	-	2,811,864.2	-	183,580.3	4,333,892.0	2,811,864.2	(814,768.0)	1,997,096.2	471,231.164	0.2	7,965,596.1
2036	-	2,868,101.5	-	176,012.0	4,157,880.0	2,868,101.5	(834,547.7)	2,033,553.8	450,632.632	0.2	8,416,228.7
2037	-	2,925,463.5	-	168,764.3	3,989,115.7	2,925,463.5	(854,576.8)	2,070,886.8	430,978.186	0.2	8,847,206.9
2038	-	-	-	161,822.8	3,827,292.9	-	50,165.1	50,165.1	9,804.657	0.2	8,857,011.6
2039	-	-	-	155,174.1	3,672,118.8	-	48,104.0	48,104.0	8,829.656	0.2	8,865,841.2
2040	-	-	-	148,805.2	3,523,313.6	-	46,129.6	46,129.6	7,951.966	0.2	8,873,793.2
2041	-	-	-	142,703.8	3,380,609.8	-	44,238.2	44,238.2	7,161.828	0.2	8,880,955.0
2042	-	-	-	136,858.2	3,243,751.7	-	42,426.0	42,426.0	6,450.467	0.2	8,887,405.5
2043	-	-	-	131,257.2	3,112,494.4	-	40,689.7	40,689.7	5,809.993	0.1	8,893,215.5
2044	-	-	-	125,890.3	2,986,604.2	-	39,026.0	39,026.0	5,233.310	0.1	8,898,448.8
2045	-	-	-	120,747.2	2,865,857.0	-	37,431.6	37,431.6	4,714.040	0.1	8,903,162.8
2046	-	-	-	115,818.2	2,750,038.8	-	35,903.7	35,903.7	4,246.442	0.1	8,907,409.3
2047	-	-	-	111,094.2	2,638,944.6	-	34,439.2	34,439.2	3,825.354	0.1	8,911,234.6
2048	-	-	-	106,566.3	2,532,378.2	-	33,035.6	33,035.6	3,446.134	0.1	8,914,680.8
2049	-	-	-	102,226.2	2,430,152.1	-	31,690.1	31,690.1	3,104.604	0.1	8,917,785.4
2050	-	-	-	98,065.7	2,332,086.4	-	30,400.4	30,400.4	2,797.004	0.1	8,920,582.4
2051	-	-	-	94,077.2	2,238,009.2	-	29,163.9	29,163.9	2,519.952	0.1	8,923,102.3
2052	-	-	-	90,253.4	2,147,755.8	-	27,978.5	27,978.5	2,270.406	0.1	8,925,372.7
Total	-	57,363,839.3	(10,882,847.0)	8,969,847.5	215,716,708.7	46,480,992.3	(15,002,137.4)	31,478,854.8	8,925,372.7		

HYD Weymouth System Projects
Decommission Weymouth

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	-	(3,285,903.0)	65,718.1	3,285,903.0	(3,285,903.0)	20,372.6	(3,265,530.4)	(3,066,801.654)	0.9	(3,066,801.7)
2014	-	-	-	128,807.4	3,091,377.5	-	39,930.3	39,930.3	35,218.140	0.9	(3,031,583.5)
2015	-	-	-	123,655.1	2,967,722.4	-	38,333.1	38,333.1	31,751.892	0.8	(2,999,831.6)
2016	-	-	-	118,708.9	2,849,013.5	-	36,799.8	36,799.8	28,626.799	0.8	(2,971,204.8)
2017	-	-	-	113,960.5	2,735,053.0	-	35,327.8	35,327.8	25,809.286	0.7	(2,945,395.5)
2018	-	-	-	109,402.1	2,625,650.9	-	33,914.7	33,914.7	23,269.078	0.7	(2,922,126.5)
2019	-	-	-	105,026.0	2,520,624.8	-	32,558.1	32,558.1	20,978.883	0.6	(2,901,147.6)
2020	-	-	-	100,825.0	2,419,799.9	-	31,255.7	31,255.7	18,914.095	0.6	(2,882,233.5)
2021	-	-	-	96,792.0	2,323,007.9	-	30,005.5	30,005.5	17,052.527	0.6	(2,865,181.0)
2022	-	-	-	92,920.3	2,230,087.5	-	28,805.3	28,805.3	15,374.179	0.5	(2,849,806.8)
2023	-	-	-	89,203.5	2,140,884.0	-	27,653.1	27,653.1	13,861.018	0.5	(2,835,945.8)
2024	-	-	-	85,635.4	2,055,248.7	-	26,547.0	26,547.0	12,496.786	0.5	(2,823,449.0)
2025	-	-	-	82,209.9	1,973,038.7	-	25,485.1	25,485.1	11,266.824	0.4	(2,812,182.1)
2026	-	-	-	78,921.5	1,894,117.2	-	24,465.7	24,465.7	10,157.918	0.4	(2,802,024.2)
2027	-	-	-	75,764.7	1,818,352.5	-	23,487.1	23,487.1	9,158.153	0.4	(2,792,866.1)
2028	-	-	-	72,734.1	1,745,618.4	-	22,547.6	22,547.6	8,256.787	0.4	(2,784,609.3)
2029	-	-	-	69,824.7	1,675,793.7	-	21,645.7	21,645.7	7,444.136	0.3	(2,777,165.2)
2030	-	-	-	67,031.7	1,608,761.9	-	20,779.8	20,779.8	6,711.467	0.3	(2,770,453.7)
2031	-	-	-	64,350.5	1,544,411.4	-	19,948.6	19,948.6	6,050.909	0.3	(2,764,402.8)
2032	-	-	-	61,776.5	1,482,635.0	-	19,150.7	19,150.7	5,455.365	0.3	(2,758,947.4)
2033	-	-	-	59,305.4	1,423,329.6	-	18,384.7	18,384.7	4,918.436	0.3	(2,754,029.0)
2034	-	-	-	56,933.2	1,366,396.4	-	17,649.3	17,649.3	4,434.353	0.3	(2,749,594.6)
2035	-	-	-	54,655.9	1,311,740.5	-	16,943.3	16,943.3	3,997.914	0.2	(2,745,596.7)
2036	-	-	-	52,469.6	1,259,270.9	-	16,265.6	16,265.6	3,604.430	0.2	(2,741,992.3)
2037	-	-	-	50,370.8	1,208,900.1	-	15,615.0	15,615.0	3,249.674	0.2	(2,738,742.6)
2038	-	-	-	48,356.0	1,160,544.1	-	14,990.4	14,990.4	2,929.834	0.2	(2,735,812.8)
2039	-	-	-	46,421.8	1,114,122.3	-	14,390.7	14,390.7	2,641.473	0.2	(2,733,171.3)
2040	-	-	-	44,564.9	1,069,557.4	-	13,815.1	13,815.1	2,381.493	0.2	(2,730,789.8)
2041	-	-	-	42,782.3	1,026,775.1	-	13,262.5	13,262.5	2,147.101	0.2	(2,728,642.7)
2042	-	-	-	41,071.0	985,704.1	-	12,732.0	12,732.0	1,935.779	0.2	(2,726,706.9)
2043	-	-	-	39,428.2	946,276.0	-	12,222.7	12,222.7	1,745.255	0.1	(2,724,961.7)
2044	-	-	-	37,851.0	908,424.9	-	11,733.8	11,733.8	1,573.483	0.1	(2,723,388.2)
2045	-	-	-	36,337.0	872,087.9	-	11,264.5	11,264.5	1,418.618	0.1	(2,721,969.6)
2046	-	-	-	34,883.5	837,204.4	-	10,813.9	10,813.9	1,278.994	0.1	(2,720,690.6)
2047	-	-	-	33,488.2	803,716.2	-	10,381.3	10,381.3	1,153.113	0.1	(2,719,537.5)
2048	-	-	-	32,148.6	771,567.6	-	9,966.1	9,966.1	1,039.621	0.1	(2,718,497.8)
2049	-	-	-	30,862.7	740,704.9	-	9,567.4	9,567.4	937.299	0.1	(2,717,560.5)
2050	-	-	-	29,628.2	711,076.7	-	9,184.7	9,184.7	845.048	0.1	(2,716,715.5)
2051	-	-	-	28,443.1	682,633.6	-	8,817.4	8,817.4	761.876	0.1	(2,715,953.6)
2052	-	-	-	27,305.3	655,328.3	-	8,464.7	8,464.7	686.891	0.1	(2,715,266.7)
Total	-	-	(3,285,903.0)	2,630,574.7	64,842,463.1	(3,285,903.0)	815,478.2	(2,470,424.8)	(2,715,266.7)		


Comparative Cumulative NPV
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Complete Weymouth Capital Work
Decommission Weymouth
Test 3
Test 4
Year

CI Number: 40308

Title: **HYD - Weymouth Falls Pipeline Replacement**

Start Date: 2011/09
Final Cost Date: 2014/04
Function: Generation
Forecast Amount: $6,752,759

DESCRIPTION:

This item consists of replacing both woodstave pipelines at the Weymouth Falls Generating Station.

Project life is estimated to be approximately 80 years.

The project will be depreciated in the Bear River depreciation class.

Summary of Related CIs +/- 2 years:
2013 CI 17581 - HYD Weymouth Electrical Replacement $1,641,359
2013 CI 20571 - HYD Weymouth Falls Tailrace Deck Refurbishment $371,469
2013 CI 43039 - HYD Weymouth Surge Tank $2,738,175
2013 CI 43136 - HYD Weymouth Headcover Replacement $438,158

JUSTIFICATION:

Justification Criteria: Hydro

Sub Criteria: Equipment Replacement

Why do this project?

The woodstave pipelines at the Weymouth Falls Generating Station were constructed in the early 1960s, and are in poor physical condition. The strength of woodstave pipe comes from the banding hardware. Failure of one band can cause the pipe to rupture because the unbanded wood must span a greater distance, and the stresses in the wood fibres are greatly increased. The pipeline has already experienced localized failures due to banding failure, as well as the condition of the wood. The life of the pipe can no longer be extended by patching and the addition of bands.

Why do this project now?

Repair work has been carried out on the pipelines over the years, and pipeline life can no longer be extended through patching and the addition of bands. The pipelines, an integral part of the Weymouth Falls Generating Station, are currently considered to be unreliable. A loss of either of these pipelines may result in an extended outage of the plant.

Why do this project this way?

Replacement of the woodstave pipe with Fibre Reinforced Plastic (FRP) pipe is most cost efficient option.

CI Number : 40308-H626 - HYD - Weymouth Falls Pipeline Replacement Unit 1&2 **Project Number** H626

Parent CI Number : -

Cost Centre : 411 - 411-Sissiboo/Weymouth System **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		139,182	0	139,182
095		095-Hydro Regular Labour AO		3,725	0	3,725
095		095-Hydro Overtime Labour AO		3,388	0	3,388
095		095-Hydro Term Labour AO		[redacted]	0	[redacted]
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
001	027	001 - HYDRO Regular Labour	027 - HGP - Waterways	19,138	0	19,138
002	027	002 - HYDRO Overtime Labour	027 - HGP - Waterways	35,000	0	35,000
004	027	004 - HYDRO Term Labour	027 - HGP - Waterways	35,000	0	35,000
011	027	011 - Travel Expense	027 - HGP - Waterways	30,000	0	30,000
012	027	012 - Materials	027 - HGP - Waterways	[redacted]	0	[redacted]
013	027	013 - POWER PRODUCTION Contracts	027 - HGP - Waterways	[redacted]	0	[redacted]
028	027	028 - Consulting	027 - HGP - Waterways	89,017	0	89,017
041	027	041 - Meals & Entertainment	027 - HGP - Waterways	7,000	0	7,000
066	027	066 - Other Goods & Services	027 - HGP - Waterways	700	0	700
001	085	001 - HYDRO Regular Labour	085 Design	302	0	302
028	085	028 - Consulting	085 Design	77,963	0	77,963
			Total Cost:	6,752,759	0	6,752,759
			Original Cost:	872,696		

HYD Weymouth Pipeline Replacements
Summary of Alternatives

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Hydro	**CI Number:**	40308
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Existing pipeline with FRP	6.48%	5,776,553	1	11.07%	17.3 years
B	Replace Existing pipeline with Steel	6.48%	2,613,019	2	8.07%	23.5 years
C	Replace Existing pipeline with HDPE	6.48%	0	3	#NUM!	0.0 years
D	Test 4	6.48%	0	3	#NUM!	0.0 years

Recommendation :

This EAM has been developed specifically for CI 40808. A system-wide EAM has also been provided.
It is recommended the woodstave pipelines be replaced with FRP pipe as opposed to HDPE or Steel pipe.

Notes/Comments :

Replace Existing pipeline with FRP

This option is for the replacement of the Weymouth Pipeline with FRP (fibre reinforced plastic) pipe. Number of repairable failures is assumed to increase each year until 2013 when the condition of the pipeline is beyond repair.

Replace Existing pipeline with Steel

This option is for the replacement of the Weymouth Pipeline with Steel pipe. The same assumptions are made in this option as made above.

Replace Existing pipeline with HDPE

High density polyethylene (HDPE) pipe is not a viable option as the HDPE cannot withstand the required pressure that a pipe of this size produces. This option is not evaluated further.

Test 4

HYD Weymouth Pipeline Replacements
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Hydro	CI Number:	40308
Originator :		Project No. :	

Replace Existing pipeline with FRP

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$5,100	$5,202		
Events/Outages (#)	2	2	2	2		
Probability of Occurance (%)	65%	80%	65%	80%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	4.56	4.56				
Duration (Hours)	72	72				
Totals	$19,745	$24,364	$6,630	$8,323	$26,375	$32,687
Total Capital Cost of Alternative						$6,752,759

Replace Existing pipeline with Steel

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$5,100	$5,202		
Events/Outages (#)	2	2	2	2		
Probability of Occurance (%)	65%	80%	65%	80%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	4.56	4.56				
Duration (Hours)	72	72				
Totals	$19,745	$24,364	$6,630	$8,323	$26,375	$32,687
Total Capital Cost of Alternative						$10,106,854

Replace Existing pipeline with HDPE

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

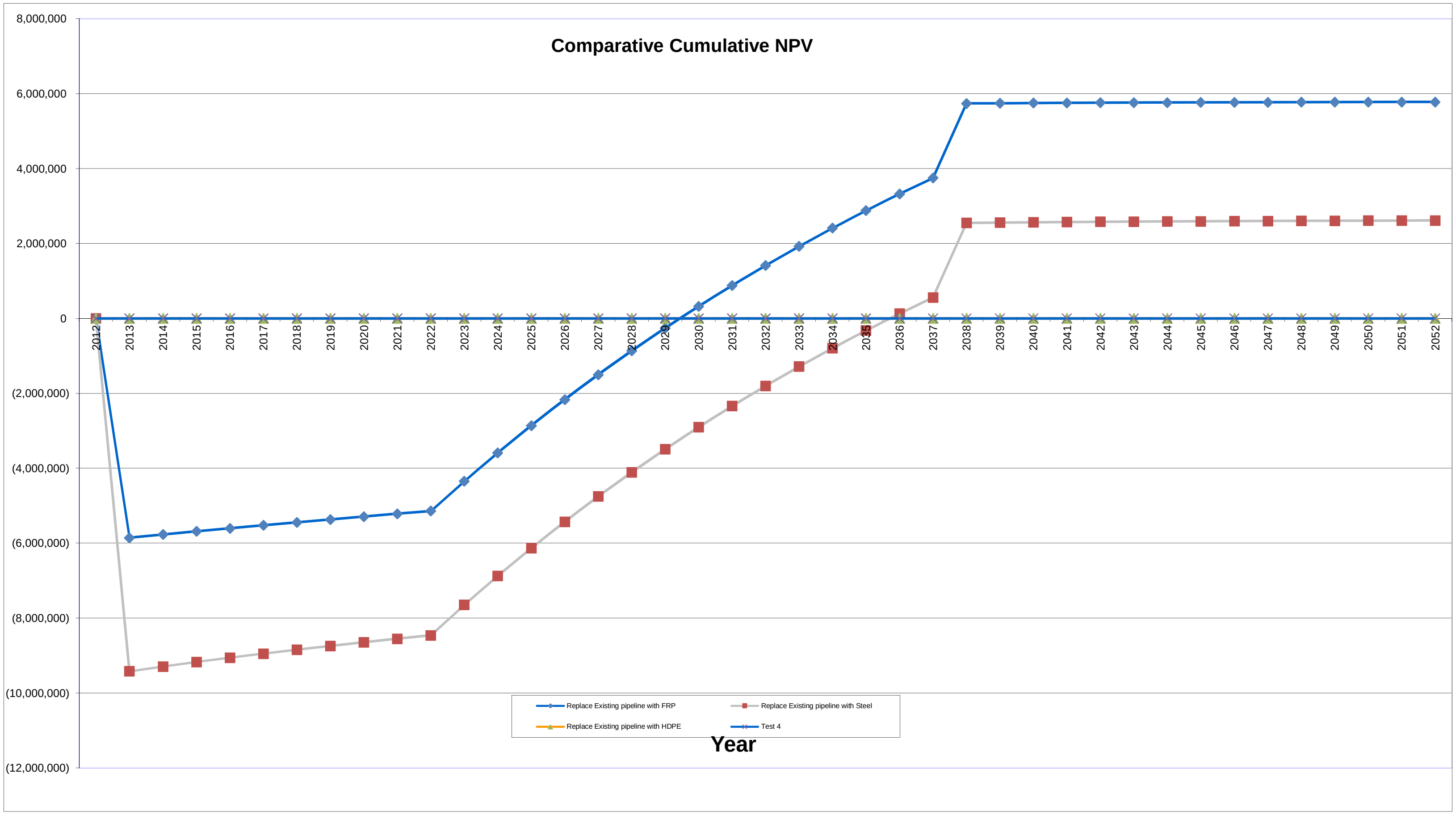
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

HYD Weymouth Pipeline Replacements
Replace Existing pipeline with FRP

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	26,374.5	(6,291,660.0)	127,764.7	6,260,470.4	(6,265,285.5)	31,431.0	(6,233,854.5)	(5,854,483.970)	0.9	(5,854,484.0)
2014	-	32,687.2	-	250,418.8	6,010,051.6	32,687.2	67,496.8	100,184.0	88,361.321	0.9	(5,766,122.6)
2015	-	41,676.1	-	240,402.1	5,769,649.5	41,676.1	61,605.0	103,281.2	85,549.417	0.8	(5,680,573.2)
2016	-	47,823.4	-	230,786.0	5,538,863.5	47,823.4	56,718.4	104,541.8	81,323.812	0.8	(5,599,249.4)
2017	-	58,535.8	-	221,554.5	5,317,309.0	58,535.8	50,535.8	109,071.6	79,684.075	0.7	(5,519,565.3)
2018	-	66,340.6	-	212,692.4	5,104,616.6	66,340.6	45,369.1	111,709.6	76,644.744	0.7	(5,442,920.6)
2019	-	81,200.9	-	204,184.7	4,900,432.0	81,200.9	38,125.0	119,325.8	76,887.942	0.6	(5,366,032.7)
2020	-	92,027.7	-	196,017.3	4,704,414.7	92,027.7	32,236.8	124,264.4	75,197.349	0.6	(5,290,835.3)
2021	-	111,468.5	-	188,176.6	4,516,238.1	111,468.5	23,779.5	135,248.0	76,863.206	0.6	(5,213,972.1)
2022	-	119,682.0	-	180,649.5	4,335,588.6	119,682.0	18,899.9	138,581.9	73,964.976	0.5	(5,140,007.1)
2023	-	2,220,337.3	-	173,423.5	4,162,165.0	2,220,337.3	(634,543.3)	1,585,794.0	794,874.039	0.5	(4,345,133.1)
2024	-	2,264,744.0	-	166,486.6	3,995,678.4	2,264,744.0	(650,459.8)	1,614,284.2	759,912.340	0.5	(3,585,220.8)
2025	-	2,310,038.9	-	159,827.1	3,835,851.3	2,310,038.9	(666,565.7)	1,643,473.3	726,571.057	0.4	(2,858,649.7)
2026	-	2,356,239.7	-	153,434.1	3,682,417.2	2,356,239.7	(682,869.8)	1,673,370.0	694,767.304	0.4	(2,163,882.4)
2027	-	2,403,364.5	-	147,296.7	3,535,120.6	2,403,364.5	(699,381.0)	1,703,983.5	664,423.130	0.4	(1,499,459.3)
2028	-	2,451,431.8	-	141,404.8	3,393,715.7	2,451,431.8	(716,108.4)	1,735,323.4	635,465.169	0.4	(863,994.1)
2029	-	2,500,460.4	-	135,748.6	3,257,967.1	2,500,460.4	(733,060.7)	1,767,399.8	607,824.319	0.3	(256,169.8)
2030	-	2,550,469.6	-	130,318.7	3,127,648.4	2,550,469.6	(750,246.8)	1,800,222.8	581,435.444	0.3	325,265.7
2031	-	2,601,479.0	-	125,105.9	3,002,542.5	2,601,479.0	(767,675.7)	1,833,803.4	556,237.109	0.3	881,502.8
2032	-	2,653,508.6	-	120,101.7	2,882,440.8	2,653,508.6	(785,356.1)	1,868,152.5	532,171.323	0.3	1,413,674.1
2033	-	2,706,578.8	-	115,297.6	2,767,143.2	2,706,578.8	(803,297.2)	1,903,281.6	509,183.313	0.3	1,922,857.4
2034	-	2,760,710.4	-	110,685.7	2,656,457.4	2,760,710.4	(821,507.6)	1,939,202.7	487,221.313	0.3	2,410,078.7
2035	-	2,815,924.6	-	106,258.3	2,550,199.1	2,815,924.6	(839,996.5)	1,975,928.0	466,236.364	0.2	2,876,315.1
2036	-	2,872,243.1	-	102,008.0	2,448,191.2	2,872,243.1	(858,772.9)	2,013,470.2	446,182.140	0.2	3,322,497.2
2037	-	2,929,687.9	-	97,927.6	2,350,263.5	2,929,687.9	(877,845.7)	2,051,842.2	427,014.775	0.2	3,749,512.0
2038	-	14,692,384.9	-	94,010.5	2,256,253.0	14,692,384.9	(4,525,496.0)	10,166,888.8	1,987,096.559	0.2	5,736,608.6
2039	-	-	-	90,250.1	2,166,002.9	-	27,977.5	27,977.5	5,135.377	0.2	5,741,743.9
2040	-	-	-	86,640.1	2,079,362.7	-	26,858.4	26,858.4	4,629.942	0.2	5,746,373.9
2041	-	-	-	83,174.5	1,996,188.2	-	25,784.1	25,784.1	4,174.252	0.2	5,750,548.1
2042	-	-	-	79,847.5	1,916,340.7	-	24,752.7	24,752.7	3,763.413	0.2	5,754,311.6
2043	-	-	-	76,653.6	1,839,687.1	-	23,762.6	23,762.6	3,393.010	0.1	5,757,704.6
2044	-	-	-	73,587.5	1,766,099.6	-	22,812.1	22,812.1	3,059.062	0.1	5,760,763.6
2045	-	-	-	70,644.0	1,695,455.6	-	21,899.6	21,899.6	2,757.982	0.1	5,763,521.6
2046	-	-	-	67,818.2	1,627,637.4	-	21,023.6	21,023.6	2,486.536	0.1	5,766,008.1
2047	-	-	-	65,105.5	1,562,531.9	-	20,182.7	20,182.7	2,241.805	0.1	5,768,249.9
2048	-	-	-	62,501.3	1,500,030.6	-	19,375.4	19,375.4	2,021.162	0.1	5,770,271.1
2049	-	-	-	60,001.2	1,440,029.4	-	18,600.4	18,600.4	1,822.234	0.1	5,772,093.3
2050	-	-	-	57,601.2	1,382,428.2	-	17,856.4	17,856.4	1,642.886	0.1	5,773,736.2
2051	-	-	-	55,297.1	1,327,131.1	-	17,142.1	17,142.1	1,481.189	0.1	5,775,217.4
2052	-	-	-	53,085.2	1,274,045.8	-	16,456.4	16,456.4	1,335.407	0.1	5,776,552.8
Total	-	53,767,420.1	(6,291,660.0)	5,114,189.3	125,934,659.7	47,475,760.1	(15,082,501.6)	32,393,258.5	5,776,552.8		

HYD Weymouth Pipeline Replacements
Replace Existing pipeline with Steel

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	26,374.5	(10,106,854.0)	202,137.1	10,106,854.0	(10,080,479.5)	54,486.4	(10,025,993.1)	(9,415,846.257)	0.9	(9,415,846.3)
2014	-	32,687.2	-	396,188.7	9,508,528.2	32,687.2	112,685.5	145,372.6	128,217.288	0.9	(9,287,629.0)
2015	-	41,676.1	-	380,341.1	9,128,187.1	41,676.1	104,986.1	146,662.3	121,482.670	0.8	(9,166,146.3)
2016	-	47,823.4	-	365,127.5	8,763,059.6	47,823.4	98,364.3	146,187.6	113,720.434	0.8	(9,052,425.9)
2017	-	58,535.8	-	350,522.4	8,412,537.2	58,535.8	90,515.8	149,051.6	108,892.149	0.7	(8,943,533.7)
2018	-	66,340.6	-	336,501.5	8,076,035.8	66,340.6	83,749.9	150,090.5	102,978.093	0.7	(8,840,555.6)
2019	-	81,200.9	-	323,041.4	7,752,994.3	81,200.9	74,970.6	156,171.4	100,629.505	0.6	(8,739,926.1)
2020	-	92,027.7	-	310,119.8	7,442,874.6	92,027.7	67,608.6	159,636.2	96,602.214	0.6	(8,643,323.9)
2021	-	111,468.5	-	297,715.0	7,145,159.6	111,468.5	57,736.4	169,204.9	96,161.356	0.6	(8,547,162.5)
2022	-	119,682.0	-	285,806.4	6,859,353.2	119,682.0	51,498.6	171,180.5	91,363.759	0.5	(8,455,798.8)
2023	-	2,220,337.3	-	274,374.1	6,584,979.1	2,220,337.3	(603,248.6)	1,617,088.7	810,560.395	0.5	(7,645,238.4)
2024	-	2,264,744.0	-	263,399.2	6,321,579.9	2,264,744.0	(620,416.9)	1,644,327.1	774,054.809	0.5	(6,871,183.6)
2025	-	2,310,038.9	-	252,863.2	6,068,716.7	2,310,038.9	(637,724.5)	1,672,314.5	739,321.593	0.4	(6,131,862.0)
2026	-	2,356,239.7	-	242,748.7	5,825,968.0	2,356,239.7	(655,182.2)	1,701,057.5	706,262.903	0.4	(5,425,599.1)
2027	-	2,403,364.5	-	233,038.7	5,592,929.3	2,403,364.5	(672,801.0)	1,730,563.5	674,787.307	0.4	(4,750,811.8)
2028	-	2,451,431.8	-	223,717.2	5,369,212.1	2,451,431.8	(690,591.5)	1,760,840.3	644,809.281	0.4	(4,106,002.5)
2029	-	2,500,460.4	-	214,768.5	5,154,443.7	2,500,460.4	(708,564.5)	1,791,895.9	616,248.762	0.3	(3,489,753.7)
2030	-	2,550,469.6	-	206,177.7	4,948,265.9	2,550,469.6	(726,730.5)	1,823,739.1	589,030.735	0.3	(2,900,723.0)
2031	-	2,601,479.0	-	197,930.6	4,750,335.3	2,601,479.0	(745,100.0)	1,856,379.0	563,084.854	0.3	(2,337,638.1)
2032	-	2,653,508.6	-	190,013.4	4,560,321.9	2,653,508.6	(763,683.5)	1,889,825.1	538,345.098	0.3	(1,799,293.1)
2033	-	2,706,578.8	-	182,412.9	4,377,909.0	2,706,578.8	(782,491.4)	1,924,087.3	514,749.451	0.3	(1,284,543.6)
2034	-	2,760,710.4	-	175,116.4	4,202,792.6	2,760,710.4	(801,534.1)	1,959,176.2	492,239.619	0.3	(792,304.0)
2035	-	2,815,924.6	-	168,111.7	4,034,680.9	2,815,924.6	(820,822.0)	1,995,102.6	470,760.757	0.2	(321,543.2)
2036	-	2,872,243.1	-	161,387.2	3,873,293.7	2,872,243.1	(840,365.3)	2,031,877.8	450,261.232	0.2	128,718.0
2037	-	2,929,687.9	-	154,931.7	3,718,361.9	2,929,687.9	(860,174.4)	2,069,513.5	430,692.394	0.2	559,410.4
2038	-	14,692,384.9	-	148,734.5	3,569,627.5	14,692,384.9	(4,508,531.6)	10,183,853.3	1,990,412.218	0.2	2,549,822.6
2039	-	-	-	142,785.1	3,426,842.4	-	44,263.4	44,263.4	8,124.702	0.2	2,557,947.3
2040	-	-	-	137,073.7	3,289,768.7	-	42,492.8	42,492.8	7,325.050	0.2	2,565,272.4
2041	-	-	-	131,590.7	3,158,177.9	-	40,793.1	40,793.1	6,604.103	0.2	2,571,876.5
2042	-	-	-	126,327.1	3,031,850.8	-	39,161.4	39,161.4	5,954.112	0.2	2,577,830.6
2043	-	-	-	121,274.0	2,910,576.8	-	37,594.9	37,594.9	5,368.095	0.1	2,583,198.7
2044	-	-	-	116,423.1	2,794,153.7	-	36,091.2	36,091.2	4,839.755	0.1	2,588,038.4
2045	-	-	-	111,766.1	2,682,387.6	-	34,647.5	34,647.5	4,363.416	0.1	2,592,401.9
2046	-	-	-	107,295.5	2,575,092.1	-	33,261.6	33,261.6	3,933.958	0.1	2,596,335.8
2047	-	-	-	103,003.7	2,472,088.4	-	31,931.1	31,931.1	3,546.769	0.1	2,599,882.6
2048	-	-	-	98,883.5	2,373,204.8	-	30,653.9	30,653.9	3,197.688	0.1	2,603,080.3
2049	-	-	-	94,928.2	2,278,276.6	-	29,427.7	29,427.7	2,882.965	0.1	2,605,963.2
2050	-	-	-	91,131.1	2,187,145.6	-	28,250.6	28,250.6	2,599.217	0.1	2,608,562.5
2051	-	-	-	87,485.8	2,099,659.8	-	27,120.6	27,120.6	2,343.396	0.1	2,610,905.8
2052	-	-	-	83,986.4	2,015,673.4	-	26,035.8	26,035.8	2,112.754	0.1	2,613,018.6
Total	-	53,767,420.1	(10,106,854.0)	8,091,180.6	199,443,899.4	43,660,566.1	(14,159,634.2)	29,500,931.9	2,613,018.6		


Comparative Cumulative NPV
8,000,000
6,000,000
4,000,000
2,000,000
0
(2,000,000)
(4,000,000)
(6,000,000)
(8,000,000)
(10,000,000)
(12,000,000)
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052
Year
Replace Existing pipeline with FRP
Replace Existing pipeline with Steel
Replace Existing pipeline with HDPE
Test 4

Location: Hydro
FP#: 40308
Title: HYD - Weymouth Falls Pipeline Replacement

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Environmental Staff Support	hr	[redacted]		$ 2,240.00		
1.2	Site Support	hr			$ 3,200.00		
1.3	Project Management	hr			$ 14,000.00		
				Sub-Total	$ 19,440.00		
2	**012 Materials**						
2.1	Supply of Pipe / Materials	lot	1	[redacted]		Cost Support 1	
2.2	Contingency	%					
2.3					$ -		
2.4					$ -		
				Sub-Total	[redacted]		
3	**013 Power Production Contracts**						
3.1	Installation of Pipe	lot	1	[redacted]		Cost Support 1	
3.2	Contingency	%					
3.3					$ -		
				Sub-Total	[redacted]		
4	**002 Overtime Labour**						
4.1	Site Supervision	lot	1	$ 35,000.00	$ 35,000.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 35,000.00		
5	**004 Term Labour**						
5.1	Site Supervision	lot	1	$ 35,000.00	$ 35,000.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 35,000.00		
6	**011 Travel Expenses**						
6.1	Travel for Project Mngmt / Site Supervision	lot	1	$ 30,000.00	$ 30,000.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 30,000.00		
7	**028 Consulting**						
7.1	Archaeology	lot	1	[redacted]			
7.2	Preliminary Design	lot	1			Cost Support 2 (60% of cost is estimated to be related to the pipeline)	
7.3	Final Design	lot	1				
				Sub-Total	$ 166,980.00		
8	**041 Meals and Entertainment**						
8.1	Meals and Entertainment	lot	1	$ 7,000.00	$ 7,000.00		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 7,000.00		
9	**066- Other Goods and Services**						
9.1	Other Goods and Services	lot	1	$ 700.00	$ 700.00		
9.2					$ -		
9.3					$ -		
				Sub-Total	$ 700.00		
10	**094 Interest Capitalized**						
10.1	Interest Capitalized	lot	1	$ 139,182.39	$ 139,182.39		
10.2					$ -		
10.3					$ -		
				Sub-Total	$ 139,182.39		
11	**095 Administrative Overhead**						
11.1	Hydro Regular Labour AO				$ 3,725.39		
11.2	T&C Regular Labour AO				$ -		
11.3	Hydro OT Labour AO				$ 3,388.00		
11.4	Hydro Term Labour AO				[redacted]		
11.5	Thermal & Hydro Contracts AO						
				Sub-Total	$ 321,917.07		
Cost Estimate				**Total**	$ 6,752,759.46		
12	**Original Cost**				$ 872,696.00		
12.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 & 2

Removed due to confidentiality

CI Number: 43039

Title: **HYD – Weymouth Surge Tank**

Start Date: 2012/06
Final Cost Date: 2014/04
Function: Generation
Forecast Amount: $2,738,175

DESCRIPTION:

This project consists of the sandblasting and coating of the exterior of both surge tanks, replacement of the concrete foundations, and miscellaneous steel repairs at the Weymouth generating station. Project life is expected to be approximately 20 years under regular operating conditions.

The depreciation class for the project is Bear River.

Summary of Related CIs +/- 2 years:
2013 CI 17581 - HYD Weymouth Electrical Replacement $1,641,359
2013 CI 20571 - HYD Weymouth Falls Tailrace Deck Refurbishment $371,469
2013 CI 40308 - HYD Weymouth Falls Pipeline Replacement $6,752,759
2013 CI 43136 - HYD Weymouth Headcover Replacement $438,158

JUSTIFICATION:

Justification Criteria: HYDRO

Sub Criteria: Maintenance

Why do this project?

The exteriors of the surge tanks are experiencing blushing and require sandblasting and recoating. The concrete foundations for the surge tanks are in poor physical condition, and do not meet current stability requirements. Sandblasting and recoating the surge tank and replacing the concrete foundation are required to maintain the structural integrity of the tank and its foundation.

Why do this project now?

The surge tank exterior is experiencing blushing. If the tanks are not recoated, there is a risk of rusting and material loss on the exterior of the surge tank, which could lead to more costly repairs in the future. The concrete foundations are in poor condition, and need to be replaced to restore their integrity. Refurbishment of the surge tanks and their foundations is intended to be completed during the same time period as the replacement of the Weymouth Falls penstocks for efficiency, and to limit loss of generation during refurbishment.

Why do this project this way?

Sandblasting and recoating the exterior of the surge tanks and replacement of the concrete foundations is the most cost effective option. Replacing the tanks is more costly, and therefore has not been evaluated further.

CI Number : 43039-H658 - HYD - Weymouth Surge Tank **Project Number** H658

Parent CI Number : -

Cost Centre : 411 - 411-Sissiboo/Weymouth System **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		55,661	0	55,661
095		095-Hydro Regular Labour AO		3,482	0	3,482
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
095		095-Hydro Overtime Labour AO		1,936	0	1,936
095		095-Hydro Term Labour AO		[redacted]	0	[redacted]
001	027	001 - HYDRO Regular Labour	027 - HGP - Waterways	18,080	0	18,080
002	027	002 - HYDRO Overtime Labour	027 - HGP - Waterways	20,000	0	20,000
004	027	004 - HYDRO Term Labour	027 - HGP - Waterways	20,000	0	20,000
011	027	011 - Travel Expense	027 - HGP - Waterways	16,800	0	16,800
013	027	013 - POWER PRODUCTION Contracts	027 - HGP - Waterways	[redacted]	0	[redacted]
028	027	028 - Consulting	027 - HGP - Waterways	[redacted]	0	[redacted]
041	027	041 - Meals & Entertainment	027 - HGP - Waterways	4,000	0	4,000
066	027	066 - Other Goods & Services	027 - HGP - Waterways	700	0	700
			Total Cost:	2,738,175	0	2,738,175
			Original Cost:	353,821		

HYD Weymouth Surge Tank Refurbishment
Summary of Alternatives

Division :	Power Production		**Date :**	**31-Oct-12**
Department :	Hydro		**CI Number:**	43039
Originator :			**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Surge Tanks	6.48%	7,449,620	1	21.75%	8.6 years
B	Replace Surge Tanks	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

This EAM has been developed for CI 43039. A system-wide EAM has also been provided.
It is recommended that the Weymouth Falls surge tanks be refurbished, and their concrete foundations be replaced.

Notes/Comments :

Refurbish Surge Tanks

This option considers the refurbishment of the surge tanks and replacement of the concrete foundations.

Replace Surge Tanks

Replacement of the surge tanks would be more expensive and is not considered necessary. This option is not evaluated further.

Test 3

2

Test 4

HYD Weymouth Surge Tank Refurbishment
Avoided Cost Calculations

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Hydro	**CI Number:**	43039
Originator :		**Project No. :**	

Refurbish Surge Tanks

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$3,000,000**	**$3,060,000**		
Events/Outages (#)	**1**	**1**	**1**	**1**		
Probability of Occurance (%)	**5%**	**6%**	**5%**	**6%**		
Capacity Factor (%)	**100%**	**100%**				
Energy Replaced (MW)	[redacted]					
Duration (Hours)	**5840**	**5840**				
Totals	**$61,596**	**$74,107**	**$150,000**	**$183,600**	**$211,596**	**$257,707**

Total Capital Cost of Alternative	**$2,738,175**

Replace Surge Tanks

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	**100%**	**100%**				
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

Total Capital Cost of Alternative	**$0**

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	**100%**	**100%**				
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

Total Capital Cost of Alternative	**$0**

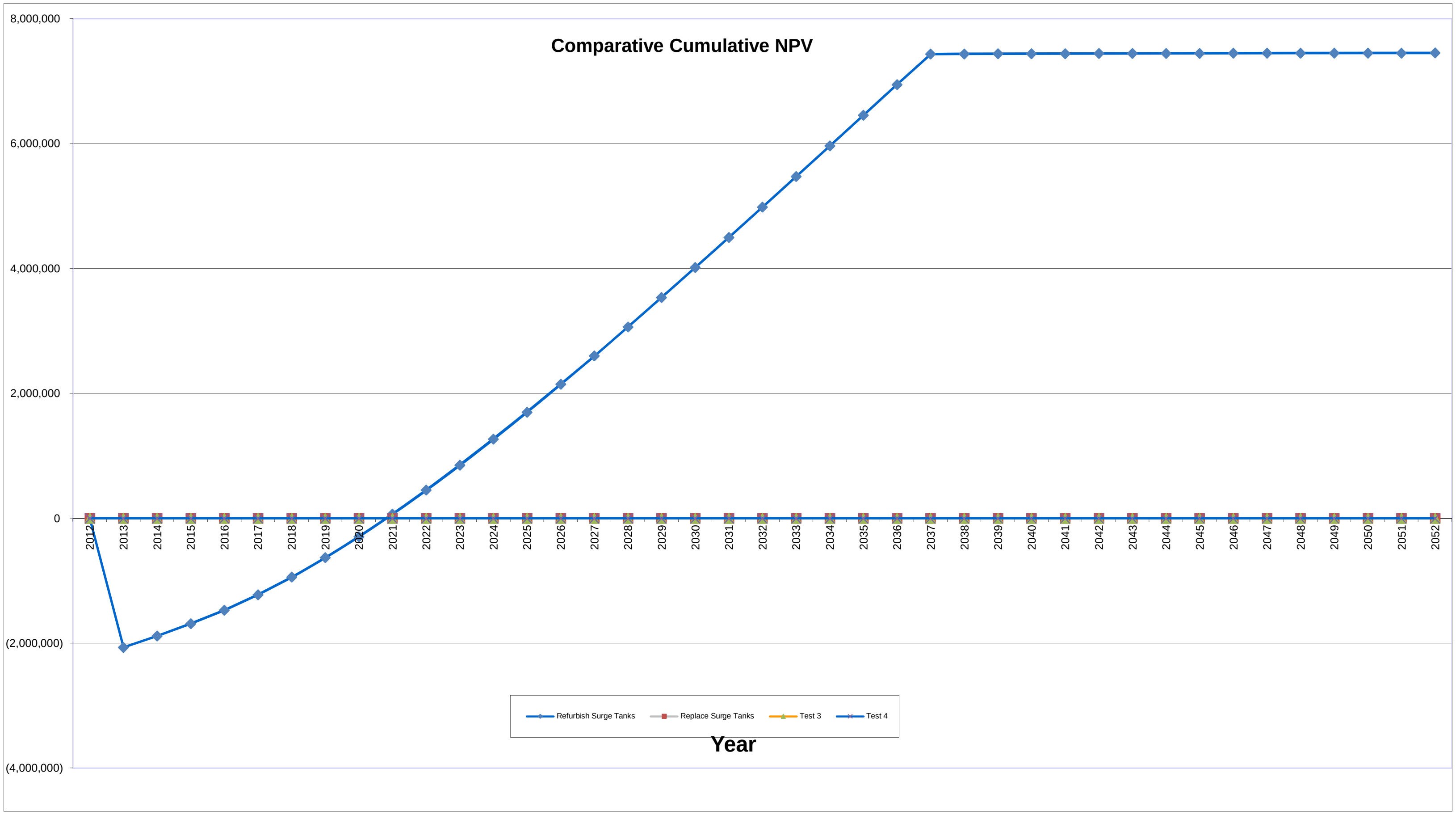
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	**100%**	**100%**				
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

Total Capital Cost of Alternative	**$0**

HYD Weymouth Surge Tank Refurbishment
Refurbish Surge Tanks

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	211,596.1	(2,362,900.0)	49,175.7	2,409,608.4	(2,151,303.9)	(50,350.3)	(2,201,654.2)	(2,067,669.252)	0.9	(2,067,669.3)
2014	-	257,707.1	-	96,384.3	2,313,224.1	257,707.1	(50,010.0)	207,697.0	183,186.809	0.9	(1,884,482.4)
2015	-	306,671.4	-	92,529.0	2,220,695.1	306,671.4	(66,384.2)	240,287.3	199,033.700	0.8	(1,685,448.7)
2016	-	357,491.3	-	88,827.8	2,131,867.3	357,491.3	(83,285.7)	274,205.6	213,306.520	0.8	(1,472,142.2)
2017	-	455,801.4	-	85,274.7	2,046,592.6	455,801.4	(114,863.3)	340,938.1	249,077.965	0.7	(1,223,064.3)
2018	-	557,900.9	-	81,863.7	1,964,728.9	557,900.9	(147,571.5)	410,329.3	281,529.764	0.7	(941,534.5)
2019	-	663,902.0	-	78,589.2	1,886,139.8	663,902.0	(181,447.0)	482,455.0	310,871.238	0.6	(630,663.3)
2020	-	773,920.1	-	75,445.6	1,810,694.2	773,920.1	(216,527.1)	557,393.0	337,300.632	0.6	(293,362.6)
2021	-	888,073.3	-	72,427.8	1,738,266.4	888,073.3	(252,850.1)	635,223.2	361,005.608	0.6	67,643.0
2022	-	1,006,483.0	-	69,530.7	1,668,735.8	1,006,483.0	(290,455.2)	716,027.8	382,163.727	0.5	449,806.7
2023	-	1,129,274.0	-	66,749.4	1,601,986.3	1,129,274.0	(329,382.6)	799,891.4	400,942.915	0.5	850,749.6
2024	-	1,256,574.0	-	64,079.5	1,537,906.9	1,256,574.0	(369,673.3)	886,900.7	417,501.912	0.5	1,268,251.5
2025	-	1,388,514.2	-	61,516.3	1,476,390.6	1,388,514.2	(411,369.4)	977,144.9	431,990.702	0.4	1,700,242.2
2026	-	1,525,229.5	-	59,055.6	1,417,335.0	1,525,229.5	(454,513.9)	1,070,715.6	444,550.933	0.4	2,144,793.2
2027	-	1,666,857.9	-	56,693.4	1,360,641.6	1,666,857.9	(499,151.0)	1,167,706.9	455,316.319	0.4	2,600,109.5
2028	-	1,813,541.4	-	54,425.7	1,306,215.9	1,813,541.4	(545,325.9)	1,268,215.5	464,413.022	0.4	3,064,522.5
2029	-	1,965,425.5	-	52,248.6	1,253,967.3	1,965,425.5	(593,084.8)	1,372,340.7	471,960.024	0.3	3,536,482.5
2030	-	2,122,659.5	-	50,158.7	1,203,808.6	2,122,659.5	(642,475.3)	1,480,184.3	478,069.485	0.3	4,014,552.0
2031	-	2,285,396.8	-	48,152.3	1,155,656.2	2,285,396.8	(693,545.8)	1,591,851.0	482,847.080	0.3	4,497,399.1
2032	-	2,453,794.4	-	46,226.2	1,109,430.0	2,453,794.4	(746,346.1)	1,707,448.3	486,392.325	0.3	4,983,791.4
2033	-	2,628,013.8	-	44,377.2	1,065,052.8	2,628,013.8	(800,927.4)	1,827,086.5	488,798.892	0.3	5,472,590.3
2034	-	2,808,220.5	-	42,602.1	1,022,450.7	2,808,220.5	(857,341.7)	1,950,878.8	490,154.909	0.3	5,962,745.2
2035	-	2,994,584.2	-	40,898.0	981,552.6	2,994,584.2	(915,642.7)	2,078,941.5	490,543.238	0.2	6,453,288.5
2036	-	3,187,279.2	-	39,262.1	942,290.5	3,187,279.2	(975,885.3)	2,211,393.9	490,041.760	0.2	6,943,330.2
2037	-	3,386,484.2	-	37,691.6	904,598.9	3,386,484.2	(1,038,125.7)	2,348,358.5	488,723.623	0.2	7,432,053.8
2038	-	-	-	36,184.0	868,415.0	-	11,217.0	11,217.0	2,192.344	0.2	7,434,246.2
2039	-	-	-	34,736.6	833,678.4	-	10,768.3	10,768.3	1,976.568	0.2	7,436,222.8
2040	-	-	-	33,347.1	800,331.2	-	10,337.6	10,337.6	1,782.030	0.2	7,438,004.8
2041	-	-	-	32,013.2	768,318.0	-	9,924.1	9,924.1	1,606.639	0.2	7,439,611.4
2042	-	-	-	30,732.7	737,585.3	-	9,527.1	9,527.1	1,448.510	0.2	7,441,059.9
2043	-	-	-	29,503.4	708,081.9	-	9,146.1	9,146.1	1,305.944	0.1	7,442,365.9
2044	-	-	-	28,323.3	679,758.6	-	8,780.2	8,780.2	1,177.410	0.1	7,443,543.3
2045	-	-	-	27,190.3	652,568.2	-	8,429.0	8,429.0	1,061.527	0.1	7,444,604.8
2046	-	-	-	26,102.7	626,465.5	-	8,091.8	8,091.8	957.049	0.1	7,445,561.9
2047	-	-	-	25,058.6	601,406.9	-	7,768.2	7,768.2	862.854	0.1	7,446,424.7
2048	-	-	-	24,056.3	577,350.6	-	7,457.4	7,457.4	777.930	0.1	7,447,202.7
2049	-	-	-	23,094.0	554,256.6	-	7,159.1	7,159.1	701.364	0.1	7,447,904.0
2050	-	-	-	22,170.3	532,086.3	-	6,872.8	6,872.8	632.335	0.1	7,448,536.4
2051	-	-	-	21,283.5	510,802.9	-	6,597.9	6,597.9	570.099	0.1	7,449,106.5
2052	-	-	-	20,432.1	490,370.8	-	6,334.0	6,334.0	513.988	0.1	7,449,620.4
Total	-	38,091,395.7	(2,362,900.0)	1,968,413.4	48,471,312.5	35,728,495.7	(11,198,124.5)	24,530,371.2	7,449,620.4		



Comparative Cumulative NPV
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2052
Refurbish Surge Tanks
Replace Surge Tanks
Test 3
Test 4
Year

Location: Hydro
FP#: 43039
Title: HYD - Weymouth Surge Tank Refurbishment

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Hydro Labour	hr	[redacted]		$ 13,440.00		
1.2	Enviro Staff Support	hr	[redacted]		$ 2,240.00		
1.3	Site Support	hr	[redacted]		$ 2,400.00		
				Sub-Total	$ 18,080.00		
2	**013 Power Production Contracts**						
2.1	Refurbish works	lot	1	[redacted]		Cost Support Item 1	
2.2	Contingency on Refurbishment	%	[redacted]				
2.3	Surge Tank exterior coating	sq ft	50000	[redacted]			
				Sub-Total	[redacted]		
3	**002 Overtime Labour**						
3.1	Site Supervision	hr	[redacted]		$ 20,000.00		
3.2					$ -		
				Sub-Total	$ 20,000.00		
4	**004 Term Labour**						
4.1	Site Supervision	hr	[redacted]		$ 20,000.00		
4.2					$ -		
				Sub-Total	$ 20,000.00		
5	**011 Travel Expenses**						
5.1	Travel to site	lot	1	$ 16,800.00	$ 16,800.00		
5.2					$ -		
				Sub-Total	$ 16,800.00		
6	**028 Consulting**						
6.1	Design	lot	1	[redacted]		Cost Support Item 2 (40% of cost is estimated to be related to the surge tank)	
6.2							
				Sub-Total	[redacted]		
7	**041 Meals and Entertainment**						
7.1	Meals during travel	lot	1	$ 4,000.00	$ 4,000.00		
7.2					$ -		
				Sub-Total	$ 4,000.00		
8	**066- Other Goods and Services**						
8.1	Other Goods and Services	lot	1	$ 700.00	$ 700.00		
8.2					$ -		
				Sub-Total	$ 700.00		
9	**094 Interest Capitalized**						
9.1	Interest Capitalized	lot	1	$ 55,661.06	$ 55,661.06		
9.2					$ -		
				Sub-Total	$ 55,661.06		
10	**095 Administrative Overhead**						
10.1	Hydro Regular Labour AO				$ 3,482.49		
10.2	Hydro OT Labour AO				$ 1,936.00		
10.3	Hydro Term Labour AO				[redacted]		
10.4	Thermal & Hydro Contracts AO						
				Sub-Total	$ 319,613.69		
Cost Estimate				**Total**	$ 2,738,174.75		
11	**Original Cost**				$ 353,821.00		
11.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 - 3

Removed due to confidentiality

SIS-WEY-ST-RP-2010-43

RAT

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FINAL REPORT

Weymouth Surge Tank Inspection

Nova Scotia Power Incorporated

PROJECT YEAR 2010
RFP NO. 38326
RAT PID ----

RFP NO. 38326
RAT PID NO. ----

DATE	October 20, 2010
REPORT TO	CT Chen, P.ENG NOVA SCOTIA POWER INCORPRATED Halifax, Nova Scotia B3J 2W5 P.O. Box 910
ON	Weymouth Surge Tank Inspection Weymouth, Nova Scotia Canada
REPORT FROM	J.Kyle Williams, CET REMOTE ACCESS TECHNOLOGY Inc. 61 Atlantic Street, Dartmouth, Nova Scotia, Canada, B2Y 4P4 Tel: (902) 434-4405, Fax: (902) 463-2053

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Executive Summary

During the week of October 4, 2010 Remote Access Technology carried out a visual inspection on the NSPI - Weymouth Surge Tank.

The concrete post foundations are in poor to very poor condition. There are some dislocated cracks visible. There is spalling and overall deterioration evident on all four post foundations.

Structurally the posts are in good condition. There were no cracks or deformed members found during the inspection.

The coating system as a whole has started to blush, this is evidence of UV breakdown in the coating system.

The balcony and handrails are in good to fair condition.

The tank exterior is in good condition. There are some localized areas where the coating has failed around unused brackets which may have been used to secure the old frost casing. The coating failure has created a type of pocket, which is holding moisture and debris, accelerating corrosion in the area. The tank interior is in very good condition. The coating is intact on all the plates and seams. There is some discoloration of the coating at, and below the water level.

The external riser exterior and interior was found to be in good condition. The coating is in good condition. The coating is intact on all the plates and seams.

The roof is in good condition. All roof structures are intact. The roof system supports are in fair to poor condition. There are many areas of active and through section corrosion.

The spider rods are in good condition. The coating system is secure and intact.

The internal riser is in good condition.

The area where the external riser meets the penstock, or tee, is in good condition.

Results of the inspection indicate, possible areas of greatest concern on the Weymouth Surge Tank are, the condition of the post footings, and the structural condition of the roof supports.

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1.0 Introduction

During the week of October 4, 2010 Remote Access Technology carried out a visual inspection on the NSPI - Weymouth Surge Tank. The following report documents the finds.
The following standards were used as reference material for this inspection:

- API STANDARD 653-05 - Tank Inspection, Repair, Alteration, and Reconstruction
- API RECOMMENDED PRACTICE 575-05 - Guidelines and Methods for Inspection Existing Atmospheric and Low-pressure Storage Tanks
- NACE Standard RP0288-2004 - Inspection of Linings on Steel and Concrete
- W59-2003 (Welded Steel Construction - Metal ARC Welding)
- CAN/CSA-S16-2001 (Limit States Design of Steel Structures)

Appendix A contains a photo record of the inspection and results. These photos are referenced in each section of the report.

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2.0 Foundations

2.1 Post Foundations

The concrete post foundations are in poor to very poor condition. All four of the foundations have cracks ranging from 1/8" to 3/4". There are some dislocated cracks visible. There is spalling and overall deterioration evident on all four post foundations. The west post foundation is in the worst condition. There appears to be scour damage from flowing water, heavy spalling, and an area with exposed rebar.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 2-10**.

2.2 Tee Foundation

The concrete Tee foundation is in fair condition. There are cracks ranging in width from 1/8" to 1" on the upstream and downstream faces of the foundation. There are a number of cracks which have dislocated horizontally. A bolted connection which attaches the bubbler houses walkway to the tee foundation was found loose. Deterioration of the foundation is mapped in the photo records identified below.

For further detail and photos refer, to **Appendix A** and see **Photo Record: 16-26**.

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3.0 Posts

Structurally the posts are in good condition. There were no cracks or deformed members found during the inspection.
The coating as a whole has started to blush, this is evidence of UV breakdown in the coating system. The coating on the posts has started to flake away in areas. It has been in service for 20 years which is the typically life expectancy for such a product.

For further detail and photos refer, to **Appendix A** and see **Photo Record: 11-15.**

3.1 Post Connections

The post connections are in good condition. There were no cracks or deformed members found during the inspection. There is some light corrosion due to coating edge failure.

For further detail and photos refer, to **Appendix A** and see **Photo Record: 11-15.**

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4.0 Balcony and Access Ladder

4.1 Balcony and Handrails

The balcony and handrails are in good to fair condition. There were no cracks or deformed members found during the inspection. The coating has started to flake away in areas.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 27-32**.

4.2 Access Ladder

The access ladder was inspected and reported on during an earlier visit for the purpose of determining the fit for use condition of the ladder and ladder system. The appliciable section of the report has been attached as an appendix to this report.
This inspection confirmed those findings.

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5.0 Tank Shell

5.1 Tank Exterior

The tank exterior is in good condition. There are some localized areas where the coating has failed around unused brackets which may have been used to secure the old frost casing.
The coating failure has created a type of pocket, which is holding moisture and debris, accelerating corrosion in the area. In all other areas the coating is solid and intact. No areas of moderate to heavy corrosion were found.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 33-42**.

5.2 Tank Interior

The tank interior is in very good condition. The coating is intact on all the plates and seams. There is some discoloration of the coating at, and below the water level. The post connection which are visible on the inside of the tank, are in good condition. The transition area where the tank bowl meets the external riser is in good condition. There is no damage to the structure of the coating.
Pitting, which covers the entire tank bowl, is approx 1/8" deep and 1/2" diameter. As noted above the tank bowl coating is 100% intact, no area of active corrosion was found. Any pitting of the structural material occurred before the current coating was applied.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 43-50**.

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6.0 External Riser

6.1 External Riser Exterior

The external riser exterior were found to be in good condition. The coating system is in good condition and the coatings on the plates and seams is intact.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 63-64**.

6.2 External Riser Interior

The external riser interior is in good condition. The coating is in good condition. The coating is intact on all the plates and seams. Any pitting of the structural material occurred before the current coating was applied.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 57-58.**

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7.0 Roof

7.1 Roof Exterior

The roof exterior is in good condition. All roof structures are intact. The reinforcement around the vent opening in the middle of the roof is heavily corroded in areas.
There is a railing around the roof of the tank, the material quite light but is intact and secure.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 65-70, 75-76**.

7.2 Roof Interior

The interior of the roof is in good condition. The coating system along the edges of the roof plates is in tack.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 77-78**.

7.1 Roof Supports

The roof system supports are in fair to poor condition. There are many areas of active and through section corrosion. It appears that in the past possibly during the last coating project, that half of the 22 equally spaced angle supports were replaced.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 67-74**.

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8.0 Spider Rods

The spider rods are in good condition. The coating system is secure and intact. There are some areas around the fasteners where surface corrosion is visible. All components were securely attached, no cracks or deformed members were found.

For further detail and photos refer to **Appendix A** and see **Photo Record: 51-52**.

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9.0 Internal Riser

9.1 Internal Riser Exterior

The internal riser exterior is in good condition. No structural defects were observed. The coating is in good condition. The coating is intact on all the plates and seams.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 53-54**.

9.2 Internal Riser Interior

The internal riser interior is in good condition. The coating is in good condition. The coating is intact on all the plates and seams.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 55-56**.

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10.0 Tee

The area where the external riser meets the penstock is in good condition. The coating is in good condition. There was no damage from flowing debris found.

For further detail and photos refer to **Appendix A** and see **Photo Record: 59-62**.

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12.0 Conclusion

The surge tank in good to fair condition overall. The post foundations are in poor condition, deterioration is evident on all four post foundations.The steel structure of the tank is in good condition with areas of localized corrosion around unused brackets which may have been used to secure the old frost casing. The roof system supports are in fair to poor condition with many areas of active and through section corrosion. The coating as a whole has started to blush, this is evidence of UV breakdown in the coating system. The interior coating is all in very good condition.

Results of the inspection indicate, possible areas of greatest concern on the Weymouth Surge Tank are, the condition of the post footings, and the structural condition of the roof supports.

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APPENDIX A

Tank Photo Record

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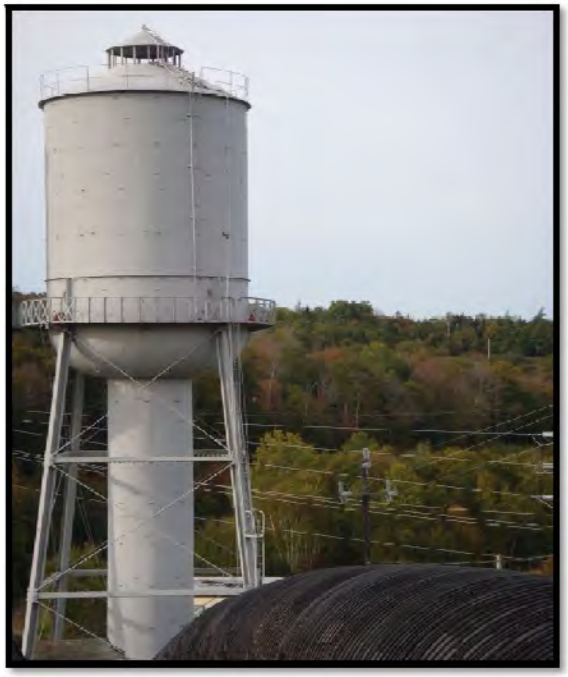
PHOTO RECORD

Photo Record: 1

Equipment:
Surge Tank

Location:
Tank exterior

Description:
General photo.



File Name: *50030*

Photo Record: 2

Equipment:
Surge Tank

Location:
Post Foundation

Description:
West post foundation.
Very poor condition.
See next page for close-up photos of areas indicated.

File Name: *50014*

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PHOTO RECORD

Photo Record: 3

Equipment:

Surge Tank

Location:

Post Foundation

Description:

West post foundation.
Severe deterioration of footing, note exposed rebar.
See below for additional photos.

File Name: *50017*

Photo Record: 4

Equipment:

Surge Tank

Location:

Post Foundation

Description:

West post foundation.
Close-up of deterioration noted in photo 2.

File Name: *50015*

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PHOTO RECORD

Photo Record: 5

Equipment:

Surge Tank

Location:

Post Foundation

Description:

West post foundation.
Large 3/4" crack and 1/2" dislocation running to anchor bolts. Note vegetation growing in cracks.

File Name: *50018*

Photo Record: 6

Equipment:

Surge Tank

Location:

Post Foundation

Description:

South post foundation.
General condition photo.
Surface map cracking consistent over footing surface. Some cracks visible up to 1/2" wide.

File Name: *5005*

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PHOTO RECORD

Photo Record: 7

Equipment:

Surge Tank

Location:

Post Foundation

Description:

East post foundation.
Poor condition.
Note large cracks in footing.
See below and next page for close-up photos of areas indicated.

File Name: *50027*

Photo Record: 8

Equipment:

Surge Tank

Location:

Post / Rod Connection

Description:

East post foundation.
Large cracks in footing 5/8".

File Name: *50039*

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PHOTO RECORD

Photo Record: 9

Equipment:
Surge Tank

Location:
Post / Rod Connection

Description:
East post foundation.
Large cracks in footing 5/8" wide, 1/4" dislocated.

File Name: *50038*

Photo Record: 10

Equipment:
Surge Tank

Location:
Posts

Description:
North post foundation.
Heavy spalling and deterioration.

File Name: *50043*

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PHOTO RECORD

Photo Record: 11

Equipment:

Surge Tank

Location:

Post

Description:

View of coating failure on posts. Not typical of all locations. See below for close-up.

File Name: *50050*

Photo Record: 12

Equipment:

Surge Tank

Location:

Posts

Description:

View of coating failure on posts.

File Name: *10010*

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PHOTO RECORD

Photo Record: 13

Equipment:

Surge Tank

Location:

Post

Description:

View of coating failure on posts.
View of typical condition of connection.

File Name: *1009*

Photo Record: 14

Equipment:

Surge Tank

Location:

Post / Rod Connection

Description:

View of typical condition of post / rod connection

File Name: *10011*

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PHOTO RECORD

Photo Record: 15

Equipment:
Surge Tank

Location:
Post / Tank Shell

Description:
Typical condition of post shell connection

File Name: *4007*

Photo Record: 16

Equipment:
Surge Tank

Location:
Tee foundation

Description:
General photo of exterior Tee foundation.

File Name: *50034*

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PHOTO RECORD

Photo Record: 17

Equipment:

Surge Tank

Location:

Walkway between tanks

Description:

Connection loose. See below for close-up.

File Name: *50061*

Photo Record: 18

Equipment:

Surge Tank

Location:

Tee foundation

Description:

Bolted connection loose.

File Name: *50062*

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PHOTO RECORD

Photo Record: 19

Equipment:

Surge Tank

Location:

Tee foundation

Description:

General photo showing bubbler house tee foundation and external riser.

File Name: *50064*

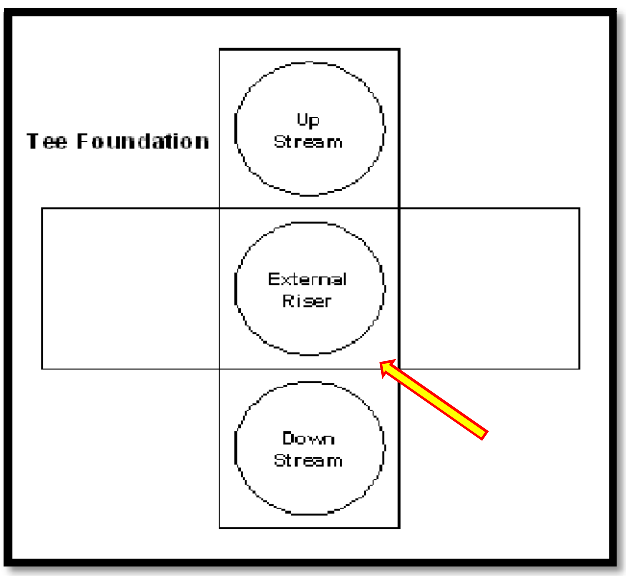

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PHOTO RECORD

Photo Record: 20

Equipment:

Surge Tank

Location:

Tee foundation

Description:

Large cracks and dislocation. Close-up of indicated area on next page.

File Name: *50039*

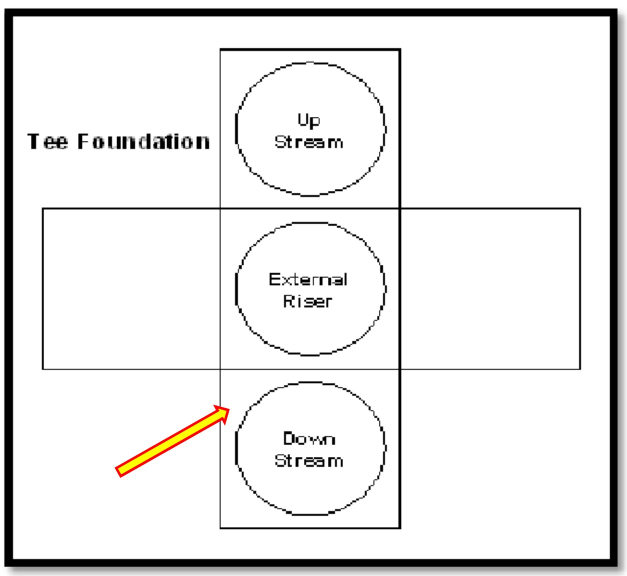

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PHOTO RECORD

Photo Record: 21

Equipment:

Surge Tank

Location:

Tee foundation

Description:

1" - Crack
3/8" - Horizontal dislocation

File Name: *50040*

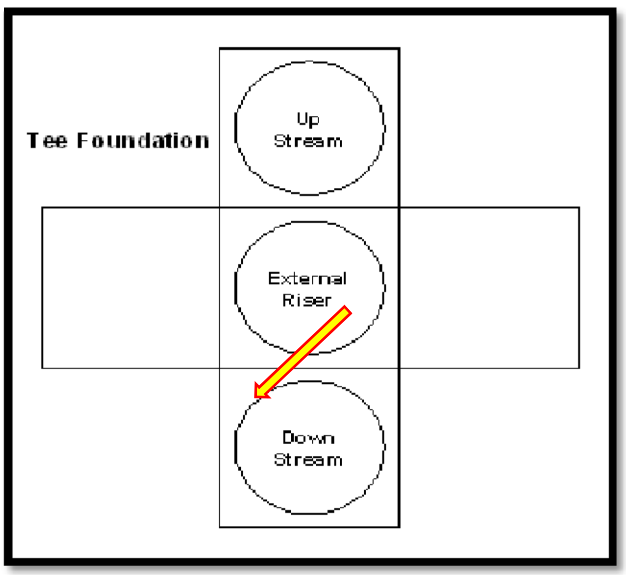

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PHOTO RECORD

Photo Record: 22

Equipment:

Surge Tank

Location:

Tee foundation

Description:

Large cracks and dislocation. Close-up of indicated area on next page.

File Name: *50044*

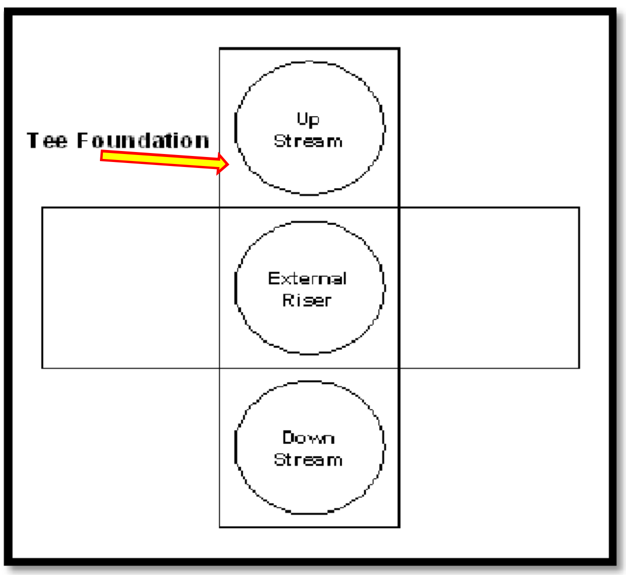

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PHOTO RECORD

Photo Record: 23

Equipment:

Surge Tank

Location:

Tee foundation

Description:

3/4" - Crack
1/4" - Horizontal dislocation

File Name: *40046*

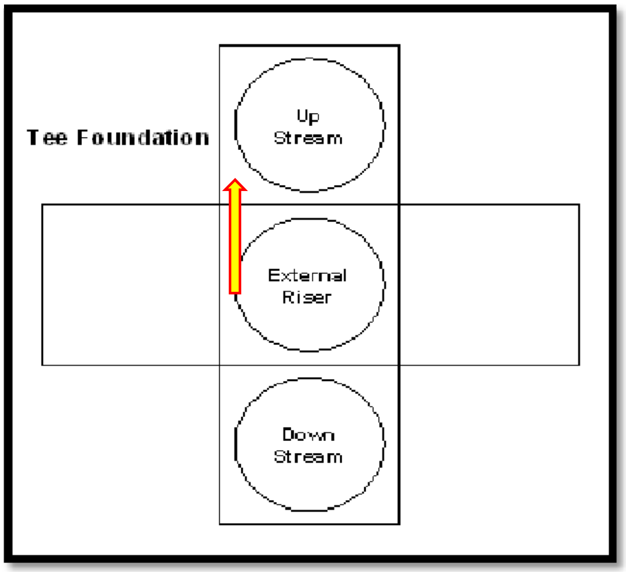

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PHOTO RECORD

Photo Record: 24

Equipment:

Surge Tank

Location:

Tee foundation

Description:

General condition photo. Some cracks (1/4") visible.

File Name: *DSC0 1715*

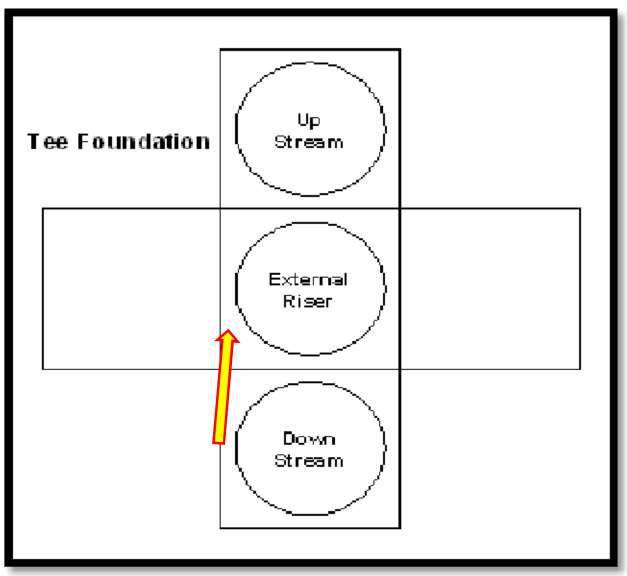

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PHOTO RECORD

Photo Record: 25

Equipment:

Surge Tank

Location:

Tee foundation

Description:

Intersection between foundation, penstock, and external riser.Some cracks visible (1/8")

File Name: *50047*

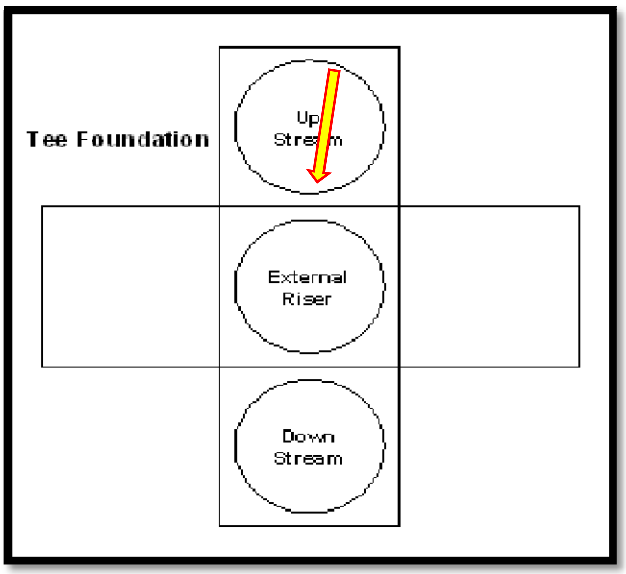

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PHOTO RECORD

Photo Record: 26

Equipment:

Surge Tank

Location:

Tee foundation

Description:

Map cracking visible over entire area.

File Name: *50060*

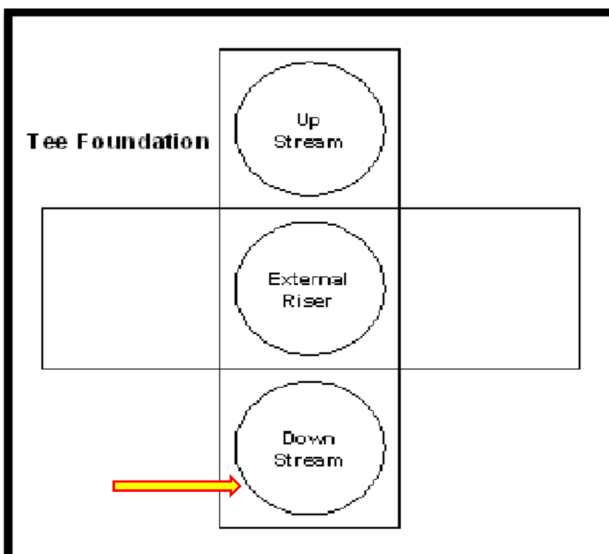

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PHOTO RECORD

Photo Record: 27

Equipment:
Surge Tank

Location:
Balcony & Handrail

Description:
Localized coating failure on balcony.
Additional photos below.

File Name: *5096*

Photo Record: 28

Equipment:
Surge Tank

Location:
Balcony & Handrail

Description:
Localized coating failure on balcony. Typical.

File Name: *50090*

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PHOTO RECORD

Photo Record: 29

Equipment:

Surge Tank

Location:

Balcony & Handrail

Description:

Failed coating on deck. Typical.
Also note the condition of the connection of the post to the tank shell.

File Name: *5095*

Photo Record: 30

Equipment:

Surge Tank

Location:

Balcony & Handrail

Description:

Typical condition of the connection of the post to the tank shell.

File Name: *50091*

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PHOTO RECORD

Photo Record: 31

Equipment:

Surge Tank

Location:

Balcony & Handrail

Description:

Typical condition of the balcony underside.

File Name: *40003*

Photo Record: 32

Equipment:

Surge Tank

Location:

Balcony & Handrail

Description:

Typical condition of the balcony underside.

File Name: *40009*

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PHOTO RECORD

Photo Record: 33

Equipment:

Surge Tank

Location:

Tank exterior

Description:

Typical condition photo.
Note localized coating failures around unused brackets.
See below for close-up photos.

File Name: *50082*

Photo Record: 34

Equipment:

Surge Tank

Location:

Tank exterior

Description:

Localized coating failure, typical around nearly all of these unused brackets.
Coating failure has created a type of pocket, which is holding moisture and debris, accelerating localized corrosion.
See next page for close-up.

File Name: *40016*

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PHOTO RECORD

Photo Record: 35

Equipment:
Surge Tank

Location:
Tank exterior

Description:
Typical condition of tank surface under coating failure.

File Name: *40018*

Photo Record: 36

Equipment:
Surge Tank

Location:
Tank exterior

Description:
Some areas of heavy localized corrosion was found below the external stiffening rib identified in the photo. Close-up of these areas on the following page.

File Name: *50082*

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PHOTO RECORD

Photo Record: 37

Equipment:
Surge Tank

Location:
Tank exterior

Description:
Areas of heavy localizes corrosion.
Pits in this area were measure to be 0.375".
Due to corrosion in the area it was not possible to use UT inspection to find the remaining wall thickness in the area of the pit.
Areas of pitting can be seen under solid areas of the coating, indicating that this type of corrosion has been active for over 20 years.

File Name: *50085*

Photo Record: 38

Equipment:
Surge Tank

Location:
Tank exterior

Description:
Close-up of area above.

File Name: *50086*

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PHOTO RECORD

Photo Record: 39

Equipment:

Surge Tank

Location:

Tank exterior

Description:

Close-up of area on previous page.

File Name: *50087*

Photo Record: 40

Equipment:

Surge Tank

Location:

Tank exterior

Description:

Failed coating located at intersection between tank roof and shell.
Note areas of localized coating failure and corrosion.
Close-up of these areas on the following page.

File Name: *40015*

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PHOTO RECORD

Photo Record: 41

Equipment:

Surge Tank

Location:

Tank exterior

Description:

Corrosion and coating failure is typical of other areas on the surge tank.
See below for area with coating removed.

File Name: *10012*

Photo Record: 42

Equipment:

Surge Tank

Location:

Tank exterior

Description:

Area above with coating removed.

File Name: *10013*

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PHOTO RECORD

Photo Record: 43

Equipment:
Surge Tank

Location:
Tank shell interior

Description:
General photo showing coating intact.
Typical of interior coating condition.

File Name: *50053*

Photo Record: 44

Equipment:
Surge Tank

Location:
Tank shell interior

Description:
Tank interior below water line. Coating in good condition.

File Name: *50055*

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PHOTO RECORD

Photo Record: 45

Equipment:

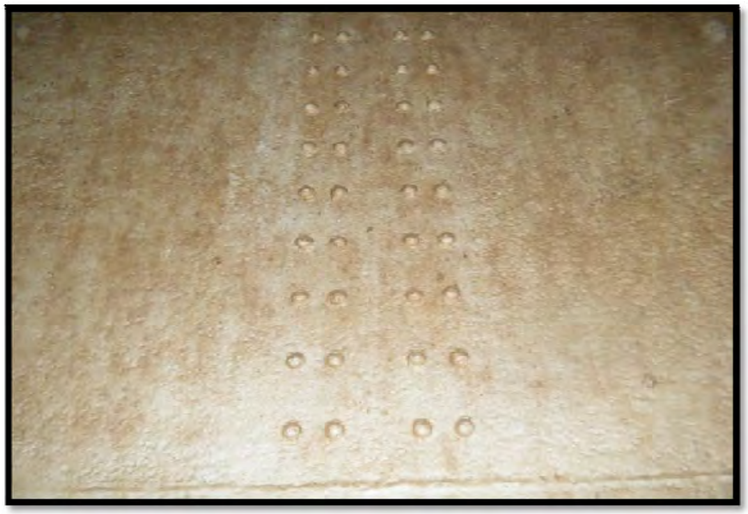
Surge Tank

Location:

Tank shell interior

Description:

View of tank bowl. View of post attachment visible in photo. Area in good condition. Coating in good condition.



File Name: *10037*

Photo Record: 46

Equipment:

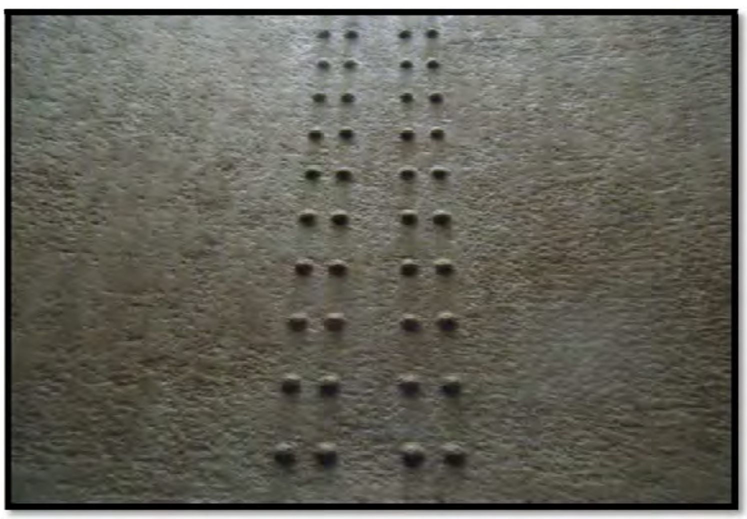
Surge Tank

Location:

Tank shell interior

Description:

View of tank bowl. View of post attachment visible in photo. Area in good condition. Coating in good condition.



File Name: *10038*

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PHOTO RECORD

Photo Record: 47

Equipment:

Surge Tank

Location:

Tank shell interior

Description:

Surface pitting which covers the entire tank bowl. Approx 1/8" deep and 1/2" diameter. Tank bowl coating is 100% intact, no area of active corrosion were found.

File Name: *10030*

Photo Record: 48

Equipment:

Surge Tank

Location:

Tank shell interior

Description:

Additional photo of above description.

File Name: *10032*

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PHOTO RECORD

Photo Record: 49

Equipment:

Surge Tank

Location:

Tank shell interior

Description:

Connection between tank bowl and internal riser. Area in good condition, coating in good condition.

File Name: *10039*

Photo Record: 50

Equipment:

Surge Tank

Location:

Tank shell interior

Description:

Intersection between tank bowl and external riser. Area in good condition, coating in good condition. View from inside

File Name: *50057*

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PHOTO RECORD

Photo Record: 51

Equipment:
Surge Tank

Location:
Spider rods / Internal riser

Description:
Connections to internal riser were in good condition. Typical condition photo.

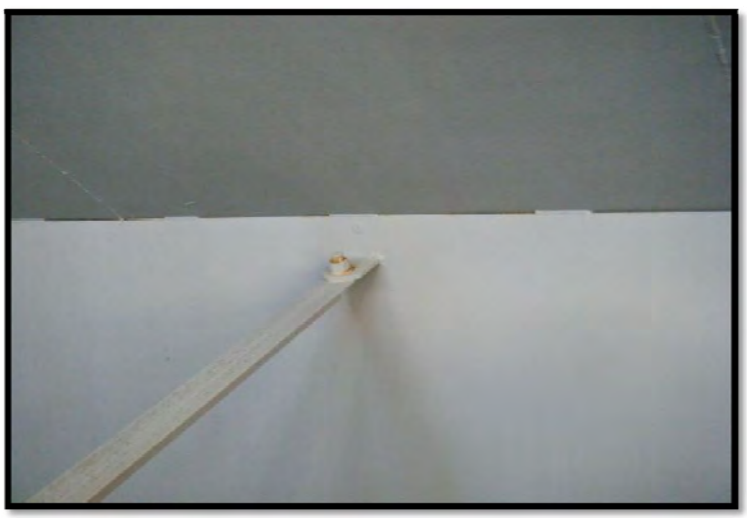
File Name: *10013*

Photo Record: 52

Equipment:
Surge Tank

Location:
Spider rods / Internal riser

Description:
Spider rod connections to tank were in good condition. Typical condition photo.



File Name: *10018*

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PHOTO RECORD

Photo Record: 53

Equipment:

Surge Tank

Location:

Internal riser exterior

Description:

Internal riser in good condition. View of stiffening member below the water line.

File Name: *10040*

Photo Record: 54

Equipment:

Surge Tank

Location:

Internal riser exterior

Description:

Typical condition photo. Coating in good condition.

File Name: *10013*

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PHOTO RECORD

Photo Record: 55

Equipment:
Surge Tank

Location:
Internal riser interior

Description:
View above water line. Coating in good condition.

File Name: *50054*

Photo Record: 56

Equipment:
Surge Tank

Location:
Internal riser interior

Description:
View below the water line. Coating in good condition.

File Name: *50056*

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PHOTO RECORD

Photo Record: 57

Equipment:

Surge Tank

Location:

External riser interior

Description:

Area where internal riser meets the external riser was in good condition. Typical condition photo.

File Name: *50058*

Photo Record: 58

Equipment:

Surge Tank

Location:

External riser interior

Description:

Additional view of area where internal riser meets the external riser.

File Name: *50079*

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PHOTO RECORD

Photo Record: 59

Equipment:
Surge Tank

Location:
Tee inside

Description:
General area photo.

File Name: *50072*

Photo Record: 60

Equipment:
Surge Tank

Location:
Tee inside

Description:
General condition photo

File Name: *50066*

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PHOTO RECORD

Photo Record: 61

Equipment:

Surge Tank

Location:

Tee inside

Description:

General photo of west side. Area was found to be in good condition. Coating in good condition.

File Name: *50064*

Photo Record: 62

Equipment:

Surge Tank

Location:

Tee inside

Description:

General photo of east side. Area was found to be in good condition. Coating in good condition.

File Name: *50065*

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PHOTO RECORD

Photo Record: 63

Equipment:

Surge Tank

Location:

External riser

Description:

External riser was found to be in good condition. Typical condition photo.

File Name: *50057*

Photo Record: 64

Equipment:

Surge Tank

Location:

External riser frost casing

Description:

Frost casing was found to be in good condition. Typical condition photo.

File Name: *50056*

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PHOTO RECORD

Photo Record: 65

Equipment:
Surge Tank

Location:
Roof

Description:
General photo. Roof was in good condition.

File Name: *10004*

Photo Record: 66

Equipment:
Surge Tank

Location:
Roof

Description:
Typical condition photo.

File Name: *10005*

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PHOTO RECORD

Photo Record: 67

Equipment:

Surge Tank

Location:

Roof

Description:

General photo of roof vent cap from inside.

File Name: *10003*

Photo Record: 68

Equipment:

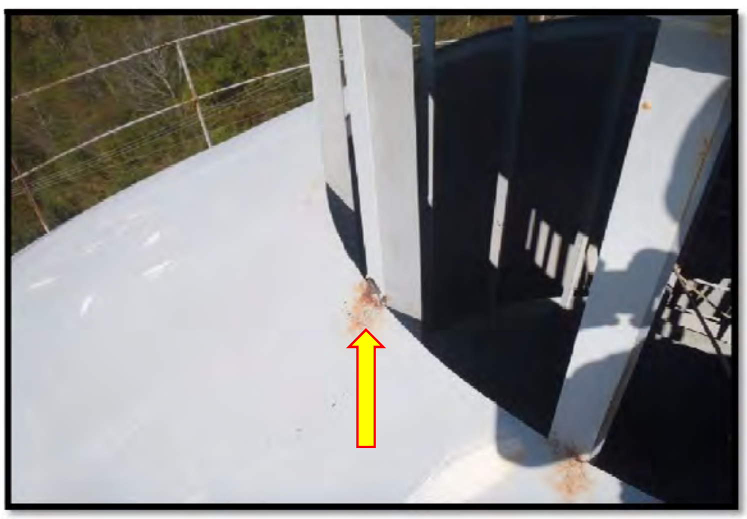
Surge Tank

Location:

Roof

Description:

General connection between roof and roof vent supports. Note corrosion at connection.



File Name: *10015*

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PHOTO RECORD

Photo Record: 69

Equipment:

Surge Tank

Location:

Roof supports

Description:

General photo, note areas of heavy and through section corrosion.

File Name: *10006*

Photo Record: 70

Equipment:

Surge Tank

Location:

Roof supports

Description:

Close-up of area indicated above. Member is angle reinforcement around edge of vent opening. Member heavily corroded.

File Name: *10007*

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PHOTO RECORD

Photo Record: 71

Equipment:

Surge Tank

Location:

Roof supports

Description:

Through section corrosion on roof support.

File Name: *10012*

Photo Record: 72

Equipment:

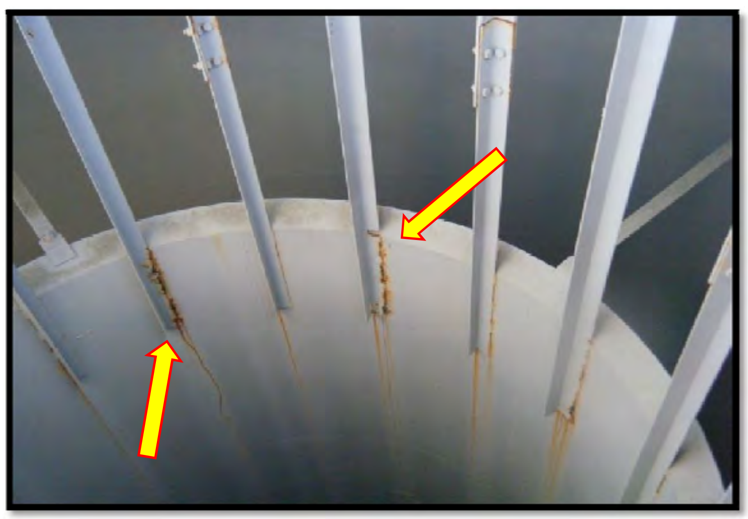
Surge Tank

Location:

Roof supports

Description:

View of roof support connection to internal riser. Note areas of heavy corrosion. See following page for close-up



File Name: *10008*

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PHOTO RECORD

Photo Record: 73

Equipment:

Surge Tank

Location:

Roof supports

Description:

Heavy corrosion and section loss at connection.

File Name: *10009*

Photo Record: 74

Equipment:

Surge Tank

Location:

Roof supports

Description:

Heavy corrosion and section loss at connection.

File Name: *10027*

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PHOTO RECORD

Photo Record: 75

Equipment:
Surge Tank

Location:
Roof access hatch

Description:
Hatch was in good working condition.

File Name: *10023*

Photo Record: 76

Equipment:
Surge Tank

Location:
Roof access hatch

Description:
General photo of roof top railing. Material quite light but is intact and secure.

File Name: *40012*

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PHOTO RECORD

Photo Record: 77

Equipment:

Surge Tank

Location:

Roof interior

Description:

Roof interior in good condition. Typical condition. Close-up below.

File Name: *10019*

Photo Record: 78

Equipment:

Surge Tank

Location:

Roof interior

Description:

Coating in good condition at plate edges.

File Name: *10020*

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APPENDIX B

Ladded Report

Appliciable sections from;
"NSPI Weymouth Generating Station- Vertical and Horziontal Fall Protection Inspection"
Dated - March 26 2010

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Findings and Recommendations: Ladder and ladder Fall Protection System surge tanks
Findings: Tank #1

The ladder construction is as noted below:
-#1 ladder length from bottom rung to top rung 19ft
-#2 ladder length from bottom rung to top rung 29ft
-#3 ladder length from bottom rung to top rung 32ft
-Side rails 2in x 0.375in flat bar
-Rungs 0.75in round bar spaced 12in on center
-Rungs are plug welded outside
-Side rails of ladder has 16in inside spacing
-Rungs have 6in clear spacing to the supporting structure
The vertical fall protection system manufacture outlines in the installation document section 1.2 –A "The ladder structure to which the system is installed must be capable of withstanding the loads applied by the system in the event of a fall."
Section 2.3-A-1:
One user = 3,375lbs
Two users = 4,350lbs
Three users = 5,325lbs
Four users = 6,300lbs

Recommendations:
Replace or repair the current ladder to meet the current ANSI A14.3-2002

Findings:
At the time of the inspection the vertical life line systems had no manufactures system label or written instructions on the use, maintenance and inspection of the system as outlined in the CSA Z259.16-04 SECTION 4. The configuration of the current bottom anchor of the vertical fall protection system (VFPS) is one that the manufacture is not familiar with.

Recommendations:
Replace existing systems with new certified systems. Attach a systems label to the side rail of ladder. Ensure all systems information including an inspection label or log is kept on site and up to date. Prior to using the fall protection systems, ensure the systems label is securely attached and fully legible. It is the responsibility of the user and purchaser of this equipment to assure they are familiar with the instructions, operating characteristics, application limits, and the consequences of improper use of this equipment. Users and purchasers of this equipment must be trained in the correct care and use of this equipment. All system components must be inspected before each use, yearly by a competent person other than the end user and after a fall has occurred.

SIS-WEY-ST-RP-2010-42

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FINAL REPORT

Weymouth Surge Tank Inspection

Nova Scotia Power Incorporated

PROJECT YEAR 2010
RFP NO. 38326
RAT PID - 4372-1

RFP NO. 38326
RAT PID NO. 4372-1

DATE: December 10, 2010

REPORT TO: Melanie Mac Cormick, P.ENG
NOVA SCOTIA POWER INCORPRATED
Halifax, Nova Scotia B3J 2W5
P.O. Box 910

ON: Weymouth Surge Tank Inspection
Weymouth, Nova Scotia
Canada

REPORT FROM: J.Kyle Williams, CET
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CANADIAN WELDING BUREAU
4542
J. Kyle Williams
LEVEL 2
CSA W178.2
CERTIFIED WELDING INSPECTOR

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Executive Summary

During the week of Nov 29, 2010 Remote Access Technology carried out a visual inspection on the NSPI - Weymouth Surge Tank #2.

The concrete post foundations are in good condition. The concrete Tee foundation is in good condition.

Structurally the posts are in good condition. The post connections are in good condition. However, the connection of the lateral supports (secondary members) to the posts did have a consistent deficiency. At every location, 12 in total, only four of the six bolts in the connection were engaged. There were no cracks or deformed members found in or around these connections.

The balcony and handrails are in good to fair condition. There were no cracks or deformed members found during the inspection. The coating failure is mainly on the deck, and the underside of the deck. This failure is likely due to the lack of adequate drainage causing ponding of water.

The tank exterior is in good condition structurally. The tank interior is in very good condition. The coating is intact on all the plates and seams. There is some discoloration of the coating at, and below the water level. The transition area where the tank bowl meets the external riser is in good condition. There is no damage to the structure, or the coating.

The external riser exterior were found to be in good condition. There were no cracks or deformed members found. The external riser interior is in good condition. The coating is in good condition. The coating is intact on all the plates and seams.

The roof exterior is in good condition. All roof structures are intact.
There is a railing around the roof of the tank, the material quite light but is intact and secure.

The spider rods are in good condition. All components were securely attached, no cracks or deformed members were found.

The internal riser exterior is in good condition. The internal riser interior is in good condition. No structural defects were observed.

The area where the external riser meets the penstock is in good condition. The coating is in good condition. There was no damage from flowing debris found.

Results of the inspection indicate, possible areas of concern on the Weymouth Surge Tank #2, as the exterior coating system and a possible review of the connection deficiency between the lateral supports and the posts.

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1.0 Introduction

During the week of Nov 29, 2010 Remote Access Technology carried out a visual inspection on the NSPI - Weymouth Surge Tank #2. The following report documents the finds.
The following standards were used as reference material for this inspection:

- API STANDARD 653-05 - Tank Inspection, Repair, Alteration, and Reconstruction
- API RECOMMENDED PRACTICE 575-05 - Guidelines and Methods for Inspection Existing Atmospheric and Low-pressure Storage Tanks
- NACE Standard RP0288-2004 - Inspection of Linings on Steel and Concrete
- W59-2003 (Welded Steel Construction - Metal ARC Welding)
- CAN/CSA-S16-2001 (Limit States Design of Steel Structures)

Appendix A contains a photo record of the inspection and results. These photos are referenced in each section of the report.

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2.0 Foundations

2.1 Post Foundations

The concrete post foundations are in good condition. The base of the posts have a grouted bearing surface which is intact, and the footings have been coated. There were no large cracks or evidence of scour found on the footings.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 2-6**.

2.2 Tee Foundation

The concrete Tee foundation is in good condition. There were 2-3 locations where heavy efflorescence is visible. This may indicate movement of moisture through the Tee foundation. If continued over time this will result in a reduction in the alkalinity of the concrete, which can cause corrosion of the subsurface rebar.

For further detail and photos refer, to **Appendix A** and see **Photo Record: 17-26**.

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3.0 Posts

Structurally the posts are in good condition. There were no cracks or deformed members found during the inspection.
The coating as a whole has started to blush, this is evidence of UV breakdown in the coating system. The coating on the posts has started to flake away in areas. It has been in service for 20 years which is the typically life expectancy for such a product.

For further detail and photos refer, to **Appendix A** and see **Photo Record: 7-16.**

3.1 Post Connections

The post connections are in good condition. However, the connection of the lateral supports (secondary members) to the posts did have a consistent deficiency. At every location, 12 in total, only four of the six bolts in the connection were engaged. There were no cracks or deformed members found in or around these connections. There is some light corrosion due to coating edge failure.

For further detail and photos refer, to **Appendix A** and see **Photo Record: 9-13.**

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4.0 Balcony and Access Ladder

4.1 Balcony and Handrails

The balcony and handrails are in good to fair condition. There were no cracks or deformed members found during the inspection. The coating failure is mainly on the deck, and the underside of the deck. This failure is likely due to the lack of adequate drainage causing ponding of water.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 27-32**.

4.2 Access Ladder

The access ladder was inspected and reported on during an earlier visit for the purpose of determining the fit for use condition of the ladder and ladder system. The applicable section of the report has been attached as an appendix to this report.
This inspection confirmed those findings.

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5.0 Tank Shell

5.1 Tank Exterior

The tank exterior is in good condition structurally. There is consistent coating delamination and UV failure, as well as localised failure around brackets which may have been used to secure the old frost casing.
The primer coat is still intact in most locations on the tank exterior, the primer will not remain intact for too long with exposure to UV. No areas of moderate to heavy corrosion were found.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 33-38**.

5.2 Tank Interior

The tank interior is in very good condition. The coating is intact on all the plates and seams. There is some discoloration of the coating at, and below the water level. The transition area where the tank bowl meets the external riser is in good condition. There is no damage to the structure, or the coating.
Pitting, which covers the entire tank bowl, is approx 1/8" deep and 1/2" diameter. As noted above the tank bowl coating is 100% intact, no area of active corrosion was found. Any pitting of the structural material occurred before the current coating was applied.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 39-42**.

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6.0 External Riser

6.1 External Riser Exterior

The external riser exterior were found to be in good condition. There were no cracks or deformed members found. The coating system is in good condition and the coatings on the plates and seams is are intact.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 53-56**.

6.2 External Riser Interior

The external riser interior is in good condition. The coating is in good condition. The coating is intact on all the plates and seams. There were no cracks or deformed members found. Any pitting of the structural material occurred before the current coating was applied.
For further detail and photos, refer to **Appendix A** and see **Photo Record: 43,44.**

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7.0 Roof

7.1 Roof Exterior

The roof exterior is in good condition. All roof structures are intact.
There is a railing around the roof of the tank, the material quite light but is intact and secure.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 57,58, 61-63**.

7.2 Roof Interior

The interior of the roof is in good condition. The coating system along the edges of the roof plates is in tack.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 59, 64-66**.

7.1 Roof Supports

The roof system supports are in good condition.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 59,60**.

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8.0 Spider Rods

The spider rods are in good condition. The coating system is secure and intact. There are some areas around the fasteners where surface corrosion is visible. All components were securely attached, no cracks or deformed members were found.

For further detail and photos refer to **Appendix A** and see **Photo Record: 64-66**.

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9.0 Internal Riser

9.1 Internal Riser Exterior

The internal riser exterior is in good condition. No structural defects were observed. The coating is in good condition. The coating is intact on all the plates and seams.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 45,46**.

9.2 Internal Riser Interior

The internal riser interior is in good condition. The coating is in good condition. The coating is intact on all the plates and seams.

For further detail and photos, refer to **Appendix A** and see **Photo Record: 47,48**.

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10.0 Tee

The area where the external riser meets the penstock is in good condition. The coating is in good condition. There was no damage from flowing debris found.

For further detail and photos refer to **Appendix A** and see **Photo Record: 49-52**.

12.0 Conclusion

The surge tank is in good condition overall. The post foundations are in good condition. The steel structure of the tank and its supporting structures are in good condition, with exception to the connection of the lateral supports (secondary members) to the posts, as described in section 3.1 Post Connections. There is widespread coating failure on the outside of the tank, due to delamination and UV failure. The coating on the interior structure is all in very good condition.

Results of the inspection indicate, possible areas of concern on the Weymouth Surge Tank #2 as; the exterior coating system, and a possible review of the connection deficiency between the lateral supports and the posts.

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APPENDIX A

Tank Photo Record

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PHOTO RECORD

Photro Record: 1

Equipment:
Surge Tank

Location:
Tank exterior

Description:
General photo.

File Name: *10039*

Photo Record: 2

Equipment:
Surge Tank

Location:
Post Foundation

Description:
East post foundation.
Components in good condition.

File Name: *10034*

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PHOTO RECORD

Photo Record: 3

Equipment:
Surge Tank

Location:
Post Foundation

Description:
West post foundation.
Components in good condition.

File Name: *10003*

Photo Record: 4

Equipment:
Surge Tank

Location:
Post Foundation

Description:
North post foundation.
Components in good condition.

File Name: *10029*

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PHOTO RECORD

Photo Record: 5

Equipment:

Surge Tank

Location:

Post Foundation

Description:

South post foundation.
Components in good condition.

File Name: *10008*

Photo Record: 6

Equipment:

Surge Tank

Location:

Post Foundation

Description:

Typical condition photo.
Footings in good condition. Grouted bearing surface intact.

File Name: *10005*

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PHOTO RECORD

Photo Record: 7

Equipment:
Surge Tank

Location:
Post

Description:
View of typical coating failure on posts. .

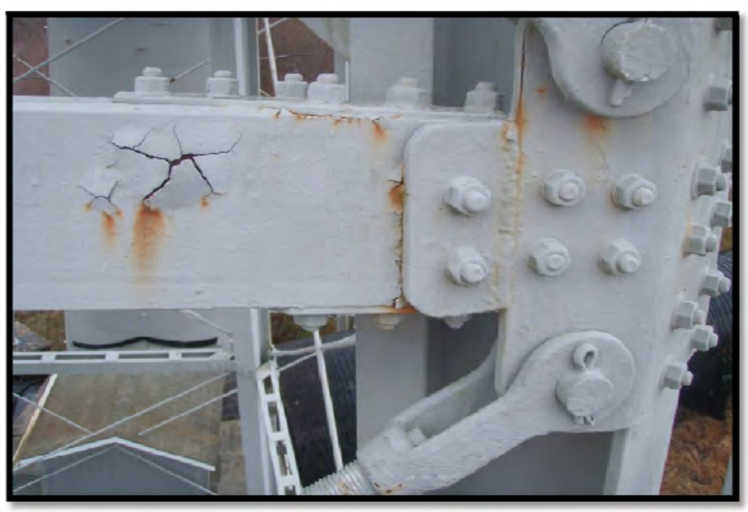
File Name: *10030*

Photo Record: 8

Equipment:
Surge Tank

Location:
Posts

Description:
View of typical coating failure on posts.



File Name: *90099*

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PHOTO RECORD

Photo Record: 9

Equipment:

Surge Tank

Location:

Post / Rod Connection

Description:

The photos to follow show a close-up typical of the connection type identified in the photo.

File Name: *90153*

Photo Record: 10

Equipment:

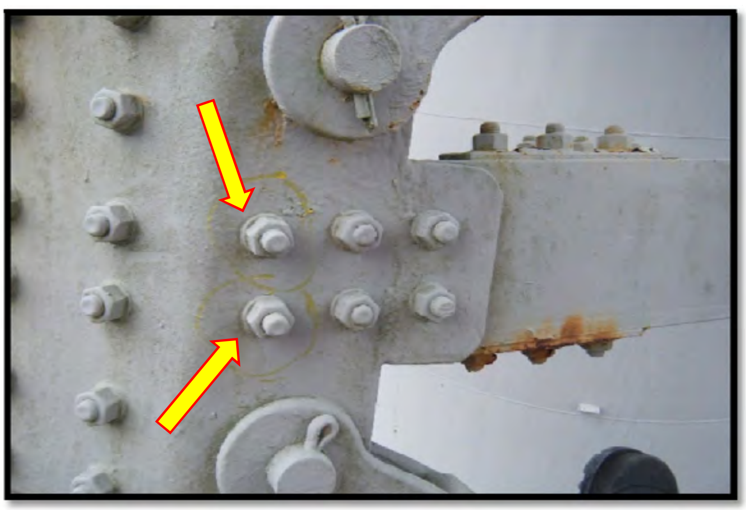
Surge Tank

Location:

Post / Rod Connection

Description:

The photo to follow shows the inside of this connection note the two bolts identified.



File Name: *7033*

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PHOTO RECORD

Photo Record: 11

Equipment:

Surge Tank

Location:

Post Foundation

Description:

two of the six bolts in the connection are not engaging the horizontal member. Typical of all connections of this type.

File Name: *50027*

Photo Record: 12

Equipment:

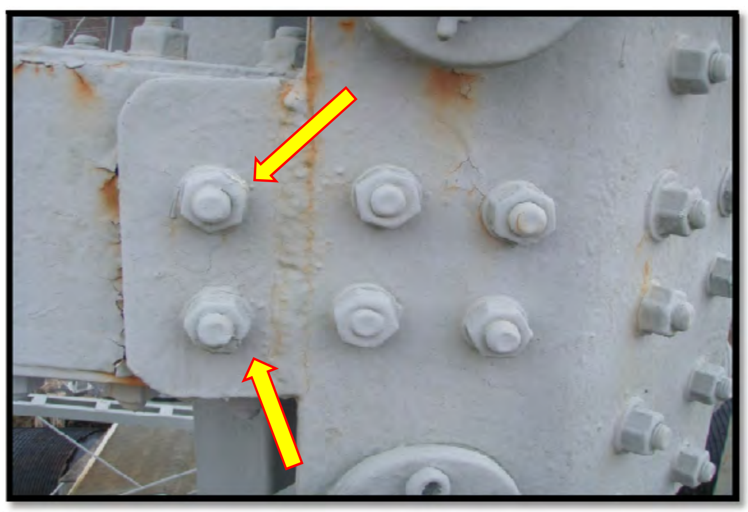
Surge Tank

Location:

Post / Rod Connection

Description:

The photo to follow shows the inside of this connection note the two bolts identified.



File Name: *7034*

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PHOTO RECORD

Photo Record: 13

Equipment:

Surge Tank

Location:

Post Foundation

Description:

two of the six bolts in the connection are not engaging the horizontal member. Typical of all connections of this type.

File Name: *50027*

Photo Record: 14

Equipment:

Surge Tank

Location:

Post / Rod Connection

Description:

Typical condition of pin connection.

File Name: *21088*

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PHOTO RECORD

Photo Record: 15

Equipment:

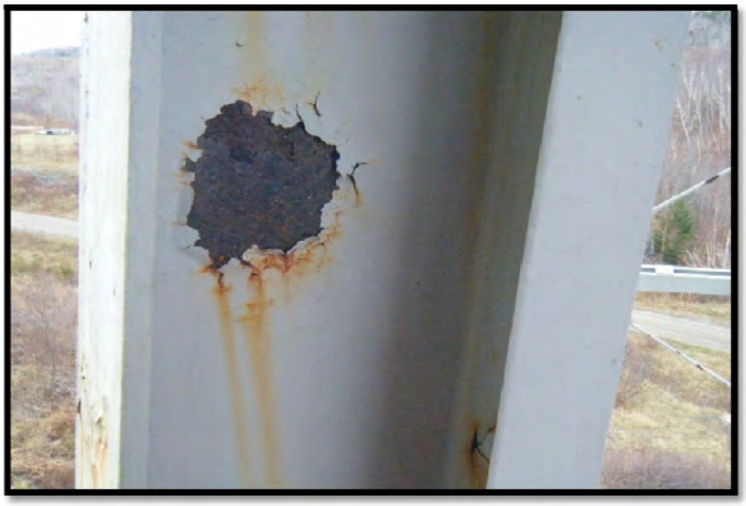
Surge Tank

Location:

Post

Description:

View of typical coating failure on posts.
Area in photo is 12 sq inches.
Note coating primer has failed.



File Name: *7028*

Photo Record: 16

Equipment:

Surge Tank

Location:

Post / Rod Connection

Description:

View of typical condition of post / rod connection

File Name: *10067*

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PHOTO RECORD

Photo Record: 17

Equipment:

Surge Tank

Location:

Tee foundation

Description:

General photo. Tee foundation and bubbler house.

File Name: *10023*

Photo Record: 18

Equipment:

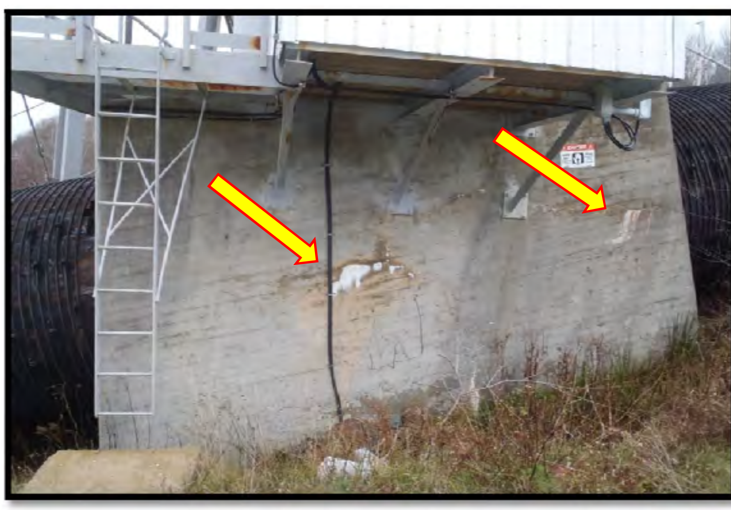
Surge Tank

Location:

Tee foundation

Description:

Tee foundation was found to be in good condition. No large cracks were found . Note efflorescence of the concrete.



File Name: *50034*

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PHOTO RECORD

Photo Record: 19

Equipment:

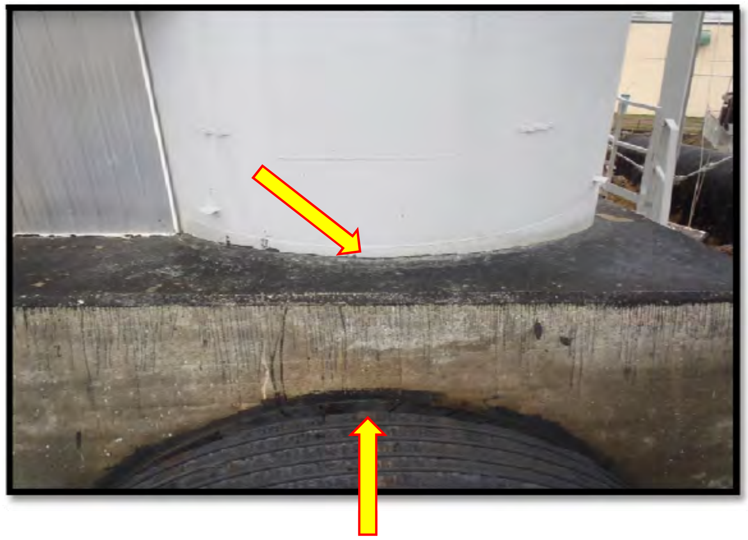
Surge Tank

Location:

Tee foundation

Description:

Close of areas indicated below and on the next page.



File Name: *10015*

Photo Record: 20

Equipment:

Surge Tank

Location:

Tee foundation

Description:

Tee foundation / Exterior riser intersection tight and solid.

File Name: *50062*

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PHOTO RECORD

Photo Record: 21

Equipment:

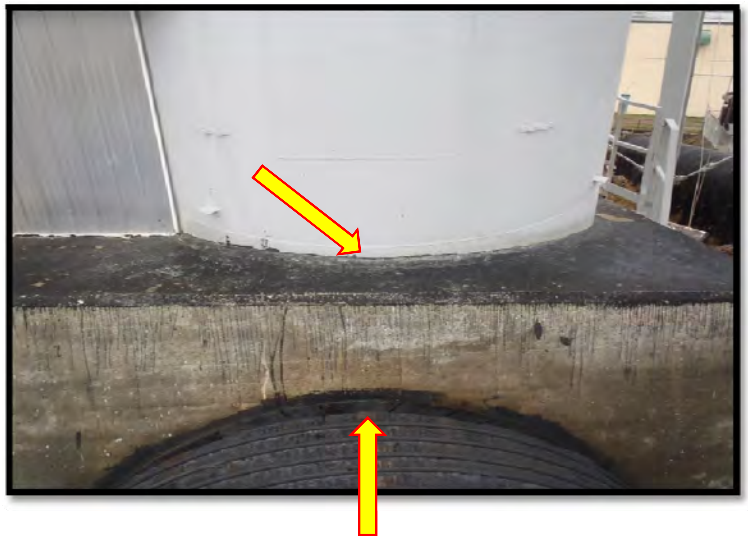
Surge Tank

Location:

Tee foundation

Description:

Close of areas indicated below and on the next page.



File Name: *10015*

Photo Record: 22

Equipment:

Surge Tank

Location:

Tee foundation

Description:

Tee foundation / Exterior riser intersection tight and solid.

File Name: *50062*

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PHOTO RECORD

Photo Record: 23

Equipment:

Surge Tank

Location:

Tee foundation

Description:

Tee foundation / Penstock intersection tight and solid.

File Name: *10012*

Photo Record: 24

Equipment:

Surge Tank

Location:

Tee foundation

Description:

View of Tee foundation and walkway between #1 & #2. No large cracks were found . Note efflorescence of the concrete.

File Name: *50062*

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PHOTO RECORD

Photo Record: 25

Equipment:

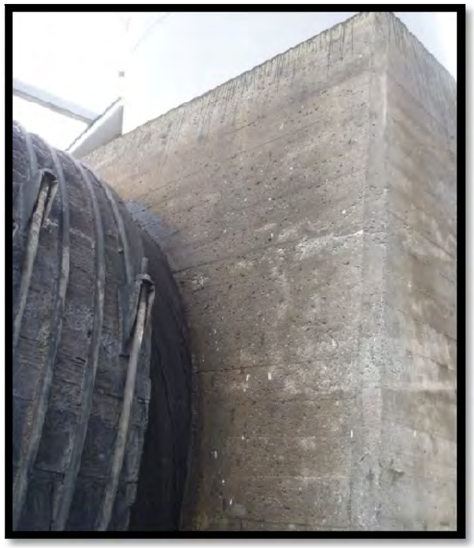
Surge Tank

Location:

Tee foundation

Description:

General condition photo. Components in good condition,



File Name: *10001*

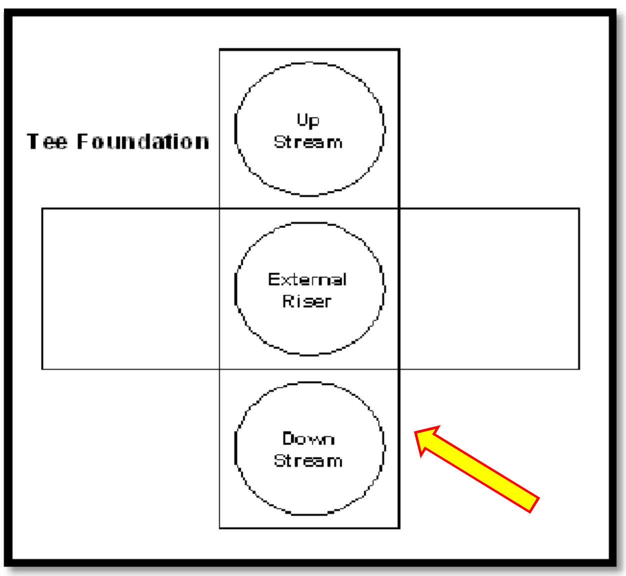


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PHOTO RECORD

Photo Record: 26

Equipment:

Surge Tank

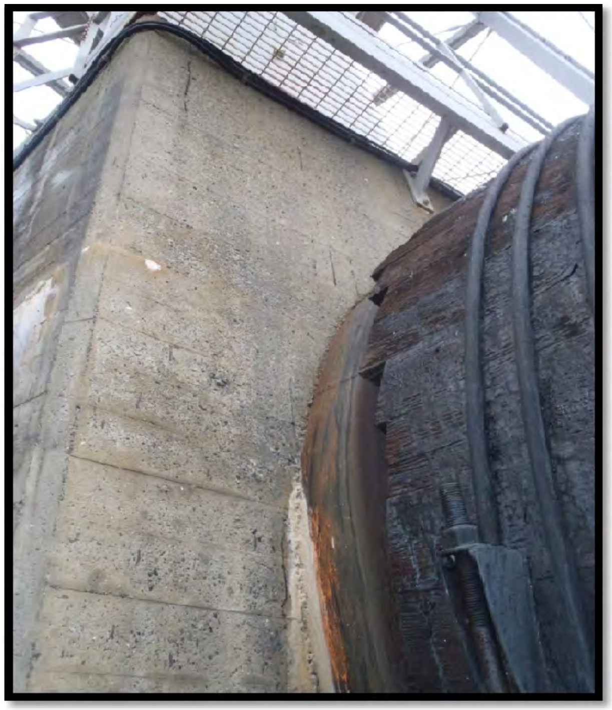
Location:

Tee foundation

Description:

General condition photo. Components in good condition,

File Name: *10011*



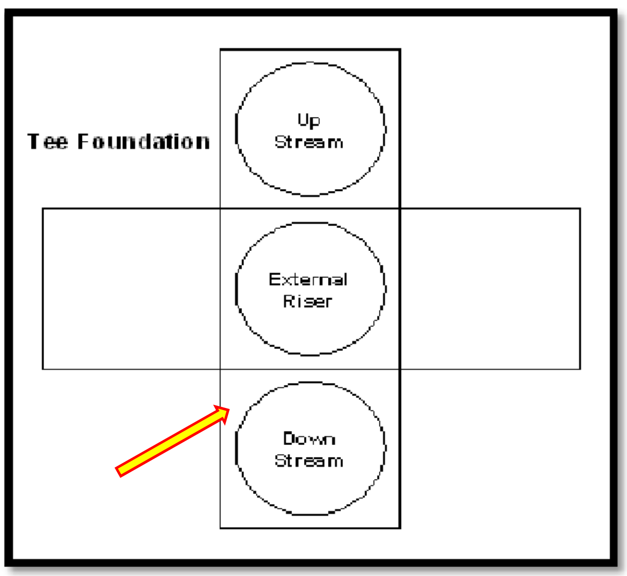


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PHOTO RECORD

Photo Record: 27

Equipment:
Surge Tank

Location:
Balcony & Handrail

Description:
Typical condition photo.

File Name: *10048*

Photo Record: 28

Equipment:
Surge Tank

Location:
Balcony & Handrail

Description:
Typical condition photo.

File Name: *10049*

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PHOTO RECORD

Photo Record: 29

Equipment:
Surge Tank

Location:
Balcony & Handrail

Description:
Failed coating on deck. Typical.

File Name: *90074*

Photo Record: 30

Equipment:
Surge Tank

Location:
Balcony & Handrail

Description:
Failed coating on deck. Typical.

File Name: *50091*

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PHOTO RECORD

Photo Record: 31

Equipment:

Surge Tank

Location:

Balcony & Handrail

Description:

Typical condition of the balcony underside. Areas of corrosion located where water is ponding on the deck above.

File Name: *10064*

Photo Record: 32

Equipment:

Surge Tank

Location:

Balcony & Handrail

Description:

Typical condition of the balcony underside. Areas of corrosion located where water is ponding on the deck above.

File Name: *90080*

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PHOTO RECORD

Photo Record: 33

Equipment:

Surge Tank

Location:

Tank exterior

Description:

Typical condition photo.
Note coating failures, delamination and UV breakdown.
See below for close-up photos.

File Name: *90034*

Photo Record: 34

Equipment:

Surge Tank

Location:

Tank exterior

Description:

Coating failure, delamination and UV breakdown. Note the primer is still intact.

File Name: *90060*

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PHOTO RECORD

Photo Record: 35

Equipment:

Surge Tank

Location:

Tank exterior

Description:

Coating failure, delamination and UV breakdown. Note the primer is still intact.

File Name: *90061*

Photo Record: 36

Equipment:

Surge Tank

Location:

Tank exterior

Description:

Typical coating failure, around external attachments. Note the primer is still intact.

File Name: *90059*

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PHOTO RECORD

Photo Record: 37

Equipment:

Surge Tank

Location:

Tank exterior

Description:

Typical condition of the roof shell intersection.

File Name: *90055*

Photo Record: 38

Equipment:

Surge Tank

Location:

Tank exterior

Description:

Typical condition of the roof shell intersection.

File Name: *90054*

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PHOTO RECORD

Photo Record: 39

Equipment:

Surge Tank

Location:

Tank shell interior

Description:

General photo showing coating intact. Typical of interior coating condition.

File Name: *10016*

Photo Record: 40

Equipment:

Surge Tank

Location:

Tank shell interior

Description:

Tank interior below water line. Coating in good condition.

File Name: *10067*

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PHOTO RECORD

Photo Record: 41

Equipment:

Surge Tank

Location:

Tank shell interior

Description:

Surface pitting which covers the entire tank bowl. Approx 1/8" deep and 3/8" diameter. Tank bowl coating is 100% intact, no area of active corrosion were found.

File Name: *10022*

Photo Record: 42

Equipment:

Surge Tank

Location:

Tank shell interior

Description:

Additional photo of above description.

File Name: *10019*

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PHOTO RECORD

Photo Record: 43

Equipment:

Surge Tank

Location:

External riser interior

Description:

Connection between tank bowl and internal riser. Area in good condition, coating in good condition.

File Name: *10032*

Photo Record: 44

Equipment:

Surge Tank

Location:

External riser interior

Description:

Intersection between tank bowl and external riser. Area in good condition, coating in good condition. View from inside

File Name: *10030*

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PHOTO RECORD

Photo Record: 45

Equipment:

Surge Tank

Location:

Internal riser exterior

Description:

Internal riser in good condition. View of stiffening member below the water line.

File Name: *10062*

Photo Record: 46

Equipment:

Surge Tank

Location:

Internal riser exterior

Description:

Typical condition photo. Coating in good condition.

File Name: *10081*

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PHOTO RECORD

Photo Record: 47

Equipment:

Surge Tank

Location:

Internal riser interior

Description:

View above water line. Coating in good condition.

File Name: *10015*

Photo Record: 48

Equipment:

Surge Tank

Location:

Internal riser interior

Description:

View below the water line. Coating in good condition.

File Name: *10026*

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PHOTO RECORD

Photo Record: 49

Equipment:
Surge Tank

Location:
Tee inside

Description:
Intersection between Tee and wooden penstock, area in good condition.

File Name: *10051*

Photo Record: 50

Equipment:
Surge Tank

Location:
Tee inside

Description:
Intersection between Tee and wooden penstock, area in good condition.

File Name: *10052*

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PHOTO RECORD

Photo Record: 51

Equipment:

Surge Tank

Location:

Tee inside

Description:

General photo of steel tee intersection. Area was found to be in good condition. Coating in good condition.

File Name: *10050*

Photo Record: 52

Equipment:

Surge Tank

Location:

Tee inside

Description:

General photo of steel tee intersection. Area was found to be in good condition. Coating in good condition.

File Name: *10049*

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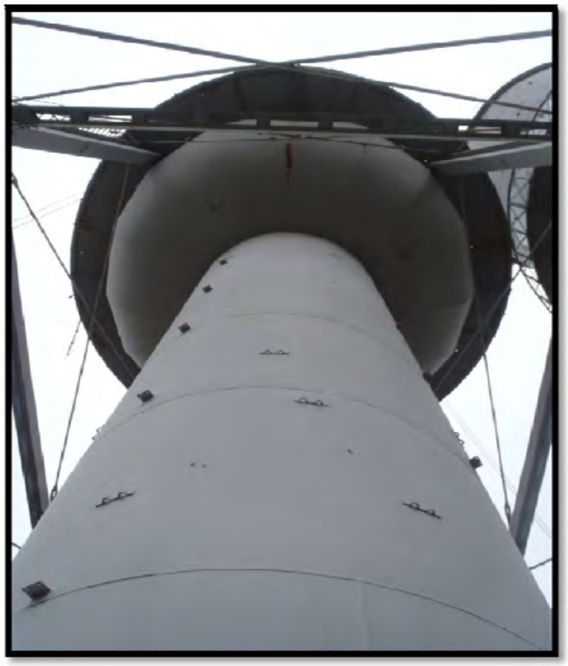
PHOTO RECORD

Photo Record: 53

Equipment:
Surge Tank

Location:
External riser

Description:
External riser was found to be in good condition. Typical condition photo.



File Name: *10018*

Photo Record: 54

Equipment:
Surge Tank

Location:
External riser

Description:
External riser was found to be in good condition. Typical condition photo.

File Name: *90092*

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PHOTO RECORD

Photo Record: 55

Equipment:

Surge Tank

Location:

External riser

Description:

External riser intersection to the Tank bowl was found to be in good condition. Typical condition photo.

File Name: *90093*

Photo Record: 56

Equipment:

Surge Tank

Location:

External riser

Description:

External riser intersection to the Tank bowl was found to be in good condition. Typical condition photo opposit side from photo above.

File Name: *10071*

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PHOTO RECORD

Photo Record: 57

Equipment:
Surge Tank

Location:
Roof

Description:
General photo. Roof was in good condition.

File Name: *7011*

Photo Record: 58

Equipment:
Surge Tank

Location:
Roof

Description:
Typical condition photo.

File Name: *7010*

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PHOTO RECORD

Photo Record: 59

Equipment:

Surge Tank

Location:

Roof

Description:

General photo of roof vent cap from inside.

File Name: *7014*

Photo Record: 60

Equipment:

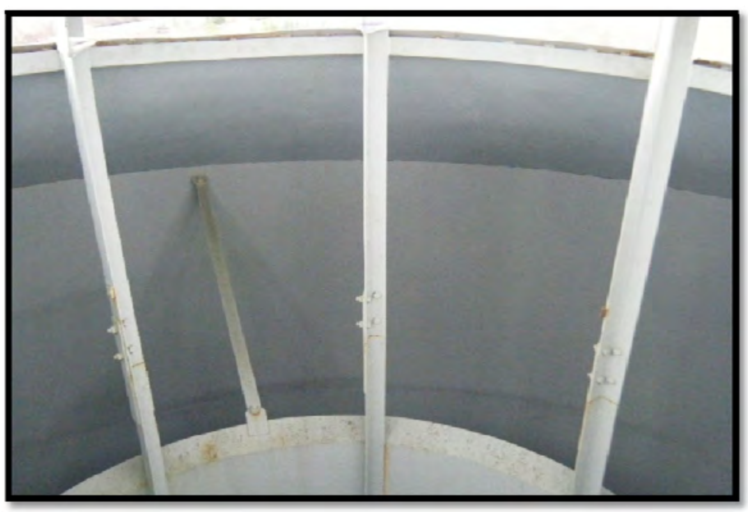
Surge Tank

Location:

Roof

Description:

General connection between roof and internal riser with spider rods.



File Name: *7005*

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PHOTO RECORD

Photo Record: 61

Equipment:

Surge Tank

Location:

Roof access hatch

Description:

Hatch was in good working condition.

File Name: *7019*

Photo Record: 62

Equipment:

Surge Tank

Location:

Roof access hatch

Description:

General photo of roof top railing. Material quite light but is intact and secure.

File Name: *7008*

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PHOTO RECORD

Photo Record: 63

Equipment:

Surge Tank

Location:

Access structures

Description:

View of roof top connection of hand rail. Note no toeboard.

File Name: *7023*

Photo Record: 64

Equipment:

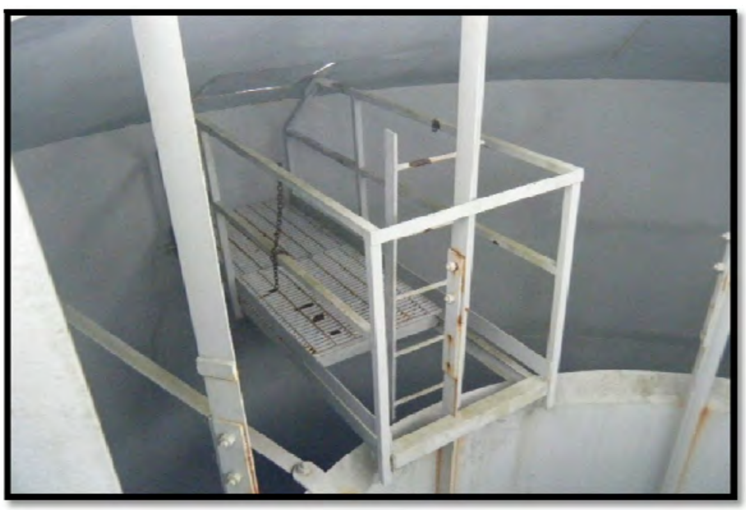
Surge Tank

Location:

Access structures

Description:

View of platform inside roof hatch. Components in good condition.



File Name: *7012*

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PHOTO RECORD

Photo Record: 65

Equipment:
Surge Tank

Location:
Spider rods / Internal riser

Description:
Spider rod connections to tank were in good condition. Typical condition photo.

File Name: *10003*

Photo Record: 66

Equipment:
Surge Tank

Location:
Spider rods / Internal riser

Description:
Spider rod connections to tank were in good condition. Typical condition photo.

File Name: *1006*

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APPENDIX B

Ladder Report

Applicable sections from;
"NSPI Weymouth Generating Station- Vertical and Horizontal Fall Protection Inspection"
Dated - March 26 2010

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Findings: Tank #2

The ladder construction is as noted below:
-#1 ladder length from bottom rung to top rung 19ft
-#2 ladder length from bottom rung to top rung 29ft
-#3 ladder length from bottom rung to top rung 32ft
-Side rails 2in x 0.375in flat bar
-Rungs 0.75in round bar spaced 12in on center
-Rungs are plug welded outside
-Side rails of ladder has 16in inside spacing
-Rungs have 6in clear spacing to the supporting structure

The vertical fall protection system manufacture outlines in the installation document section 1.2 –A "The ladder structure to which the system is installed must be capable of withstanding the loads applied by the system in the event of a fall."
Section 2.3-A-1:
One user = 3,375lbs
Two users = 4,350lbs
Three users = 5,325lbs
Four users = 6,300lbs

Recommendations:
Replace or repair the current ladder to meet the current ANSI A14.3-2002

Findings:
At the time of the inspection the vertical life line systems had no manufactures system label or written instructions on the use, maintenance and inspection of the system as outlined in the CSA Z259.16-04 SECTION 4. The configuration of the current bottom anchor of the vertical fall protection system (VFPS) is one that the manufacturer is not familiar with.

continued on next page;

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continued;

Recommendations:

Replace existing systems with new certified systems. Attach a systems label to the side rail of ladder. Ensure all systems information including an inspection label or log is kept on site and up to date. Prior to using the fall protection systems, ensure the systems label is securely attached and fully legible. It is the responsibility of the user and purchaser of this equipment to assure they are familiar with the instructions, operating characteristics, application limits, and the consequences of improper use of this equipment. Users and purchasers of this equipment must be trained in the correct care and use of this equipment. All system components must be inspected before each use, yearly by a competent person other than the end user and after a fall has occurred.

Conclusion:

There are many areas on the surge tank access ladders that need to be addressed as seen in photos 29, 30 and 31. It is the recommendation of Remote Access Technology to flag these access ladders out of service until repairs have been completed and new vertical fall protection systems have been installed.

CI Number: 17581

Title: **HYD – Weymouth Electrical Replacement**
Start Date: 2012/07
Final Cost Date: 2014/03
Function: Generation
Forecast Amount: $1,641,359

DESCRIPTION:

A condition and risk assessment of the medium voltage switchgear at the Weymouth Falls powerhouse revealed the existing oil-filled circuit breakers in Unit 1, the air blast circuit breakers in Unit 2, power cables, control relays, protective relays, and voltage regulators are of old design, and have reached the end of their safe working life. This project consists of replacing the existing medium voltage switchgear and associated equipment at the Weymouth Falls powerhouse. The existing switchgear on Unit 1 was installed in 1959, and on Unit 2 in 1966. There has been no significant refurbishment on this equipment. The equipment has long exceeded its recommended operational life.

The project life is expected to be 40 years.

This project will be depreciated in the Bear River depreciation class.

Summary of Related CIs +/- 2 years:
2013 CI 20571 - HYD Weymouth Falls Tailrace Deck Refurbishment $371,469
2013 CI 40308 - HYD Weymouth Falls Pipeline Replacement $6,752,759
2013 CI 43039 - HYD Weymouth Surge Tank $2,738,175
2013 CI 43136 - HYD Weymouth Headcover Replacement $438,158

JUSTIFICATION:

Justification Criteria: Health & Safety

Sub Criteria: Equipment Replacement

Why do this project?

A condition and risk assessment of the medium voltage switchgear at the Weymouth Falls powerhouse was undertaken. The assessment revealed the existing oil-filled circuit breakers in Unit 1 and air blast circuit breakers in Unit 2, power cables, control relays, protective relays, and voltage regulators are of old design, and have reached the end of their safe working life. In addition, the oil-filled switchgear poses a fire hazard to the plant and equipment. It was noted during the assessment that the integrity of solid insulation is a concern. In addition, spare parts for this vintage of equipment can be difficult to source. Sticky operating mechanisms, worn contacts and linkages impact both the functionality of the switchgear, as well as its safety.

Why do this project now?

This equipment has reached the end of its safe, reliable operational life. Failure of the switchgear or protective relays under fault conditions would present a fire hazard to the plant, any personnel in the plant, and would expose the hydro turbine generator to potential damage.

Why do this project this way?

Replacement of equipment of this vintage with modern electrical equipment is standard industry practice, and is the only practical way of achieving the necessary level of personnel safety.

CI Number : 17581-H660 - HYD - PE Weymouth Electrical Replacement **Project Number** H660

Parent CI Number : -

Cost Centre : 411 - 411-Sissiboo/Weymouth System **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		71,177	0	71,177
095		095-Hydro Regular Labour AO		20,444	0	20,444
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
095		095-Hydro Overtime Labour AO		[redacted]	0	[redacted]
095		095 - T&CS Regular Labour AO		5,570	0	5,570
001	022	001 - HYDRO Regular Labour	022 - HGP - Elec Contr.Equip.	105,600	0	105,600
001	022	001 - T&CS Regular Labour	022 - HGP - Elec Contr.Equip.	18,520	0	18,520
002	022	002 - HYDRO Overtime Labour	022 - GTG - Elec Contr.Equip.	28,480	0	28,480
011	022	011 - Travel Expense	022 - HGP - Elec Contr.Equip.	1,600	0	1,600
012	022	012 - Materials	022 - HGP - Elec Contr.Equip.	638,327	0	638,327
013	022	013 - POWER PRODUCTION Contracts	022 - HGP - Elec Contr.Equip.	[redacted]	0	[redacted]
028	022	028 - Consulting	022 - HGP - Elec Contr.Equip.	176,800	0	176,800
041	022	041 - Meals & Entertainment	022 - HGP - Elec Contr.Equip.	4,000	0	4,000
			Total Cost:	1,641,359	0	1,641,359
			Original Cost:	219,843		

Location: Hydro
FP#: 17581
Title: HYD - Weymouth Electrical Replacement

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Management	hr	[redacted]	[redacted]	$ 11,760.00		
1.2	Document Control	hr	[redacted]	[redacted]	$ 2,800.00		
1.3	Drafting	hr	[redacted]	[redacted]	$ 3,960.00		
1.4	Decommissioning	hr	[redacted]	[redacted]	$ 28,800.00		
1.5	Site support during construction	hr	[redacted]	[redacted]	$ 25,600.00		
1.6	Commissioning	hr	[redacted]	[redacted]	$ 51,200.00		
				Sub-Total	$ 124,120.00		
2	**012 Materials**						
2.1	Switchgear	ea	2	[redacted]	[redacted]		17583
2.2	Control Panel	ea	2	[redacted]	[redacted]		
2.3	Contginency	%	[redacted]	[redacted]	[redacted]		
2.4	Miscellaneous Electrical Supplies	lot	1	[redacted]	[redacted]		
				Sub-Total	$ 638,326.80		
3	**013 Power Production Contracts**						
3.1	Refurbishment	lot	1	[redacted]	[redacted]		17583
3.2	Contingency	%	[redacted]	[redacted]	[redacted]		
3.3					$ -		
				Sub-Total	[redacted]		
4	**002 Overtime Labour**						
4.1	Decommissioning	hr	[redacted]	[redacted]	$ 10,240.00		
4.2	Commissioning	hr	[redacted]	[redacted]	$ 18,240.00		
4.3					$ -		
				Sub-Total	$ 28,480.00		
5	**011 Travel Expenses**						
5.1	Travel to site	lot	1	$ 1,600.00	$ 1,600.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 1,600.00		
6	**028 Consulting**						
6.1	Design	lot	1	[redacted]	[redacted]	Cost Support 1	17583
6.2	Site Supervision	months	7	[redacted]	[redacted]		
6.3					$ -		
				Sub-Total	$ 176,800.00		
7	**041 Meals and Entertainment**						
7.1	Meals	lot	1	$ 4,000.00	$ 4,000.00		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 4,000.00		
8	**094 Interest Capitalized**						
8.1	Interest Capitalized	lot	1	$ 71,176.58	$ 71,176.58		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 71,176.58		
9	**095 Administrative Overhead**						
9.1	Hydro Regular Labour AO	lot	1	$ 20,444.16	$ 20,444.16		
9.2	T&C Regular Labour AO	lot	1	$ 5,569.68	$ 5,569.68		
9.3	Hydro OT Labour AO	lot	1	[redacted]	[redacted]		
9.4	Thermal & Hydro Contracts AO	lot	1	[redacted]	[redacted]		
				Sub-Total	$ 93,055.60		
Cost Estimate				**Total**	$ 1,641,358.98		
10	**Original Cost**						
10.1					$ 219,843.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

HYD-GEN-SG-RP-2009-54

This document is intended as technical support only. For cost support, please refer to the detailed cost estimate.

Nova Scotia Power Inc.

Hydroplant Medium Voltage Switchgear Assessment

Final Report

H332112
Rev. 0
August 12, 2009

Nova Scotia Power Inc.
Hydroplant Medium Voltage Switchgear Assessment

Final Report

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Executive Summary

Hatch conducted a condition assessment of the medium voltage switchgear at five hydroelectric generating stations in southern Nova Scotia: White Rock, Nictaux, Sissiboo Falls, Weymouth and Gulch. These facilities have 1950's to early 1960's vintage switchgear equipment with oil-filled circuit breakers. The study included a review of drawings, work history and preventative maintenance routines. Site visits were conducted over a two day period, during which equipment was visually inspected and discussions held with NSPI personnel. This report contains assessments of the present condition of the switchgear, short-term operation and maintenance recommendations for risk mitigation and recommendations for eventual refurbishment or replacement.

The facilities are presented in this report in the order of priority for immediate intervention and replacement.

The following recommendations should be immediately implemented at all five generating stations:

- The safety of these aging switchgear assemblies is a major concern, therefore operating procedures need to be reviewed to ensure risks are mitigated until the equipment is replaced. Of particular concern is the wearing of appropriate personal protective equipment (PPE) to address the arc flash potentials.
- The integrity of solid insulation is a major concern. A program of ultrasonic testing to verify bus, cable and circuit breaker insulation integrity should be undertaken.
- In the short term there must be a focus on improved maintenance frequency and documentation to ensure developing problems can be detected before they deteriorate.
- Spare parts for this vintage of equipment can be a problem but must be addressed if the equipment is to remain in service. Sticky operating mechanisms, worn contacts and linkages do not just impact the functionality of switchgear but also its safety.
- There must be an awareness of the fire hazard associated with operating oil-filled switchgear. Fire detection and suppression equipment should be in place and good housekeeping practices enforced.
- The technical specification for the replacement switchgear should address such requirements as the number of operations and difficulty in maintenance, selective protection so that generator breaker trips for faults on the low voltage side of step-up transformer, transient recovery voltage for generator or system fed faults, arcing considerations and minimum fault damage by isolating within 3 to 5 cycles. Include a fused load break switch for the feed to the station service transformer, rated for nominal transformer load and momentary short circuit current as required as per the results of a transient recovery voltage (TRV) study.

Based on the condition assessment of the equipment as per Condition Assessment (CA) sheets attached in Appendix A of this report, it is our considered opinion and recommendations that the switchgear at all the five generating facilities should be replaced within the next five years. The approximate labour and material cost for each upgrade is estimated as [redacted] This includes main and generator breakers, associated protective relaying, station service power supply and medium voltage power cables. Arc flash rated switchgear will cost an additional [redacted] per facility. These estimates do not include the cost for new generator protection and controls.

The White Rock and Nictaux stations should be upgraded within the next year. If this is not possible, the decision as to the order of priority should be based on the results of further inspection and testing, any developing problems and operational considerations.

Gulch is the next candidate for upgrade after White Rock and Nictaux are completed. This is subject to change depending on the results of further inspections and testing, problems that may arise in the interim and operational considerations. In the case of Weymouth and Gulch there is an unused breaker that may be refurbished as an interim measure to provide additional reliability until the switchgear is replaced. At this point in time, with the limited maintenance information and test data available, it appears that the Sissiboo facility would be the last candidate for upgrade but should be replaced within the next five years.

Maintenance practices and operating procedures need to be changed in order to continue to operate the aging switchgear at all five generating facilities. Generally the frequency and rigour for switchgear maintenance activities needs to be increased. Section 3.3.1 outlines specific maintenance program improvements that should be implemented for all five facilities.

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1. Introduction

Nova Scotia Power Inc. (NSPI) engaged Hatch to perform a condition assessment of medium voltage switchgear at five small hydro generating stations. The stations in question have 1950's to early 1960's vintage oil-filled circuit breakers in service to connect the generator winding to the generator step up transformer. The intention of the study is to provide NSPI with recommendations on risk mitigation and operation and maintenance requirements to enable equipment to remain in service for the next two to five years until the eventual replacement of the equipment. This report documents the investigations, observations and analyses conducted, and lists recommendations to achieve NSPI's objective.

1.1 Objectives

The key objectives of the current study will be as follows:

- assess the present condition of switchgear;
- assess operation and maintenance practices;
- provide recommendations on risk mitigation;
- provide recommendations on refurbishment and/or replacement of switchgear equipment and associated costs. Recommendations are itemized by location and priority.

1.2 Approach

Hatch undertook the following activities in preparation of the recommendations.

- Reviewed available drawings of existing switchgear.
- Reviewed preventative maintenance program and work order history.
- Conducted visual inspections during site visits and preparation of condition assessment documents.
- Held discussions with NSPI personnel.
- Itemized recommendations in order of priority for each generating facility.
- Prepared a budget cost estimate for labour, materials and engineering for implementing the recommendations.

1.3 Report Organization

Section 2 of this report describes the methodology used to perform the assessments, conduct the analyses, and make the recommendations. Sections 3 provide analysis, assessment findings, results and recommendations for each generating facility. Detailed condition assessment information and photographs can be found in Appendix A, in the Condition Assessment Forms. Section 4 of the report provides the basis of the cost estimates.

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2. Methodology

The project was completed in primarily two phases: Data Collection and Analysis. The Data Collection Phase consisted of visual inspections conducted during a two-day site visit to the five facilities and a review of available maintenance records. During the site visits, discussions were held with NSPI personnel familiar with each facility. The Analysis Phase consisted of collating maintenance and field inspection data and rating the equipment on condition assessment forms. Industry experience and trends have been considered through consultation with equipment manufacturers and published papers on the subject.

Information relating to the condition of the equipment as obtained from the site inspections and a review of maintenance records, together with research into industry and manufacturer experience, was used to facilitate the drawing conclusions and preparing the recommendations.

2.1 Data Sources

Various sources of information were included in this study, as described below.

2.1.1 Drawings

NSPI provided electrical drawings for the equipment at the majority of the facilities. The drawings were primarily used in developing a familiarity with the facilities and equipment for the site visits.

2.1.2 Interviews

Rather than conduct formal interviews, Hatch engaged NSPI staff during the site inspections. This approach allowed staff to demonstrate their concerns and quickly recall maintenance and repair history. Valuable information was provided by the staff and that information fed directly into the equipment assessments.

2.1.3 Preventative Maintenance History

NSPI provided preventative maintenance records for each of the facilities. The records provided are found in Appendix B.

2.1.4 Site Inspections

Site inspections were conducted on March 17 and 18, 2009, by Dan Brennan, Dwayne Keddy, and Wes Trimper of NSPI and Lewis Hann of Hatch. The site inspections consisted of visual assessment of equipment condition; NSPI maintenance staff opened doors and removed covers to permit internal inspections of breaker compartments and in some cases bus supports and instrument transformers.

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2.2 Analysis

2.2.1 Maintenance Program

Available maintenance records for all five facilities were reviewed for frequency, thoroughness and follow-up. The objective of this review was to identify serious or recurring problems and to assess the effectiveness of the maintenance program for safely extending the life expectancy of the equipment by an additional two to five years. Data obtained from the maintenance records is a key input into the condition assessment of the equipment.

2.2.2 Industry Experience

Published articles and equipment manufacturers were consulted for recommendations and industry experience in extending the life of aging oil-filled medium voltage switchgear.

3. Assessment and Recommendations

3.1 General

The major concern in extending the life of aging oil-filled switchgear is the risk of catastrophic failure. If switchgear is regularly and adequately maintained according to manufacturer recommendations it can be expected to last for approximately 40 years. Other factors that influence the expected life include the operating environment, fault history, power system growth, the cost of unexpected downtime, safety and fire implications [Ref. 1, 2].

The main failure modes for oil-filled switchgear are as follows:

- Fault within the oil compartment, invariably resulting in an explosion and fire, putting at risk personnel and surrounding structures.
- Failure to trip resulting in increased damage to equipment and extended downtime.
- Solid insulation faults (cable or bus insulation) resulting in extensive equipment damage and risk to personnel and surrounding structures.

The practicality of securing an adequate supply of spare parts in order to properly service and maintain the equipment must be a consideration as well. The availability of major items such as bushings, insulators, instrument transformers, operating mechanisms, etc., are critical in assuring the ability to execute major repairs. The availability of routine maintenance items such as contacts, gaskets, tripping and closing coils are essential for performing effective maintenance routines.

When replacing an existing switchgear installation there are a number of options available [Ref. 3]:

- Replace the entire switchgear assembly;
- Replace individual switchgear sections;
- Retrofit with new vacuum or SF6 circuit breakers.

The decision to completely replace versus a retrofit often comes down to a short list of the following basic considerations:

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- If the existing equipment has inadequate capacity, fault ratings or fault clearing time, complete replacement is recommended.
- If during interruption of a three phase grounded fault, the transient recovery voltage exceeds the rated transient recovery voltage envelope of the circuit breaker, complete replacement of switchgear or mitigation by adding capacitors for either generator source-fed or system fed faults or both.
- If the switchgear insulation is deteriorated or defective, complete replacement is recommended.
- If the safety and reliability of the retrofitted switchgear can not be brought to an acceptable level, replacement is recommended.

If the decision to replace the switchgear is not answered as a result of the preceding criteria a detailed analysis is required to assess the potential risk of leaving the switchgear in service [Ref. 4]. When deciding not to undertake a complete switchgear replacement, there must be a level of technical confidence that those parts to be retained have adequate ratings and sufficient life remaining to make this a viable option. This includes the extent of deterioration for such components as the bus bar insulation, instrument transformers, control wiring and cable terminations. This can only be attained by thorough inspection and testing, typically involving some form of partial discharge or high-pot testing.

Old paper/lead power cables can be easily damaged if disturbed and should be considered for replacement. If not replaced, precautions must be taken to ensure adequate protection and testing should be performed prior to the start of the work and after the work is complete.

Completely new switchgear will incorporate modern advances in technology and provide the opportunity to modernize the protection and control system.

3.2 Arc Flash Considerations

When evaluating whether to upgrade or replace switchgear installations companies are with increased frequency, compelled to consider safety implications of arc flash hazards. The arc flash hazard is a function of the arcing current and hence dependent on the voltage, gap distances and available fault current. The energy released is also a function of the fault clearing time which becomes a major consideration in installations that do not have a main incoming breaker whereby bus faults must be cleared by upstream primary protection equipment. In the case of small hydro installations in remote locations the clearing time of the primary transmission protection equipment is likely to be the determining factor. This is precisely the case for the White Rock, Nictaux and Weymouth generating facilities.

Arc flash hazards are becoming recognized by companies and regulatory agencies [Ref. 5]. The recent release of CSA Z462 – Workplace Electrical Safety, places significant emphasis on the mitigation of arc flash hazards and has adopted the methodologies of IEEE 1584 and NFPA 70E for performing arc flash calculations.

Arc flash calculations are required to properly assess risk hazards associated with working near energized electrical equipment (see Table 3.1). The intent of such calculations is to determine the Arc Flash Protection Boundary Distance and to identify the level of PPE required when working within this boundary near energized equipment.

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Arc Flash Protection Boundary Distance is the distance at which a person is likely to receive a second degree burn. The onset of a second degree burn is assumed to occur when the skin receives 5.0J/cm^2 (1.2 cal/ cm^2) of incident energy. (Ref. CSA Z462-08)

Arc Flash Incident Energy is the amount of energy, impressed on a surface a certain distance from the source, generated during an electrical arc event. (Ref. CSA Z462-08)

The level of PPE required when working within the arc flash protection boundary is dependent on the arc flash incident energy available. Outside this boundary no specialized PPE is required for protection from arc flash.

The incident energy is defined in NFPA 70E as the amount of energy that is impressed on a surface at a certain distance from an arcing event. The distance is chosen as the normal working distance based on voltage level and equipment type. Typical working distances are provided in Table 3 of IEEE Standard 1584-2002.

Table 3.1 – Calculated Arc Flash Energy For Estimated Clearing Times

Fault Clearing Time =>			0.2 s	0.4 s	0.5 s	1.0 s
Station	3-Ph Fault (kA)	Voltage (kV)	Incident Energy (cal/cm^2)			
White Rock	4.4	6.9	1.0	2.0	2.5	5.1
Nictaux	9.4	6.9	2.3	4.5	5.7	11.3
Gulch	4.3	13.2	1.0	2.0	2.5	4.9
Weymouth	7.5	6.6	1.8	3.6	4.5	8.9
Sissiboo	8.1	13.8	1.9	3.9	4.8	9.7

Note: Above Arc Flash Energy values are rough estimates and are not meant to replace a detailed Arc flash study. A detailed arc flash study is required in order to identify the correct HRC category.

Table 3.2 – Hazard Risk Category (HRC) per CSA Z462-08

HRC	Incident Energy	Protective Clothing
0	0 - 1.2 cal/cm^2	Non-melting, flammable material such as untreated cotton long sleeve shirt and pants,
1	1.2 - 4 cal/cm^2	Arc rated shirt and arc rated pants, or arc rated coverall, Arc rated face shield or flash hood, **Total protection must be 4 cal/cm^2 minimum**
2	4 - 8 cal/cm^2	Arc rated shirt and arc rated pants, or arc rated coverall, Arc rated face shield or flash hood, **Total protection must be 8 cal/cm^2 minimum**
3	8 - 25 cal/cm^2	Arc rated shirt and arc rated pants, or arc rated coverall, Arc rated flash hood, Arc rated flash suit as needed, Arc rated gloves, **Total protection must be 25 cal/cm^2 minimum**
4	25 - 40 cal/cm^2	Arc rated shirt and arc rated pants, or arc rated coverall, Arc rated flash hood, Arc rated flash suit as needed, Arc rated gloves, **Total protection must be 40 cal/cm^2 minimum**

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3.3 Maintenance Program

Oil-filled switchgear was designed and introduced at a time when the predominant maintenance philosophy was time based consisting of overhauls at fixed intervals. Adherence to these fixed schedules has provided high levels of reliability. The absence of a rigorous maintenance programme can lead to a switchgear condition whereby it is unable to safely and reliably perform its intended duty.

Shrinking budgets, changing priorities, availability of equipment downtime, lack of awareness of the risks involved and the reliable track record of oil-filled switchgear, are all factors that contribute to equipment being left in service beyond its service life, without the necessary monitoring and maintenance that must accompany such a decision.

Maintenance records were provided by NSPI for all five generating facilities. The records provided for each facility are less than comprehensive and include a mixture of yearly visual inspections, five-year maintenance routines, Doble insulation tests and variations of handwritten and typed reports. The was no facility with a complete and documented maintenance regime.

The following table is a brief overview of the maintenance and inspection activities at the five generating facilities.

Table 3.3 Maintenance Summary

Station	Most Recent Record	Maintenance Type	Comments
White Rock	02-Aug-2003	5 Year Routine	Required parts not available; Problem with arcing contacts
Nictaux	26-Jul-2004	Other	Sticky film on close coil; Problem with breaker closing in 2000
Gulch	02-Oct-2008	1 Year Routine	Required parts not available
Weymouth	21-Feb-2006	1 Year Routine	Required parts not available; Problem with arcing contacts
Sissiboo	05-Oct-2000	5 Year Routine	Replaced bad contacts

In the five facilities that were reviewed, there is a heavy reliance on visual inspections. The maintenance documentation that is available does not always use consistent or proper maintenance forms, resulting in a lack of rigour and a likelihood that important procedures and tolerances will not be adhered to. Inconsistent inspections and lack of records make it difficult to review historical test data to identify developing problems. For example, the condition and deterioration of contacts is best analyzed by comparing to previous contact resistance measurements. Infrequent testing and the organization of the check sheets make such comparisons difficult.

When deficiencies are identified the remedial work must be prioritized so the work can be carried immediately, at the earliest possible opportunity or at the next scheduled equipment outage. It is evident from the maintenance records that this is not always the case. In several instances, follow-up repairs were identified on the inspection but there is no record of this work taking place.

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It is expected that the availability of spares for this old equipment will be a potential problem, thus preventing necessary repairs from being undertaken as they were identified during routine checks. This is evident in the inspection documentation on several occasions.

Visual inspections are an important part of any maintenance program but need to be accompanied by routine functional checks and tests that will clearly identify problems that require mitigation.

Of particular concern in older switchgear is the integrity of the solid insulation hardware, bus support insulators, bushings and stress cones. Insulation degradation can lead ultimately to serious failures posing a danger to personnel and equipment unavailability. Assessment of the insulation integrity of medium voltage equipment is performed by visual inspection and testing using a mega-ohm meter (Megger) testing, Hi-pot, power factor (pf) testing, and corona discharge- ultrasonic testing. The breakdown of solid insulation can result in corona discharge, arcing and tracking. All three conditions emit an ultrasound at the site of the problem and can be located by scanning the area with an ultrasound detection equipment.

Based on the maintenance records available for this assessment, the switchgear maintenance program for all five facilities is insufficient for safely and reliably keeping the aging oil-filled switchgear in service.

3.3.1 Recommendations, Maintenance Program

The effectiveness of the switchgear maintenance program at these facilities can be greatly improved with the following changes and additions:

1. Rigorously adhere to an annual inspection regime.
2. Implement the use of standardized forms that are conducive to comparisons with previous test results.
3. Oil dielectric testing must be conducted annually.
4. Improve the availability of routine maintenance items such as contacts, gaskets, tripping and closing coils, as these are essential for performing effective maintenance routines.
5. Incorporate annual trip-testing via the protection scheme to confirm the functionality of the trip system.
6. Increase rigour for contact wear and alignment checks. Make adjustments per OEM recommendations and ensure replacement parts are available.
7. Include ultrasonic testing as part of the annual predictive maintenance testing required for all five switchgear installations.

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3.4 White Rock

The White Rock Generating Station was constructed in 1952 and has a generator nameplate rating of 4,000 kVA at 6.9 kV. The generator is connected to the power grid via a 4000 kVA, 6.9:22 kV step-up transformer. The generator switchgear was manufactured by Canadian Westinghouse and is an open architecture design.

3.4.1 Assessment, White Rock

The following is a summary of key findings from the site visit and maintenance records, a condition assessment sheet is included in Appendix A.

- The switchgear nominal rated voltage is 7.5 kV.
- The switchgear bus ampacity could not be verified from drawings or nameplates.
- The breaker and switchgear short circuit capacities could not be verified from drawings or field data.
- NSPI records indicate the three phase fault level at the switchgear bus as being 4.4 kA. (Bus No. 955)
- The generator breaker is a 7.5 kV, 600A Type BK oil-filled circuit.
- The switchgear contains a Westinghouse Type DB, DC circuit breaker for the generator field supply.
- Exposed energized 6.9 kV bus and other components are readily accessible to maintenance personnel. This poses an arc flash and shock hazard to personnel. Until this hazard is eliminated, procedures need to be implemented to manage this risk.
- The breaker cubicle requires frequent access to work on the operating mechanism, auxiliary contacts and to flash the generator field.
- The clearing time for a bus fault at this facility is dependant on the settings for the transmission system as there is no main breaker in this switchgear. This arrangement is not uncommon but additional clearing time significantly adds to the available arc flash energy.
- The bus work and insulator supports are heavily contaminated and there is no record of previous cleaning or insulation testing. The integrity of the bus insulation is highly suspect and susceptible to failure.
- The generator breaker is connected to the line side bus via a 600A gang operated disconnect switch. The switchgear detail drawing indicates that the disconnect is electrically interlocked with the generator breaker.
- The bus potential transformers appear to be original and beyond their service life. The equipment is very dirty and the connection leads have cracked insulation and unreliable terminations.
- Switchgear contains station service transformers and antiquated molded case circuit breaker distribution equipment.

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- The stress cones for the medium voltage power cables have a residue that is typical of corona discharge activity. This happens when the surface resistivity is not properly graded, i.e. the surface of the cone has lost its semi-conductive characteristics and the potential ionizes the area surrounding the stress cone. This requires close monitoring and may require the stress cone to be replaced if it further deteriorates and results in serious arching.
- The protective relays are obsolete induction disc type and are beyond their service life.
- This switchgear does not appear to have undergone any significant upgrades and all components appear to be original equipment.
- The switchgear is 1950's vintage and is beyond its recommended service life.

3.4.2 Recommendations, White Rock

1. This switchgear equipment is beyond an acceptable level of reliability and safety and should be replaced as soon as practical.
2. Implement the practice of wearing appropriate arc flash protective clothing and protective equipment when working in the vicinity of this switchgear, particularly when opening doors or removing panel covers.
3. During the next plant outage verify functionality of the safety interlock on the breaker isolation switch to ensure there is no accidental opening with the generator on line. A detailed procedure will be required to ensure that this work is executed safely.
4. Perform an IR scan of power connections to check for high resistance connections and overheated components, particularly the breaker isolation switch and station service distribution equipment.
5. To ensure some level of reliability until this equipment is replaced the following remedial measures are recommended:
   a) Investigate the severity of the corona discharge on the power cable stress cones. Ultrasonic testing will identify issues with tracking and corona discharge.
   b) Perform ultrasonic testing on the entire switchgear assembly to identify tracking and corona issues on bus insulation and terminations.
   c) Perform a thorough cleaning of the bus and bus insulation.
   d) Perform an inspection of the cloth insulated control wiring and terminations

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3.5 Nictaux

The Nictaux Generating Station was constructed in 1954 and has a generator nameplate rating of 8,500 kVA at 6.9 kV. The generator is connected to the power grid via a 6.9:69 kV step-up transformer. The generator switchgear was manufactured by Canadian Westinghouse and is an open architecture design.

3.5.1 Assessment, Nictaux

The following is a summary of key findings from the site visit and maintenance records, a condition assessment sheet included in Appendix A.

- The switchgear nominal rated voltage is 7.5 kV.
- The switchgear bus ampacity could not be verified from drawings or nameplates.
- The breaker and switchgear short circuit capacities could not be verified from drawings or field data.
- NSPI records indicate the three phase fault level at the switchgear bus as being 9.4 kA. (Bus No. 537)
- The generator breaker is a 15 kV, 1200A Type BKHB oil-filled circuit breaker.
- The switchgear contains a Westinghouse Type DB-25, DC breaker for the generator field supply.
- Exposed energized 6.9 kV bus and other components are readily accessible to maintenance personnel. This poses an arc flash and shock hazard to personnel. Until this hazard is eliminated, procedures need to be implemented to manage this risk.
- The breaker cubicle requires frequent access to work on the operating mechanism and auxiliary contacts.
- The clearing time for a bus fault at this facility is dependant on the settings for the transmission system as there is no main breaker in this switchgear. This arrangement is not uncommon but additional clearing time significantly adds to the available arc flash energy.
- The bus work and insulator supports are heavily contaminated and there is no record of previous cleaning or insulation testing. The integrity of the bus insulation is highly suspect and susceptible to failure.
- The generator breaker is connected to the line side bus via a 600A gang operated disconnect switch. The switchgear detail drawing indicates that the disconnect is electrically interlocked with the generator breaker.
- Switchgear contains station service transformers and antiquated molded case circuit breaker distribution equipment. Documentation indicates the station service transformer are oil-filled distribution type.
- Protective relays are Westinghouse Type CO, COR and BL induction disc design and are beyond their service life.

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- This switchgear does not appear to have undergone any significant upgrades and all components appear to be original equipment.
- The switchgear is 1950's vintage and is beyond its recommended service life.

3.5.2 Recommendations, Nictaux

1. This equipment is beyond an acceptable level of reliability and safety and should be replaced as soon as practical.
2. Implement practice of wearing appropriate arc flash protective clothing and equipment when working in the vicinity of this switchgear, particularly when opening doors or removing panel covers.
3. During the next plant outage verify functionality of the safety interlock on the breaker isolation switch to ensure there is no accidental opening with the generator on line. A detailed procedure will be required to ensure that this work is executed safely.
4. Perform an IR scan of power connections to check for high resistance connections and overheated components, particularly the generator breaker isolation switch and station service distribution equipment.
5. To ensure some level of reliability until this equipment is replaced the following remedial measures are recommended:

   a) Perform ultrasonic testing on the entire switchgear assembly to identify tracking and corona issues on bus insulation and terminations.

   b) Perform a thorough cleaning of the bus and bus insulation.

   c) Follow up on issue with breaker hesitation while closing and undertake repairs to resolve issues noted in the linkages or solenoids.

   d) Perform an inspection of the cloth insulated control wiring and terminations.

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3.6 Gulch

The Gulch Generating Station was constructed in 1950. The original generator nameplate rating was of 7,500 kVA at 13.8 kV. In 2000 the generator was upgraded to 9000 kVA. The station is connected to the power grid via 13.8:69 kV step-up transformer. The generator switchgear is 15kV metal-clad manufactured by Canadian Westinghouse. The equipment is an enclosed design with grounded metal compartments separating bus, breakers and instrument transformers as is typical in modem metal-clad switchgear.

3.6.1 Assessment, Gulch

The following is a summary of key findings from the site visit and maintenance records, a condition assessment sheet included in Appendix A.

- The switchgear bus ampacity could not be verified from drawings or nameplates.
- The main circuit breaker to the step-up transformer is a 15 kV, 600A, De-Ion Grid, Type BKB, oil-filled circuit breaker.
- The generator breaker is a 15 kV, 600A, De-Ion Grid, Type BKB, oil-filled circuit breaker.
- The switchgear assembly contains an unused 600A, Type BKB, breaker identified as the Cornwallis feeder.
- The breaker interrupting capacities could not be verified from drawings or nameplates.
- NSPI records indicate the three phase fault level at the switchgear bus as being 4.2 kA. (Bus No. 576)
- The medium voltage cables exiting the switchgear are old and based on a visual inspection from a distance, these cables are of concern.
- Protective relaying is located in the onsite control centre.
- This switchgear does not appear to have undergone any significant upgrades and all components appear to be original equipment.

3.6.2 Recommendations, Gulch

1. This equipment is at or near its design service life and should be upgraded or replaced within the next five years.
2. The medium voltage cables from the switchgear to the step up transformer should be inspected and tested to verify their condition is adequate to remain in service.
3. The unused Cornwallis breaker should be assessed for suitability to be reconditioned and installed to replace the existing generator breaker. This will provide an added degree of reliability until the switchgear is replaced.
4. Frequency of maintenance checks needs to be increased to at least yearly.

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5. The generator capacity increase would have changed the X/R ratio and therefore 3-ph fault contribution to ground at the generator terminals will increase, as will as the TRV. A study is therefore required for specifying the generator circuit breaker.

3.7 Weymouth

The Weymouth Generating Station was constructed in 1961 and has two generators with nameplate capacities of 11,250 kVA at 13.8 kV. The station is connected to the power grid via a 13.8:69 kV step-up transformer. Switchgear for the station consists of two separate assemblies, one for each generator. The two assemblies are connected together by a tie-breaker in the generator No.1 assembly. Both switchgear assemblies are 15 kV metal-clad manufactured by General Electric. The equipment is an enclosed design with grounded metal compartments separating bus, breakers and instrument transformers as is typical in modem metal-clad switchgear.

3.7.1 Assessment, Weymouth

The following is a summary of key findings from the site visit and maintenance records, a condition assessment sheet included in Appendix A.

- The switchgear bus ampacity could not be verified from drawings or nameplates.
- The generator No. 1 breaker is a 15 kV, 600A, Oil Blast, Type FKR-255-250, oil-filled circuit breaker.
- The tie-breaker is a 15 kV, 1200A, Oil Blast, Type FKR-255-250, oil-filled circuit breaker.
- The generator No.1 assembly contains an unused 600A, Oil Blast breaker, identified as the Digby feeder.
- The Oil Blast breakers in the generator No.1 assembly have interrupting capacities, as identified on the nameplates is 9.7 kA RMS at 15 kV.
- The generator No. 2 breaker is a 15 kV, 1200A, Magna Blast, Type AM-13.8-500, air circuit breaker. This breaker was overhauled by Siemens in 2000.
- NSPI records indicate the three phase fault level at the switchgear bus as being 7.5 kA. (Bus No. 961)
- Switchgear contains a non-load break isolation switch that supplies the station service transformer. The compartment housing the disconnect switch has a key interlock to prevent access until the transformer is offloaded. The key interlock appears to have been taken out of service.
- Protective relays are General Electric induction disc design and are beyond their service life.
- This switchgear does not appear to have undergone any significant upgrades and all components appear to be original equipment.

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3.7.2 Recommendations, Weymouth

1. This switchgear for generator No. 1 is at or near its design service life and should be upgraded or replaced within the next five years.
2. The unused Digby feeder breaker should be overhauled and installed to replace the generator No.1 breaker. If it is determined that such an overhaul is impractical due to its state of deterioration, the useable spare parts should be salvaged.
3. Frequency of maintenance checks needs to be increased to at least yearly.
4. The upgrade of the switchgear for generator No. 2 is not as urgent, as the breaker is an air blast type and was overhauled in 2007.
5. The generator No. 2 switchgear needs to be included in all maintenance and testing improvements, particularly the solid insulation assessment utilizing ultrasonic testing.

3.8 Sissiboo Falls

The Sissiboo Falls Generating Station was constructed in 1961 and has a generator nameplate rating of 7,500 kVA at 6.9 kV. The generator is connected to the power grid via 6.6:69 kV step-up transformer. The generator switchgear is 7.5 kV metal-clad manufactured by General Electric. The equipment is an enclosed design as is typical in modem metal-clad switchgear.

3.8.1 Assessment, Sissiboo Falls

The following is a summary of key findings from the site visit and maintenance records, a condition assessment sheet included in Appendix A.

- The switchgear bus ampacity could not be verified from drawings or nameplates.
- The main breaker is a 7.5 kV, 2000A, Oil Blast, Type FKR-255-250, oil-filled circuit breaker.
- The generator breaker is a 7.5 kV, 1200A, Oil Blast, Type FKR-255-250, oil-filled circuit breaker.
- The breaker interrupting capacities as identified on the nameplates is 19.5 kA RMS at 7.5 kV.
- NSPI records indicate the three phase fault level at the switchgear bus as being 8.1 kA. (Bus No. 596)
- Switchgear contains a non-load break isolation switch that supplies the station service transformer. The compartment housing the disconnect switch is key interlocked to the transformer secondary breaker.
- Protective relays are General Electric induction disc design and are beyond their service life.
- This switchgear does not appear to have undergone any significant upgrades and all components appear to be original equipment.
- The switchgear is 1960's vintage and is beyond its recommended service life.

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3.8.2 Recommendations, Sissiboo Falls

1. This equipment is at or near its design service life and should be upgraded or replaced within the next five years.
2. Frequency of maintenance checks needs to be increased to at least yearly.

3.9 Recommendations, General

All five installations require the switch gear be replaced as soon as practical. The White Rock and Nictaux stations are of particular concern due their open architecture design and concern as to the reliability of the bus and cable insulation. It is recommended that both stations be upgraded within the next year. If this is not possible, the decision as to which equipment is to be replaced first should be based on the results of further inspections and testing and any developing problems. Ultrasonic testing and a thorough switchgear inspection should be undertaken at the first opportunity.

At this point in time, it appears that Gulch would be the likely candidate for upgrade after White Rock and Nictaux are completed. This is subject to change depending on the results of inspections and testing at all stations and problems that may arise in the interim.

It is recommended that the new switchgear equipment use vacuum interrupter circuit breakers, as this technology has a proven track record and will provide many years of reliable, safe and low maintenance service.

It is recommended that the new switchgear installations incorporate a main incomer breaker to afford a higher level of protection for bus faults. In absence of a main breaker the fault clearing times will be longer, resulting in an increased arc flash hazard. As the sensitivities to the risk of arc flash hazards continues to increase it is highly likely that arc resistant switchgear will become the industry standard. It is recommended that this be the standard for these switchgear upgrades. The additional cost for arc resistant switchgear is currently in the order of 10%-20% and this premium is reducing as arc resistant switchgear becomes the norm.

It is recommended that in the selection of a manufacturer and design for the new switchgear assemblies, a standard design should be adopted. This will simplify and lower the cost for a comprehensive spare parts supply. This will also simplify training requirements.

The following recommendations should be implemented at all five generating facilities:

1. Arc flash levels need to be determined at the switchgear bus and appropriate procedures implemented consistent with the available incident energy.
2. The risk of fire is a major concern when oil-filled electrical equipment fails. Fire detection and suppression equipment should be in place and functional in facilities operating such equipment. Good housekeeping practices must prevent the accumulation of flammable materials and dust, in an effort to limit the available fuel should a catastrophic switchgear failure occur.
3. Implement a testing program to verify bus, cable and circuit breaker insulation integrity. Ultrasonic testing would identify issues with tracking a corona discharge within the complete assembly.

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4. Increase frequency of preventative maintenance checks to at least once per year to provide some level of assurance as to the reliability of the equipment.
5. Maintenance routines must utilize standard forms to ensure that key procedures and tolerances are followed and data recorded for trending purposes.
6. The existing program of contact resistance measurement, power factor testing, oil testing and de-tanking for visual inspection, should be continued but additional tasks are recommended. The following additional tasks are recommended:
7. Verification of the breaker operating mechanisms for loose hardware and missing or broken pins and retaining rings.
8. Verify the alignment and adjustment of the contacts.
9. Clean and lubricate operating mechanism and apply suitable grease for the wearing surfaces of cams, rollers, bearings etc.
10. Spare parts such as contacts, springs, pins, flexible connectors, etc. must be made available such that worn or damaged components can be replaced during maintenance inspections.
11. The technical specification for the replacement switchgear should address such requirements as the number of operations and difficulty in maintenance, selective protection so that generator breaker trips for faults on the low voltage side of step-up transformer, transient recovery voltage for generator or system fed faults, arcing considerations and minimum fault damage by isolating within three to five cycles. Include a fused load break switch for the feed to the station service transformer, rated for nominal transformer load and momentary short circuit current as required as per the results of a transient recovery voltage (TRV) study.

4. Budget Estimate

Switchgear Hardware	
• Main Breaker Section, Vacuum Breaker, Instrument Transformers & Protective Relays	[redacted]
• Generator Breaker Section, Vacuum Breaker, Instrument Transformers & Protective Relays	[redacted]
• Station Service Section, Transformer and Molded Case Distribution Panel	[redacted]
Medium Voltage Cable Replacement	[redacted]
Engineering Costs	[redacted]
Installation and Commissioning Labour	[redacted]
Total Estimate Switchgear Replacement Cost	[redacted]

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Notes:

1. The budget estimates provided are Class 4, as per AACE.
2. Estimates are based on experience for recent projects.
3. Engineering, installation labour and commissioning cost may be reduced if several projects are undertaken at the same time.
4. Arc Flash Resistant Switchgear will add and additional $25,000 to the switchgear hardware.
5. To the switchgear hardware cost

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5. Kalkstein, E. W., Doughty, R., Paullin, A., Jackson, J., Ryner, J., The Safety Benefits of Arc Resistant Metalclad Medium Voltage Switchgear, IEEE Paper No. PIC-94-36, 1994.

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Appendix A

Condition Assessment Sheets

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Location: White Rock Generating Station (4V) **Unit No:** 1 **Date:** March 17, 2009

Make: Westinghouse **Year Installed:** 1952 **Plant Operation/Shutdown:** Operation

Item	Rating	Reason for Rating/O & M Data/Comments
7.5-kV Metalclad Switchgear, Bus including Switchgear Enclosure & Ground Connections		
Component Labeling	B	Ok
Nameplate	No rating	No Nameplate (Westinghouse,7.5kV, Metalclad)
Cleanliness, External Damage	B	Ok
Conformance to Rated Design	B	Yes. The current rating of the generator is 336A. Symmetrical fault level at 6.9 kV bus, Bus # 955, is 4.4 kA.
Bus Connections, Mounting	Not rated	Not checked
Bus Insulation Condition	D	No records of test results or cleaning. Visual evidence of contamination of bus insulators. No test results available.
Hi Pot, Megger Tests	Not rated	Not checked
Audible (corona discharge)	D	Not reported. Visual evidence of corona discharge on stress cones for 6.9 kV cables going to outdoor substation.
Evidence of Overheated or Damaged Components	D	Old and dirty. Evidence of corona discharge on stress cones.
Moisture Entry, Corrosion	C	Some rust on inside panels
Condition of switchgear enclosure	D	Open bus architecture exposes workers to shock and arc flash hazards. Old, requires replacement.
Ground bus and Connections (general)	C	No visible ground bus
Drawings/Manuals record location (site, office, both)	D	Very little information available.
Circuit Breaker (Generator Breaker 4V-301)		
Component Labeling	C	Ok
Cleanliness, External Damage	B	Moderately dirty, old design
Nameplate	Not Rated	No nameplate (Westinghouse, Type: BK Style S.O.172 246, 600A)
Conformance to Rated Design	B	Yes. The current rating of the generator is 336A.
Auxiliary Switches and Contactors	D	Old, requires replacement.
Insulation Condition	C	Test results available from 2003 indicate acceptable but more frequent testing required.

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: White Rock Generating Station (4V) **Unit No:** 1 **Date:** March 17, 2009

Make: Westinghouse **Year Installed:** 1952 **Plant Operation/Shutdown:** Operation

Item	Rating	Reason for Rating/O & M Data/Comments	
Mechanism restrictions	D	Not checked but age of equipment provides very little confidence in future performance.	
Mechanism to Specification	D	Not checked but equipment is beyond service life and has a high number of operations, reportedly in excess of 200 operations per year.	
General Performance	D	Present Condition poor	Failure History None reported but future performance questionable
Trip Test; pick worst of: A. Low-voltage close test (75% of operating voltage) B. Low-voltage trip test (75% of operating voltage)	Not rated	Test not performed.	
Rack in Mechanism	B	Not checked but no problems recorded.	
Manual Operation	B	Not checked but no problems recorded.	
Time/Travel Test	Not rated	No record of test results.	
Micro-Ohm Test	C	Test Records for Oct'04: Pole 1-2: 104μΩ; Pole 3-4: 100μΩ; Pole 5-6: 93μΩ	
Contact Wear	D	Not measured but maintenance records indicate problems with arcing contact springs flexible leads are breaking	
Number of Breaker Operations, Counter Reading	D	Not known but estimated to be 100-200 operations per year.	
Gasket, Valves, Fittings, Welds	B	No leaks	
Security/Locks	B	Building locked; No door interlocks	
Drawings/Manuals record location (site, office, both)	C	Minimal information available on this equipment	

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **White Rock Generating Station (4V)** **Unit No:** **1** **Date:** **March 17, 2009**

Make: **Westinghouse** **Year Installed:** **1952** **Plant Operation/Shutdown:** **Operation**

Current and Voltage Transformers (Visual)			
(A) Current Transformers			
Component Labeling	B	Ok	
Cleanliness, External Damage	C	Original equipment at the end of service life	
Nameplate	C	Information not available	
Conformance to Rated Design	Not rated	Not assessed	
Insulation Condition	C	Old at end of life. No test results available.	
General Performance	C	Present Condition Fair	Failure History Not available
Ratio & Polarity Test	Not rated	Test not performed.	
Excitation Test (knee point voltage)	Not rated	Test not performed.	
Resistance Test	Not rated	Test not performed.	
Condition of Terminal Cable and Connections	B	Visually fair condition. No signs of damaged or overheated connections	
(B) Voltage Transformers			
Component Labeling	B	Ok	
Cleanliness, External Damage	D	Old, dirty	
Nameplate	Not rated	Information not available	
Conformance to Rated Design	Not rated	Not assessed	
Insulation Condition	D	Very dirty	
General Performance	D	Present Condition Bad	Failure History Not available
Ratio Test	Not rated	Test not performed.	
Resistance Test	Not rated	Test not performed.	
Condition of Terminal Cable and Connections, Ground Connections	D	Old wiring and connections that needs to be replaced	

Rating	***Condition Description***	***Details***
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **White Rock Generating Station (4V)** **Unit No:** **1** **Date:** **March 17, 2009**

Make: **Westinghouse** **Year Installed:** **1952** **Plant Operation/Shutdown:** **Operation**

Technical Evaluations, Comments & Recommendations	
Switchgear, bus, circuit breaker	The assessment of the switchgear has indicated no structural and insulation failure of the switchgear cubicles. The switchgear is an open architecture design; as such the bus is not enclosed posing an unacceptable risk to personnel for shock and arc flash hazards. This risk is exacerbated by the fact manual interventions are frequently required to deal with nuisance problems associated with equipment of this vintage.
Cables	The stress cones are showing evidence of corona discharge and will need to be replaced if there is further deterioration. The switchgear itself is old with scarce or expensive replacement parts.
Current and voltage transformers	The current and voltage transformers were not tested but are very old and obsolete. Connection leads to the PT's are cracked and brittle and should be replaced. Evidence of previous failures in PT compartment.

Prepared by (print): **L. Hann** **(Sign):** ________________ **(Date):** ____________

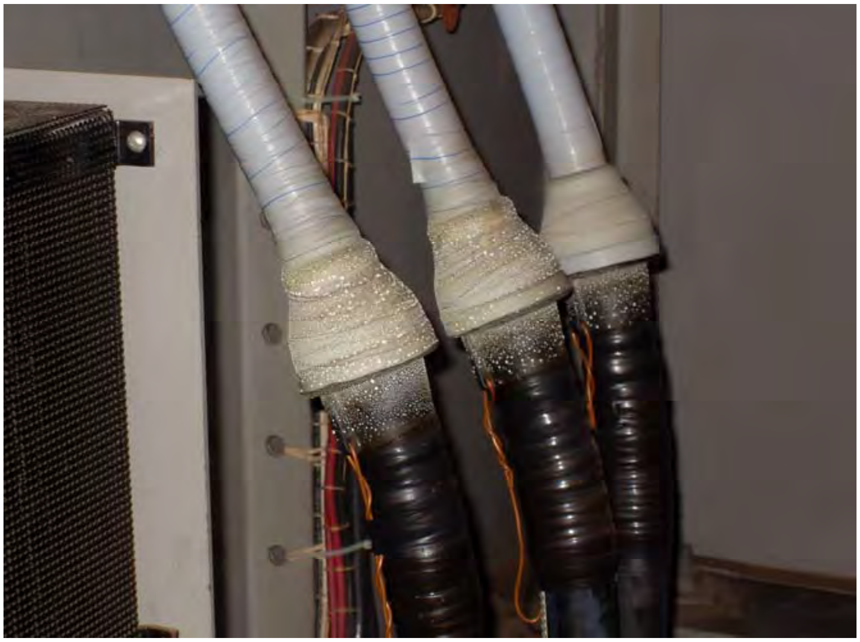
Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **White Rock Generating Station (4V)** **Unit No:** **1** **Date:** **March 17, 2009**

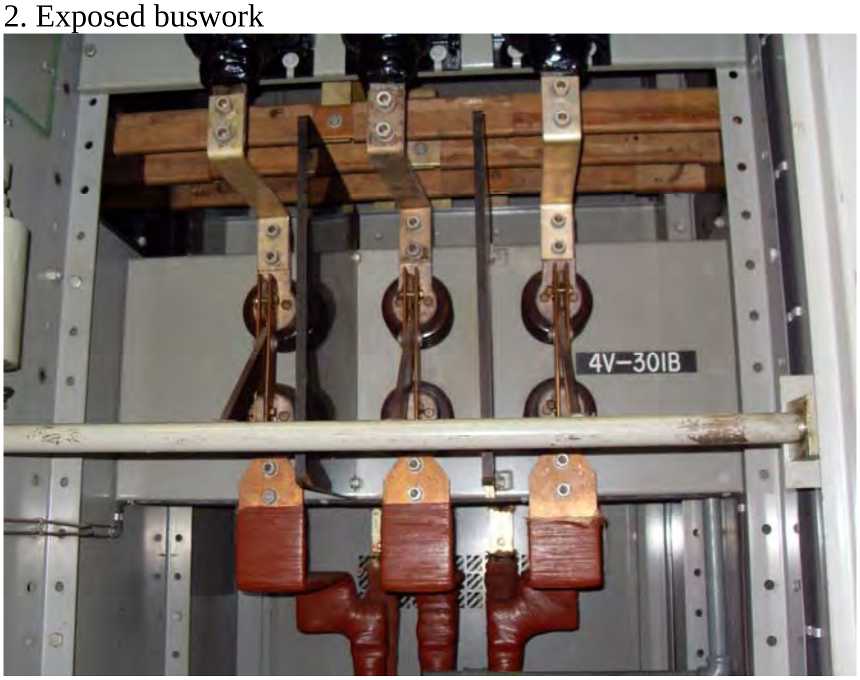
Make: **Westinghouse** **Year Installed:** **1952** **Plant Operation/Shutdown:** **Operation**

Additional information (Test Results, Photos, Notes, Sketches, etc)

1. 6.9 kV cables to outdoor substation



2. Exposed buswork

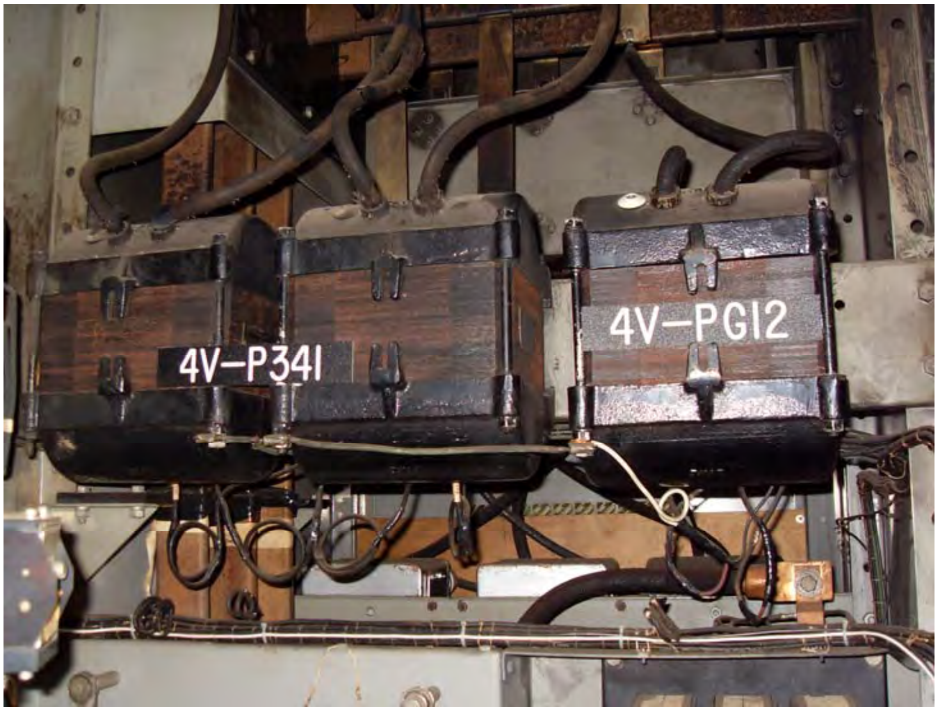


Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **White Rock Generating Station (4V)** **Unit No:** **1** **Date:** **March 17, 2009**

Make: **Westinghouse** **Year Installed:** **1952** **Plant Operation/Shutdown:** **Operation**

3. Bus PT's



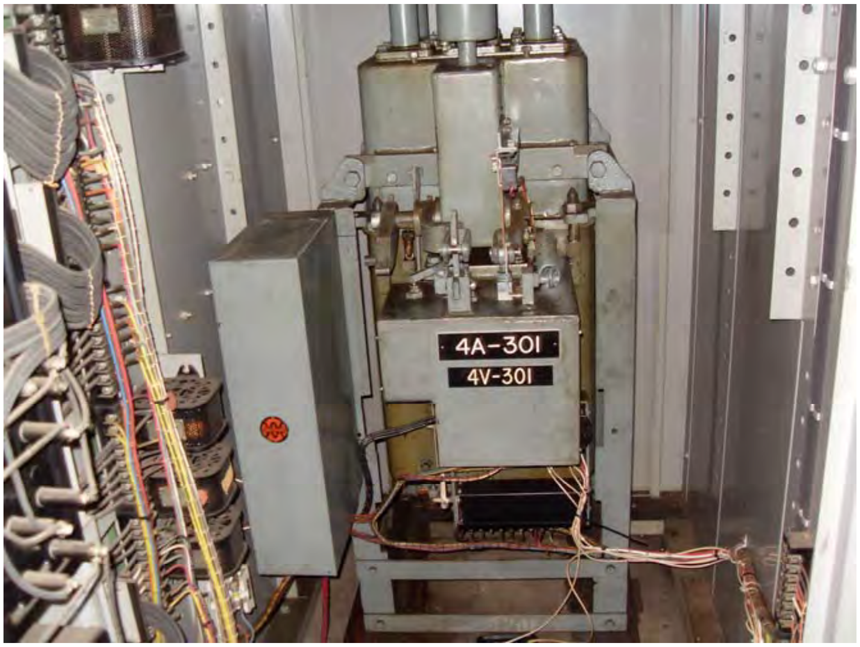
Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Condition Assessment Form – 7.5kV Switchgear

Location: **White Rock Generating Station (4V)** **Unit No:** **1** **Date:** **March 17, 2009**

Make: **Westinghouse** **Year Installed:** **1952** **Plant Operation/Shutdown:** **Operation**

4. Generator Breaker



Rating	***Condition Description***	***Details***
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: Nictaux Generating Station (10V) **Unit No:** 1 **Date:** March 17, 2009

Make: Westinghouse **Year Installed:** 1954 **Plant Operation/Shutdown:** Operation

Item	Rating	Reason for Rating/O & M Data/Comments
7.5-kV Metalclad Switchgear, Bus including Switchgear Enclosure & Ground Connections		
Component Labeling	B	Ok
Nameplate	No rating	No Nameplate
Cleanliness, External Damage	C	Dirty
Conformance to Rated Design	C	Yes. The current rating of the generator is 710A. Symmetrical fault level at 6.9 kV bus, Bus # 537, is 9.4 kA.
Bus Connections, Mounting	D	Visible sections of bus a badly tarnished and evidence of a bus repairs immediately above the breaker. No records of tests or cleaning.
Bus Insulation Condition	C	No records of test results or cleaning.
Hi Pot, Megger Tests	Not rated	Not checked
Evidence of Overheated or Damaged Components	D	Old and dirty.
Audible (corona discharge)	D	Corona discharge evident where bus passes through support insulators. Ultrasonic testing recommended.
Moisture Entry, Corrosion	C	Minor corrosion inside panels
Condition of switchgear enclosure	D	Open bus architecture exposes workers to shock and arc flash hazards. Old, requires replacement.
Ground bus and Connections (general)	C	No visible ground bus
Drawings/Manuals record location (site, office, both)	D	Very little information available.
Circuit Breaker (Generator Breaker 10V-301)		
Component Labeling	C	Ok
Cleanliness, External Damage	B	Moderately dirty, old design
Nameplate	B	15kV, Type: BKHB Style S.O.33-S -703K, 1200A
Conformance to Rated Design	B	Yes. The current rating of the generator is 710A.
Auxiliary Switches and Contactors	D	Old, requires replacement. Problems reported with auxiliary contacts. Problem reported with 52X contacts.
Insulation Condition	D	Megger test in 2007 lowest phase = 1GΩ

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: Nictaux Generating Station (10V) **Unit No:** 1 **Date:** March 17, 2009

Make: Westinghouse **Year Installed:** 1954 **Plant Operation/Shutdown:** Operation

Item	Rating	Reason for Rating/O & M Data/Comments	
Mechanism restrictions	D	Not checked but age of equipment provides very little confidence in future performance.	
Mechanism to Specification	D	Reportedly in excess of 200 operations per year. Problems reported with breaker hesitation on closing.	
General Performance	D	Present Condition poor	Failure History Evidence of failure in breaker cabinet
Trip Test; pick worst of: A. Low-voltage close test (75% of operating voltage) B. Low-voltage trip test (75% of operating voltage)	Not rated	Test not performed.	
Rack in Mechanism	B	Not checked but no problems recorded.	
Manual Operation	B	Not checked but problems have been recorded.	
Time/Travel Test	Not rated	No record of test results.	
Micro-Ohm Test	C	Test Records for April'07: Pole 1-2: 72µΩ; Pole 3-4: 65µΩ; Pole 5-6: 61µΩ	
Contact Wear	D	Not measured but reported number of problems is a concern.	
Number of Breaker Operations, Counter Reading	D	Not known but estimated to be 100-200 operations per year.	
Gasket, Valves, Fittings, Welds	B	No leaks	
Security/Locks	B	Building locked; No door interlocks	
Drawings/Manuals record location (site, office, both)	C	Minimal information available on this equipment	

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Nictaux Generating Station (10V)** **Unit No:** **1** **Date:** **March 17, 2009**

Make: **Westinghouse** **Year Installed:** **1954** **Plant Operation/Shutdown:** **Operation**

Current and Voltage Transformers (Not assessed)			
(A) Current Transformers			
Component Labeling			
Cleanliness, External Damage			
Nameplate			
Conformance to Rated Design			
Insulation Condition		Old at end of life. No test results available.	
General Performance		Present Condition	Failure History
Ratio & Polarity Test			
Excitation Test (knee point voltage)			
Resistance Test			
Condition of Terminal Cable and Connections			
(B) Voltage Transformers			
Component Labeling			
Cleanliness, External Damage			
Nameplate			
Conformance to Rated Design			
Insulation Condition			
General Performance		Present Condition	Failure History
Ratio Test			
Resistance Test			
Condition of Terminal Cable and Connections, Ground Connections			

Technical Evaluations, Comments & Recommendations

Rating	***Condition Description***	***Details***
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Nictaux Generating Station (10V)** **Unit No:** **1** **Date:** **March 17, 2009**

Make: **Westinghouse** **Year Installed:** **1954** **Plant Operation/Shutdown:** **Operation**

Switchgear, bus, circuit breaker	Burn marks on the inside of the enclosure indicate a significant failure event in the generator breaker cubicle. The switchgear is an open architecture design; as such the bus is not enclosed posing an unacceptable risk to personnel for shock and arc flash hazards. Manual interventions are frequently required to deal with nuisance problems associated with equipment of this vintage, thus adding to the risk to personnel. Switchgear is very dirty with evidence of corona discharge on bus support insulators. The switchgear itself is old with scarce or expensive replacement parts.
Cables	Not inspected.
Current and voltage transformers	The current and voltage transformers were not assessed but are very old and obsolete.

Prepared by (print): **L. Hann** **(Sign):** _________________ **(Date):** _____________

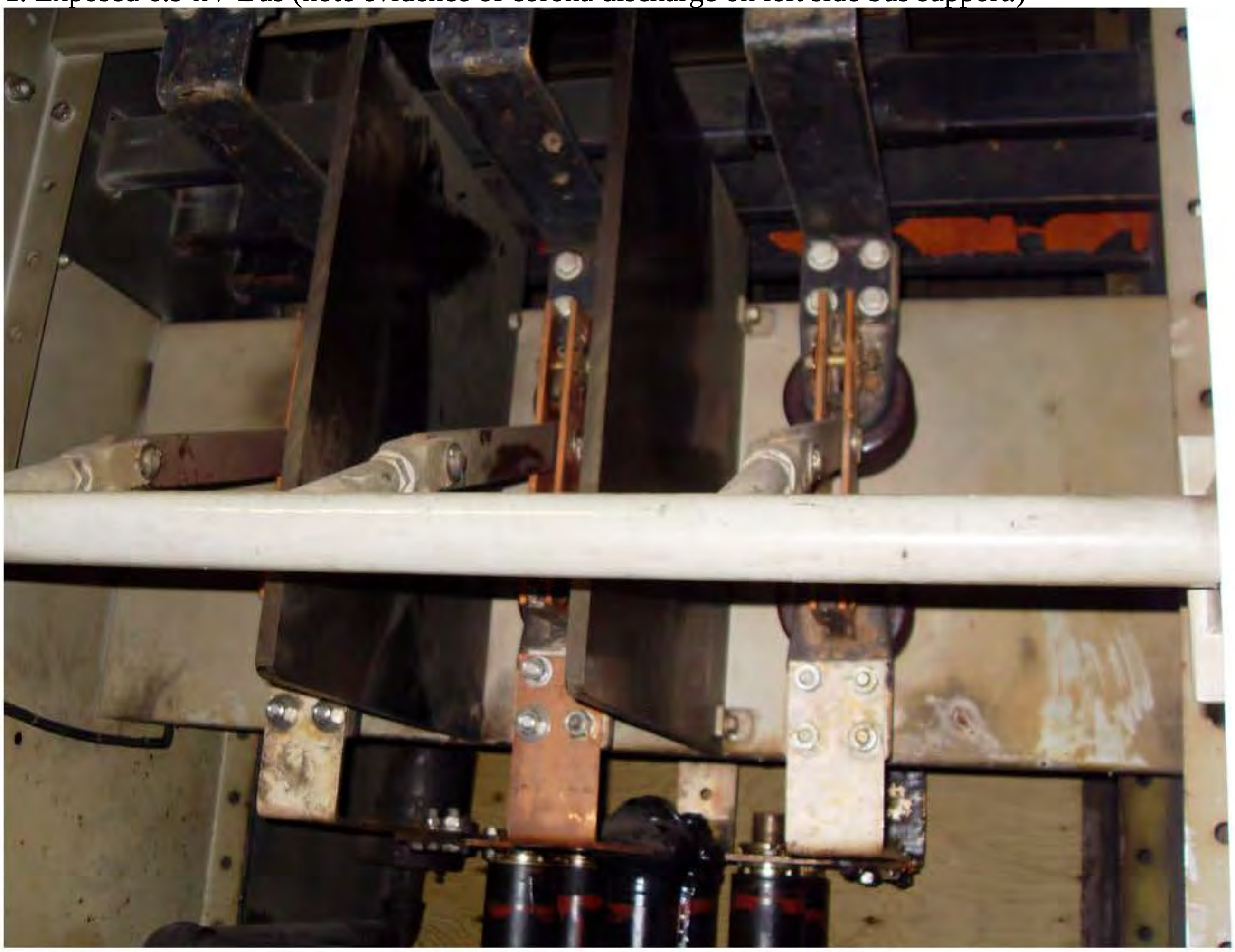
Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Nictaux Generating Station (10V)** **Unit No:** **1** **Date:** **March 17, 2009**

Make: **Westinghouse** **Year Installed:** **1954** **Plant Operation/Shutdown:** **Operation**

Additional information (Test Results, Photos, Notes, Sketches, etc)

1. Exposed 6.9 kV Bus (note evidence of corona discharge on left side bus support.)

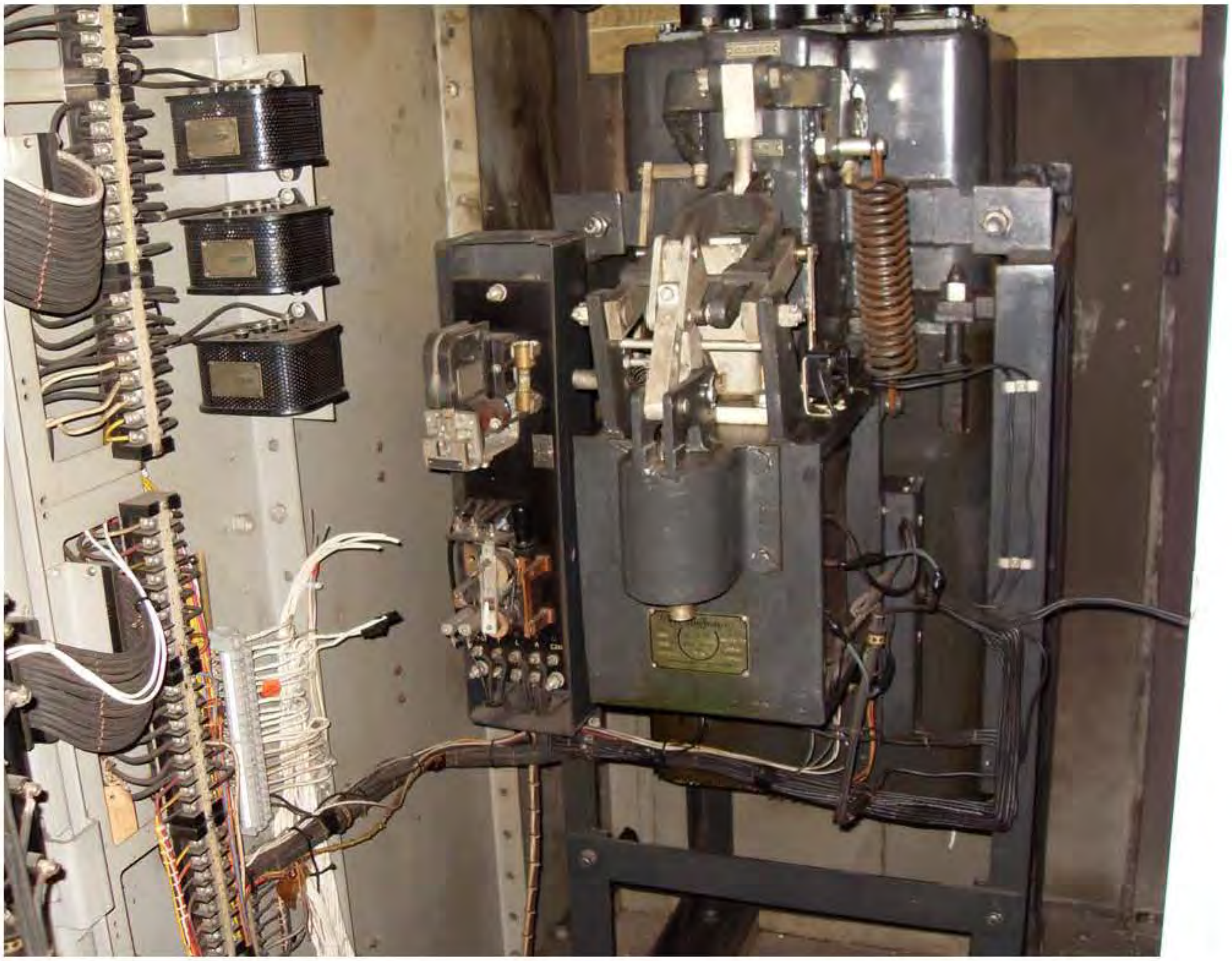


Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Nictaux Generating Station (10V)** **Unit No: 1** **Date:** **March 17, 2009**

Make: Westinghouse **Year Installed: 1954** **Plant Operation/Shutdown: Operation**

2. Generator Breaker



Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Condition Assessment Form – 7.5kV Switchgear

Location: **Nictaux Generating Station (10V)** **Unit No:** **1** **Date:** **March 17, 2009**

Make: **Westinghouse** **Year Installed:** **1954** **Plant Operation/Shutdown:** **Operation**

3. Station Service Distribution Section

Rating	***Condition Description***	***Details***
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: Gulch Generating Station (16V) **Unit No: 1** **Date: March 18, 2009**

Make: Westinghouse **Year Installed: 1950** **Plant Operation/Shutdown: Operating**

Item	Rating	Reason for Rating/O & M Data/Comments
15-kV Metalclad Switchgear, Bus including Switchgear Enclosure & Ground Connections		
Component Labeling	B	Ok
Nameplate	No rating	No Nameplate
Cleanliness, External Damage	C	Dirty
Conformance to Rated Design	B	Yes. The current rating of the generator is 377A. The symmetrical fault level on the 13.8 kV bus, Bus # 576, is 4.2 kA.
Bus Connections, Mounting	Not rated	Not checked
Bus Insulation Condition	C	No records of test results or cleaning
Hi Pot, Megger Tests	Not rated	Not checked
Evidence of Overheated or Damaged Components	C	Old and dirty
Moisture Entry, Corrosion	B	None observed
Condition of switchgear enclosure	C	Old, requires replacement
Ground bus and Connections (general)	Not Rated	Not visible
Drawings/Manuals record location (site, office, both)	C	Limited drawings and maintenance records
Circuit Breaker (13V-301) Generator #1		
Component Labeling	C	Ok
Cleanliness, External Damage	B	Moderately dirty, old design
Nameplate	Not rated	Westinghouse, De-Ion Grid, Type BKB S.0.24F-653, 15kV, 600A
Conformance to Rated Design	B	Yes. The current rating of the generator is 377A.
Audible (corona discharge)	B	Not reported.
Auxiliary Switches and Contactors	C	Old, requires replacement; 2008 maintenance records indicate a cracked contact block and no spare available to replace it.

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Gulch Generating Station (16V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **Westinghouse** **Year Installed:** **1950** **Plant Operation/Shutdown:** **Operating**

Item	Rating	Reason for Rating/O & M Data/Comments	
Insulation Condition	C	Maintenance record of 2008 indicate lowest bushing to ground = 8.4GΩ.	
Mechanism Restrictions	C	Not checked but no problems recorded.	
Mechanism to Specification	C	Not checked but no problems recorded.	
General Performance	C	Present Condition Fair	Failure History None reported
Trip Test; pick worst of: A. Low-voltage close test (75% of operating voltage) B. Low-voltage trip test (75% of operating voltage)	Not rated	Test not performed.	
Rack in Mechanism	B	Not checked but no problems recorded.	
Manual Operation	B	Not checked but no problems recorded.	
Time/Travel Test	C	No record of test results.	
Micro-Ohm Test	C	Test Records for Oct'08: Pole 1-2: 111μΩ; Pole 3-4: 102μΩ; Pole 5-6: 114μΩ	
Contact Wear	B	Not measured; Maintenance record of 2008 indicates okay.	
Number of Breaker Operations, Counter Reading	C	Not known	
Gasket, Valves, Fittings, Welds	C	Minor leaking	
Security/Locks	C	None	
Drawings/Manuals record location (site, office, both)	C	None	

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Gulch Generating Station (16V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **Westinghouse** **Year Installed:** **1950** **Plant Operation/Shutdown:** **Operating**

Current and Voltage Transformers (Not assessed)			
(A) Current Transformers			
Component Labeling			
Cleanliness, External Damage			
Nameplate			
Conformance to Rated Design			
Insulation Condition			
General Performance		Present Condition	Failure History
Ratio & Polarity Test			
Excitation Test (knee point voltage)			
Resistance Test			
Condition of Terminal Cable and Connections			
(B) Voltage Transformers			
Component Labeling			
Cleanliness, External Damage			
Nameplate			
Conformance to Rated Design			
Insulation Condition			
General Performance		Present Condition	Failure History
Ratio Test			
Resistance Test			
Condition of Terminal Cable and Connections, Ground Connections			

Rating	***Condition Description***	***Details***
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **<u>Gulch Generating Station (16V)</u>** **Unit No:** **<u>1</u>** **Date:** **<u>March 18, 2009</u>**

Make: **<u>Westinghouse</u>** **Year Installed:** **<u>1950</u>** **Plant Operation/Shutdown:** **<u>Operating</u>**

Technical Evaluations, Comments & Recommendations	
Switchgear, bus, circuit breaker	The assessment of the switchgear has indicated no structural and insulation failure of the switchgear cubicles.
Cables	The medium voltage cables exiting the switchgear look to be original and of concern. Further inspection and testing is required.
Current and voltage transformers	The Instrument transformers and bus hardware were not exposed for inspection but the vintage of the equipment requires that this be carried out and ultrasonic testing be performed to detect any tracking, arcing or corona discharge.

Prepared by (print): **<u>L. Hann</u>** **(Sign):** ________________ **(Date):** ____________

Rating	***Condition Description***	***Details***
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Gulch Generating Station (16V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **Westinghouse** **Year Installed:** **1950** **Plant Operation/Shutdown:** **Operating**

Additional information (Test Results, Photos, Notes, Sketches, etc)

1. Generator No.1 600A Breaker

2. 13.8 kV Cables

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Condition Assessment Form – 15kV Switchgear

Location: **Gulch Generating Station (16V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **Westinghouse** **Year Installed:** **1950** **Plant Operation/Shutdown:** **Operating**

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: Weymouth Generating Station (16V) **Unit No:** 1 **Date:** March 18, 2009

Make: Canadian General Electric **Year Installed:** 1959 **Plant Operation/Shutdown:** Shutdown

Item	Rating	Reason for Rating/O & M Data/Comments
15-kV Metalclad Switchgear, Bus including Switchgear Enclosure & Ground Connections		
Component Labeling	B	Ok
Nameplate	No rating	15-kV, Metalclad, Type: M-106, 600A
Cleanliness, External Damage	B	Ok
Conformance to Rated Design	B	Yes. The current rating of the generator is 471A. The symmetrical fault level on the 13.2 kV bus, Bus # 961, is 7.5 kA.
Bus Connections, Mounting	Not rated	Not checked
Bus Insulation Condition	C	No records of test results or cleaning
Hi Pot, Megger Tests	Not rated	Not checked
Evidence of Overheated or Damaged Components	C	Old and dirty
Moisture Entry, Corrosion	C	Minor evident of rust on inside panels
Condition of switchgear enclosure	C	Old, requires replacement
Ground bus and Connections (general)	C	No visible ground bus
Drawings/Manuals record location (site, office, both)	B	Some drawings and maintenance records
Circuit Breaker (16V-301) Generator #1		
Component Labeling	C	Ok
Cleanliness, External Damage	B	Moderately dirty, old design
Nameplate	Not rated	Oil blast oil circuit breaker, Type FKR-255-250, 250MVA, 15kV, 600A, 60Hz, 9.7 kA sym.
Conformance to Rated Design	B	Yes. The current rating of the generator is 471A.
Audible (corona discharge)	C	Not reported.
Auxiliary Switches and Contactors	C	Old, requires replacement

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: Weymouth Generating Station (16V) **Unit No:** 1 **Date:** March 18, 2009

Make: Canadian General Electric **Year Installed:** 1959 **Plant Operation/Shutdown:** Shutdown

Item	Rating	Reason for Rating/O & M Data/Comments	
Insulation Condition	B	Maintenance records indicate 125GΩ in 2006 breaker bushing to tank.	
Mechanism Restrictions	C	Not checked but no problems recorded.	
Mechanism to Specification	C	Not checked but no problems recorded.	
General Performance	C	Present Condition Fair	Failure History None reported
Trip Test; pick worst of: A. Low-voltage close test (75% of operating voltage) B. Low-voltage trip test (75% of operating voltage)	Not rated	Test not performed.	
Rack in Mechanism	B	Not checked but no problems recorded.	
Manual Operation	B	Not checked but no problems recorded.	
Time/Travel Test	C	No record of test results.	
Micro-Ohm Test	C	Test Records for Oct'04: Pole 1-2: 104μΩ; Pole 3-4: 100μΩ; Pole 5-6: 93μΩ	
Contact Wear	D	Not measured but maintenance records indicate problems with arcing contact springs flexible leads are breaking. PM report of February 2006 by W. Sullivan & K. Sponagle indicates significant problems with flexible leads and pieces falling into the breaker tank.	
Number of Breaker Operations, Counter Reading	C	Not known	
Gasket, Valves, Fittings, Welds	C	Minor leaking	
Security/Locks	C	None	
Drawings/Manuals record location (site, office, both)	C	None	

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: Weymouth Generating Station (16V) **Unit No:** 1 **Date:** March 18, 2009

Make: Canadian General Electric **Year Installed:** 1959 **Plant Operation/Shutdown:** Shutdown

Circuit Breaker (16V-312) Tie-Breaker			
Component Labeling	B	Ok	
Cleanliness, External Damage	B	Moderately dirty, old design	
Nameplate	Not rated	Oil blast oil circuit breaker, Type FKR-255-250, 250MVA, 15kV, 1200A, 60Hz, 9.7 kA sym.	
Conformance to Rated Design	B	Yes. The current rating of the both generators is 471A.	
Audible (corona discharge)	C	Not reported	
Auxiliary Switches and Contactors	C	Old, requires replacement	
Insulation Condition	B	Maintenance records indicate 125GΩ in 2006 breaker bushing to tank.	
Mechanism Restrictions	C	Not checked but no problems recorded.	
Mechanism to Specification	C	Not checked but no problems recorded.	
General Performance	C	Present Condition Fair	Failure History None reported
Trip Test; pick worst of: C. Low-voltage close test (75% of operating voltage) D. Low-voltage trip test (75% of operating voltage)	Not rated	Test not performed.	
Rack in Mechanism	B	Not checked but no problems recorded.	
Manual Operation	B	Not checked but no problems recorded.	
Time/Travel Test	Not Rated	No record of test results.	
Micro-Ohm Test	Not Rated	Old Test Records with date unknown: Pole 1-2: 42μΩ; Pole 3-4: 42μΩ; Pole 5-6: 37μΩ	
Contact Wear	D	Not measured but little information available in maintenance records to indicate this is being monitored.	

Rating	***Condition Description***	***Details***
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: Weymouth Generating Station (16V) **Unit No: 1** **Date: March 18, 2009**

Make: Canadian General Electric **Year Installed: 1959** **Plant Operation/Shutdown: Shutdown**

Number of Breaker Operations, Counter Reading	D	Age of breaker and the service would dictate that the number of operations is excessive. Similar issues as with 16V-301 are likely.
Gasket, Valves, Fittings, Welds	C	Minor leaking
Security/Locks	C	None
Drawings/Manuals record location (site, office, both)	C	None

Circuit Breaker (16V-302) Generator #2			
Component Labeling	B	Ok	
Cleanliness, External Damage	B	Moderately dirty, obsolete design	
Nameplate	Not rated	Magna blast air circuit breaker, Type AM-13.8-500, 15kV, 1200A, (Overhaul by Siemens in 2000)	
Conformance to Rated Design	B	Yes. The current rating of the both generators is 471A.	
Audible (corona discharge)	B	None reported	
Auxiliary Switches and Contactors	B	No issues reported	
Insulation Condition	B	No maintenance records available since overhaul in 2000	
Mechanism Restrictions	Not rated	Not checked	
Mechanism to Specification	B	Not checked but no problems recorded.	
General Performance	B	No issues reported	Failure History None reported
Trip Test; pick worst of: E. Low-voltage close test (75% of operating voltage) F. Low-voltage trip test (75% of operating voltage)	Not rated	Test not performed.	
Rack in Mechanism	B	Not checked but no problems recorded.	
Manual Operation	B	Not checked but no problems recorded.	

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Weymouth Generating Station (16V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **Canadian General Electric** **Year Installed:** **1959** **Plant Operation/Shutdown:** **Shutdown**

Time/Travel Test	Not Rated	No record of test results.
Micro-Ohm Test	C	No maintenance records available since overhaul in 2000
Contact Wear	C	Not measured but little information available in maintenance records to indicate this is being monitored.
Number of Breaker Operations, Counter Reading	B	Service would dictate that the operating duty is similar to 16V-301 but overhaul in 2000 has extended life.
Gasket, Valves, Fittings, Welds	Not Rated	N/A
Security/Locks	B	Building locked
Drawings/Manuals record location (site, office, both)	C	None available on site

Current and Voltage Transformers (Not assessed)			
(A) Current Transformers			
Component Labeling			
Cleanliness, External Damage			
Nameplate			
Conformance to Rated Design			
Insulation Condition			
General Performance		Present Condition	Failure History
Ratio & Polarity Test			
Excitation Test (knee point voltage)			
Resistance Test			
Condition of Terminal Cable and Connections			
(B) Voltage Transformers			
Component Labeling			
Cleanliness, External Damage			
Nameplate			

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: Weymouth Generating Station (16V) **Unit No: 1** **Date: March 18, 2009**

Make: Canadian General Electric **Year Installed: 1959** **Plant Operation/Shutdown: Shutdown**

Conformance to Rated Design			
Insulation Condition			
General Performance		Present Condition	Failure History
Ratio Test			
Resistance Test			
Condition of Terminal Cable and Connections, Ground Connections			

Technical Evaluations, Comments & Recommendations	
Switchgear, bus, circuit breaker	The assessment of the switchgear has indicated no structural and insulation failure of the switchgear cubicles. The switchgear itself is old with scarce or expensive replacement parts. Generator #1 breaker (16V-301) and tie-breaker (16V-312) are 1950's vintage oil filled circuit breakers and are beyond their expected service life. Generator #2 breaker (16V-302) is in a separate switchgear line-up and was overhauled by Siemens in 2000. While the reliability of the breaker should be greatly improved due to this work, the reliability of the other switchgear components would not have been impacted. This equipment is still beyond its service life and should be closely monitored and maintained until it is replaced.
Cables	Cables were not inspected.
Current and voltage transformers	The Instrument transformers and bus hardware were not exposed for inspection but the vintage of the equipment requires that this be carried out and ultrasonic testing be performed to detect any tracking, arcing or corona discharge. The bus PT's have been removed service and it appears that a PT has been salvaged for use as replacement part for another service.

Prepared by (print): L. Hann **(Sign):** ________________ **(Date):** ____________

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Weymouth Generating Station (16V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **Canadian General Electric** **Year Installed:** **1959** **Plant Operation/Shutdown:** **Shutdown**

Rating	***Condition Description***	***Details***
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Weymouth Generating Station (16V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **Canadian General Electric** **Year Installed:** **1959** **Plant Operation/Shutdown:** **Shutdown**

Additional information (Test Results, Photos, Notes, Sketches, etc)

1. Generator No.1 600A Breaker

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Weymouth Generating Station (16V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **Canadian General Electric** **Year Installed:** **1959** **Plant Operation/Shutdown:** **Shutdown**

2. Bus PT's

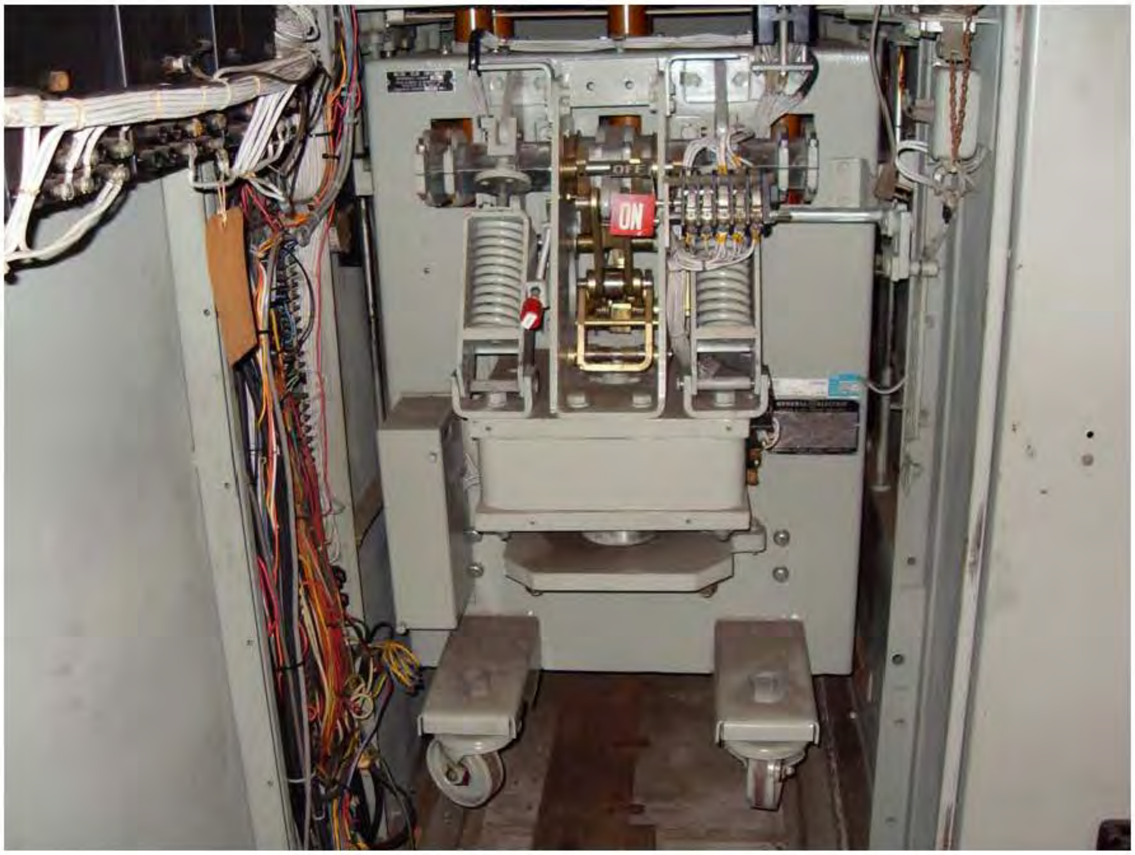
Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Condition Assessment Form - 15kV Switchgear

Location: **Weymouth Generating Station (16V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **Canadian General Electric** **Year Installed:** **1959** **Plant Operation/Shutdown:** **Shutdown**

3. Generator No. 2 breaker



Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: Sissiboo Falls Generating Station (15V) **Unit No:** 1 **Date:** March 18, 2009

Make: General Electric **Year Installed:** 1961 **Plant Operation/Shutdown:** Operation

Item	Rating	Reason for Rating/O & M Data/Comments
7.5-kV Metalclad Switchgear, Bus including Switchgear Enclosure & Ground Connections		
Component Labeling	B	Ok
Nameplate	No rating	7.5kV, Metalclad, General Electric
Cleanliness, External Damage	B	Ok
Conformance to Rated Design	B	Yes. The current rating of the generator is 628A. Symmetrical fault level at 6.6 kV bus, Bus # 596, is 8.1 kA.
Bus Connections, Mounting	Not rated	Not checked
Bus Insulation Condition	C	No records of test results or cleaning. No test results available. Equipment of this vintage needs to be tested annually.
Hi Pot, Megger Tests	Not rated	Not checked
Audible (corona discharge)	B	Not reported.
Evidence of Overheated or Damaged Components	B	None observed.
Moisture Entry, Corrosion	C	None observed
Condition of switchgear enclosure	C	Old, at or near end of service life.
Ground bus and Connections (general)	C	No issues observed
Drawings/Manuals record location (site, office, both)	D	Very little information available.
Circuit Breaker (Generator Breaker 15V-301)		
Component Labeling	C	Ok
Cleanliness, External Damage	B	Moderately dirty, old design
Nameplate	B	Oil blast oil circuit breaker, Type FKR-255-250, 250MVA, 7.5kV, 1200A, 60Hz, 19.5 kA sym.
Conformance to Rated Design	B	Yes. The current rating of the generator is 628A.
Auxiliary Switches and Contactors	C	Requires regular maintenance and testing. Maintenance records indicate burnt and pitted contacts replaced in 2000.
Insulation Condition	B	Test results available from 2000 indicate acceptable but more frequent testing required.

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: Sissiboo Falls Generating Station (15V) **Unit No:** 1 **Date:** March 18, 2009

Make: General Electric **Year Installed:** 1961 **Plant Operation/Shutdown:** Operation

Item	Rating	Reason for Rating/O & M Data/Comments	
Mechanism restrictions	D	Not checked but age of equipment provides very little confidence in future performance.	
Mechanism to Specification	D	Not checked but equipment is beyond service life and has a high number of operations, reportedly in excess of 200 operations per year.	
General Performance	D	Present Condition poor	Failure History None reported but future performance questionable
Trip Test; pick worst of: A. Low-voltage close test (75% of operating voltage) B. Low-voltage trip test (75% of operating voltage)	Not rated	Test not performed.	
Rack in Mechanism	B	Not checked but no problems recorded.	
Manual Operation	B	Not checked but no problems recorded.	
Time/Travel Test	Not rated	No record of test results.	
Micro-Ohm Test	C	Test Records for Oct'2000: Pole 1-2: 37μΩ; Pole 3-4: 36μΩ; Pole 5-6: 37μΩ More frequent testing required.	
Contact Wear	Not Rated	Not measured.	
Number of Breaker Operations, Counter Reading	C	Not known but estimated to be 100-200 operations per year.	
Gasket, Valves, Fittings, Welds	C	No leaks observed	
Security/Locks	B	Building locked; No door interlocks	
Drawings/Manuals record location (site, office, both)	C	Minimal information available on this equipment	

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Sissiboo Falls Generating Station (15V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **General Electric** **Year Installed:** **1961** **Plant Operation/Shutdown:** **Operation**

Current and Voltage Transformers (Not assessed)			
(A) Current Transformers			
Component Labeling			
Cleanliness, External Damage			
Nameplate			
Conformance to Rated Design			
Insulation Condition			
General Performance		Present Condition	Failure History
Ratio & Polarity Test			
Excitation Test (knee point voltage)			
Resistance Test			
Condition of Terminal Cable and Connections			
(B) Voltage Transformers			
Component Labeling			
Cleanliness, External Damage			
Nameplate			
Conformance to Rated Design			
Insulation Condition			
General Performance		Present Condition	Failure History
Ratio Test			
Resistance Test			
Condition of Terminal Cable and Connections, Ground Connections			

Rating	***Condition Description***	***Details***
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Sissiboo Falls Generating Station (15V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **General Electric** **Year Installed:** **1961** **Plant Operation/Shutdown:** **Operation**

Technical Evaluations, Comments & Recommendations	
Switchgear, bus, circuit breaker	The assessment of the switchgear has indicated no structural and insulation failure of the switchgear cubicles.
Cables	Were not Inspected
Current and voltage transformers	The Instrument transformers and bus hardware were not exposed for inspection but the vintage of the equipment requires that this be carried out and ultrasonic testing be performed to detect any tracking, arcing or corona discharge.

Prepared by (print): **L. Hann** **(Sign):** __________________ **(Date):** ______________

Rating	***Condition Description***	***Details***
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Sissiboo Falls Generating Station (15V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **General Electric** **Year Installed:** **1961** **Plant Operation/Shutdown:** **Operation**

Additional information (Test Results, Photos, Notes, Sketches, etc)

1. Generator Breaker (15V-301)

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Location: **Sissiboo Falls Generating Station (15V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **General Electric** **Year Installed:** **1961** **Plant Operation/Shutdown:** **Operation**

Rating	*Condition Description*	*Details*
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Condition Assessment Form – 7.5kV Switchgear

Location: **Sissiboo Falls Generating Station (15V)** **Unit No:** **1** **Date:** **March 18, 2009**

Make: **General Electric** **Year Installed:** **1961** **Plant Operation/Shutdown:** **Operation**

2. TL Breaker (15V-311)

Rating	Condition Description	Details
A	Good	Only minor deterioration or defects are evident.
B	Fair	Moderate deterioration. Function is adequate.
C	Poor	Serious deterioration of at least some parts. Function is inadequate.
D	Unacceptable	Extensive deterioration. Barely functional. May be unsafe to operate.

Appendix B

Maintenance Records

© Hatch 2006/03 ⌘

WESTINGHOUSE BREAKER TYPE ~~BJO-B~~ GK and ~~BNO-B~~
34.5 kV MAINTENANCE
Five Year Maintenance TMP 45C.8

1 of 1
R-0

Breaker System No. 4V-301

Serial No. 751821

Yearly Maintenance Plus:

1.- Counter Reading: Start N/A
Finish

2.- Cam Operated Limit Switch Checked OK

3.- Tank Loss Index - Calculate on Doble Sheets 6.5mw, 8mw, 25mw

4. - Contact Resistance
Measurement Poles 1 - 2 103 microohms
Poles 3 - 4 107 microohms
Poles 5 - 6 107 microohms

5. - Oil Power Factor (Doble)
Corrected to 20 ^{0}C .007

6. - Analyzer Results

a. Close Time (Max 35 cycles) N/A cycles
b. Trip Time (Max 6 cycles) cycles
c. Trip Free Time ( ) cycles

REMARKS: Several flexible leads for electrical connection on arcing contacts are broken on each contact. Springs for arc contact are loosing tension. Some pitting on arc contacts. Main contacts are OK.
Oil was replaced.

Station No. 4V

Date Aug 21/03

Inspected By DF/KS

DOBLE INSULATION TESTS

CIRCUIT BREAKER

DOBLE ENGINEERING COMPANY
WATERTOWN, MASS.
FORM MH—CB178

COMPANY	NSP	DATE	Aug 21/03		
LOCATION OF TESTS	White Rock 4V	AIR TEMP.	20	OIL TEMP.	
CIRCUIT BREAKER	4V-301	WEATHER	Inside.	% HUM.	
BREAKER MFR.	West	TYPE	BK Style 5.0.172 246	AGE	
BREAKER SERIAL NO.	751821	KV	7.5	AMPS.	600
DATE LAST INSP.		DATE LAST TEST		LAST TEST SHEET NO.	
BUSHING MFR.		BUSHING (TYPE-FORM-DWG. NO.)			

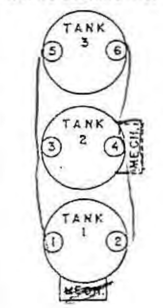
Inst. Book H-7040A

	BUSH. NO.	BUSHING SERIAL NO.	SIDE	PHASE	FEET OF BUS	INS. IN PAR'L'L	TEST KV	EQUIVALENT 10 KV READINGS — MICROAMPERES — METER READING	MULTI-PLIER	MICRO-AMPERES	WATTS (mW) — METER READING	MULTI-PLIER	WATTS	% POWER FACTOR — MEASURED	COR. 20°C	COLLAR TEST (WATTS/CURRENT)	INSULATION RATING
CIRCUIT BREAKER OPEN	1						2.10			844			125.6	1.40			
	2						2.10		904	~~855~~		149	~~139~~	~~1.62~~	1.85		
	3						2.10			855			139	1.62			
	4						2.10			778			148	1.9			
	5						2.10			865			165	1.91			
	6						2.10			782			130	1.67		TLI	
C.B. CLOSED	TANK 1						2.10			1652			272	1.65		65 mW	
	TANK 2						2.10			1641			295	1.8		8 mW	
	TANK 3						2.10			1,645			269.8	1.63		25 mW	

OTHER TESTS

LINE NO.																
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16	O:I								545			2.303	0.04	0.04	C=1445 pf	

KEY TO BUSHING NO.



REMARKS

Disconnected BKR at bottom of 4V-301 switch & from bus bars above BKR Only testing BKR

KEY TO INSULATION RATING

BUSHINGS-INSULATORS-ETC.	WOOD MEMBERS-OIL-ETC.	WINDINGS
G = GOOD	XG = GOOD	WG = GOOD
D = DETERIORATED	XD = DETERIORATED	WD = DETERIORATED
I = INVESTIGATE	XI = INVESTIGATE	WI = INVESTIGATE
B = BAD (REMOVE OR RECONDITION)	XB = BAD (REMOVE OR RECONDITION)	WB = BAD (REMOVE OR RECONDITION)

TEST SET NO. ________ TEST BY DF/KS CHECKED BY ________ SHEET NO. ________

04/07/26.

10V-301 Nictaux

Contact Resistance. Φ1 72 μΩ.

Φ2 65 μΩ.

Φ3 61 μΩ.

Megger :	Φ1	open	20 GΩ	@ 5KV.
		Closed	5 GΩ.	
	Φ2	open	15 GΩ.	
		Closed	1 GΩ.	
	Φ3	open	10 GΩ.	
		closed.	5 GΩ.	

Remark: oil was changed & tested @ 40KV.

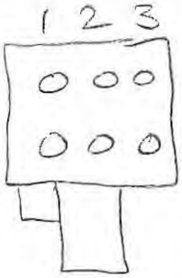
[signature]

10V - NICTAUX

10V-301

Changed oil with new

Contact resistance



#1 → 72μΩ

#2 → 52μΩ

#3 → 49μΩ

Front of unit

Meggar BKR OPEN 1000V

1 ∞
2 ∞
3 ∞

Could not bittle unit as cap. & generator windings are tied into bus.

Cleaned close coil piston, bottom of piston had a sticky film all over it.

10V-NICTAUX

Problem: When the ECC initates a "start" on 10V-G1 the breaker 10V-301 sometimes will close in and stay closed. However, when the operator initates a manual close on the breaker it operates and stay closed.

On June 14/2000 maintenance crews were sent to 10V to investigate this problem. We completed a "5 year inspection" on 10V-301 by changing the oil, wiping down the unit along with a visual inspection of the breaker. We could not find anything broken or bent inside the breaker. We put it back together and proceeded to operate the breaker. On closing the breaker we noticed that the 52CC piston kind of studdered alittle before actually closing.
We started to look into the 52X coil that is mounted on the side of the breaker. It has an arc chute over the contacts as it is used to pick up the 52CC. We took the 52X apart and looked at the contacts, although they were not burnt we cleaned them and also noticed that the contacts were getting thin. We checked the gap on the contacts and noticed that it was ≈ 1cm wide, at this time we took the 52X arm off and bent the contact arm so that it is now ≈0.5 cm apart. We reassembled the 52X and tried the breaker, the 52 CC piston was still doing the same thing. At this time we noticed that the 52CC piston was extremely sticky on the bottom and preceded to clean the piston. As we could not get the piston out we could only spray cleaner up inside the 52CC. The next time we operated the breaker the piston moved smoothly up into the coil. When the operator ran 10V-G1 up using the auto sync 10V-301 operated smoothly, this may have fixed the problem.

Recommendations: The next time the unit comes down for maintenance the 52CC piston show be removed and thoroughly cleaned. The movable arm on the 52X should be changed out with a new one.

WESTINGHOUSE BREAKER TYPE ~~BJO-B and BNO-B~~ DB - 10N Grd
~~34.5 kV MAINTENANCE~~ BKHB
Yearly Maintenance

TMP 45C.8

Visual Check

Breaker System No. 10V-301

Serial No. 1013146

1.- Breaker Oil Level ✓

2.- Housing Heater N/A

3.- Oil Leaks Nil

4.- Bushings Oil Level (BJOB only) N/A

5.- Oil Dielectric No valve

6.- Lubrication N/A

7.- Position Indicator ✓

8.- Operations Counter Reading N/A

9. - Tank Grounding (2 Locations) X

10.- Foundation Clamps Tight ✓

11.- Condition of Bushings and Connections ✓

Station No. Nictaux

Date Nov 4/97

Inspected By GWD

12KV Breaker Maintenance
Yearly Inspection (Visual).

Breaker System No.: 13V-301 Serial No. 1235271
Manufacturer: Westinghouse.
Type: BKB

Test Results

1. Location: Gulch Plant
2. Type: Oil
3. Grounding: ~~NA~~ ✓ (Ground connection made in Panel)
4. Paint: OK
5. Bushings: Good.
6. Tank oil level: Good Oil looks like new.
7. Air Pressure: N/A
8. Auxilliary Switch: OK
9. Position Indicator: OK
10. Counter: N/A
11. Main contact condition: Good.
12. Contact Resistance:
    #1 111 μΩ #2 102 μΩ #3 114 μΩ

13. Meggar @ 5KV.

BKR open each pole to ground
1 15.0 GΩ 3 21.1 GΩ 5 12.6 GΩ
2 11.9 GΩ 4 21.6 GΩ 6 8.37 GΩ

Across open contact 1-2: 29.5 GΩ 3-4: 44 GΩ 5-6: 21G

Inspected by: ~~MF~~ KRC / MM / JH
Oct. 2 2008

Notes

- tightened arc chutes
- visual inspection of internal contacts and mechanism. All looks good.
- the auxiliary contact block had one screw missing in the contact block assembly in the panel. Screw was replaced and properly tightened. The block should be replaced as it is cracked. No spares around ~~for~~ and probably unable to get any new.
- Oil looks like ~~tha~~ is brand new condition. 25KV breakdown

13Y- 301

12 KV BREAKER MAINTENANCE

YEARLY INSPECTION (VISUAL)

West. Type BKB

Breaker System No. 13V-301 Serial No. 1235271

1. Location: Plant ✓ Substation
2. Type: Oil ✓ Air
3. Grounding in Panel
4. Paint ✓
5. Bushings OK
6. Tank Oil Level Good Changed Oil
7. Air Pressure N/A
8. Auxiliary Switch OK
9. Position Indicator Good
10. Counter N/A

Contact Resistance 94 uΩ 103 uΩ 105 uΩ

Megger 5KV BKR Open ① ② 75 GΩ ③ ④ 50G ⑤ ⑥ 50G BKR Closed. ① 17.5 GΩ ③ 13 GΩ ⑤ 4.5 GΩ

REMARKS: Tighten arc chute bolts & wooden rack bolts. Tightened screws on Aux Switch. Changed Oil in BKR.

SYSTEM NO. 13V-301 Generator Breaker

DATE July 10/03

INSPECTED BY KS/DF

C:\DATA\WP51\FORMS\BREAKER.FRM

OIL BREAKER - 4 KV, 12 KV, 23 KV, 25 KV	Reference: MP 45.59	Rev: 2
	Page: 3 of 4	
	Date: 1992 09 Revised: 1998 05	

System Device Number: 13V-803

Location Name and Number: GULCH

Manufacturer: WESTINGHOUSE

Type : BKB Serial Number: 1235274

Mechanism Type: Stored Energy ____ D.C. Solenoid ✓

1) Counter as Found: N/A

2) Check Exterior Condition of Breaker for Rust, Oil Leaks, etc.: ☑

3) Check Bushings for Cracks, Broken Sheds, or Contamination and Check Connections: ☑

4) Check Breaker Oil Level: OK

5) Check Bushing Oil Levels (where applicable): NA

6) Operate Manually: ☑

SKV MEGGAR

OPEN	CLOSED TO GND
A = 200GΩ	A = 30GΩ
B = 200GΩ	B = 45GΩ
C = 225GΩ	C = 40GΩ

7) Operate Electrically. ☐ NA
RACK OUT BKR.
NO TEST POSITION

8) Trip by Relays: ☐ NA

9) Position Indicator and Indicator Lights: ☐

10) Counter as Left: NA.

OIL BREAKER - 4 KV, 12 KV, 23 KV, 25 KV	Reference: MP 45.59	Rev: 2
	Page: 4 of 4	
	Date: 1992 09 Revised: 1998 05	

11) Comments, repairs or adjustments made: CHANGED OIL (OLD = 15KV - NEW = 28KV)
CHECKED - MOVABLE, STATIONARY + ARCH. CONTACTS - OK

Date: SEPT. 19/08 Maintained By: WHS & LB

Equipment #	16V-301	Date	Feb. 21, 2006
Type	FKR-255-250	Serial #	53608

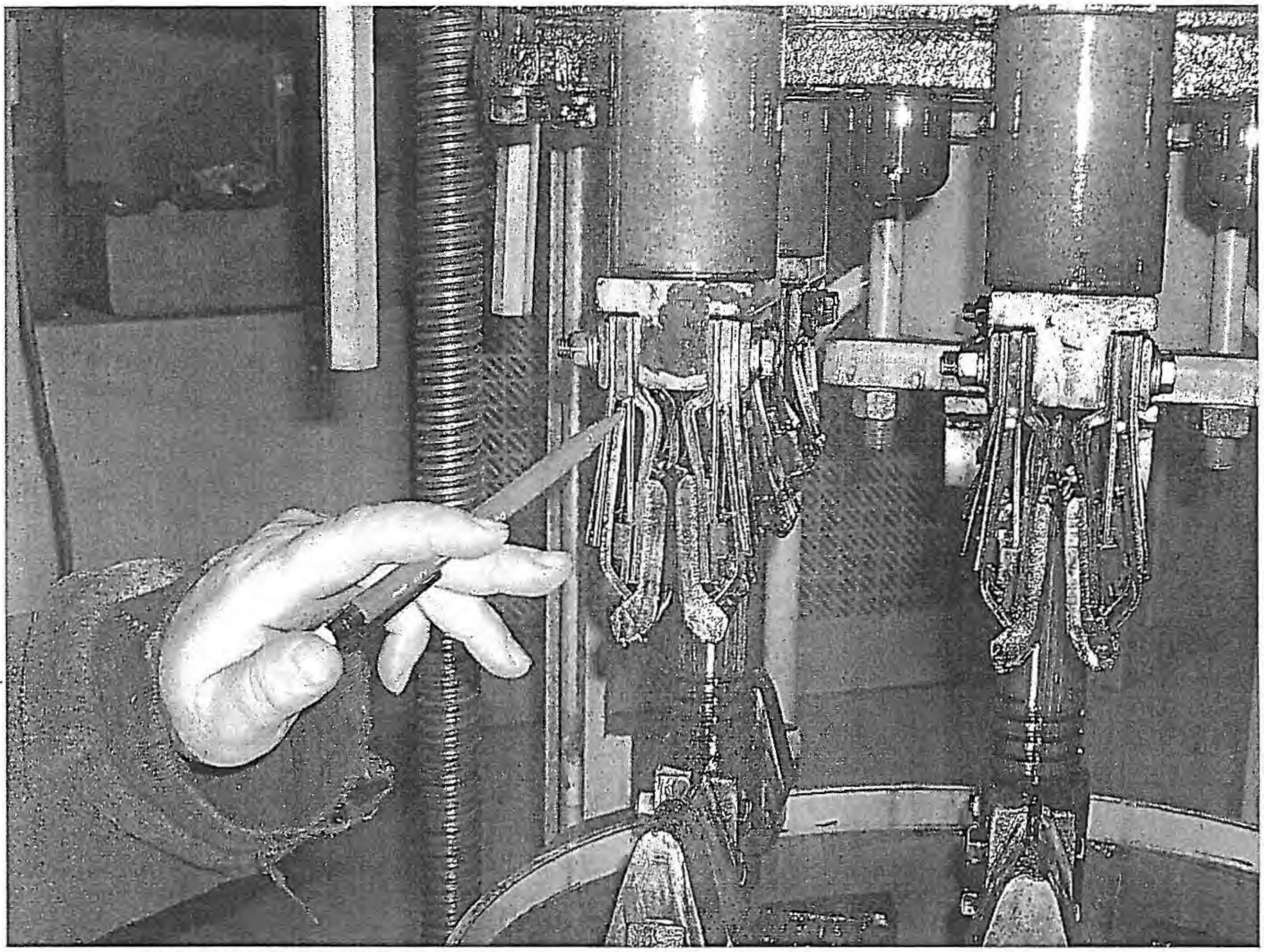
Megger Readings	5KV	As Found	As Left
Phase A	Between Bushings	130GΩ	300GΩ
1 &2	To Tank (closed)	50GΩ	125GΩ
Phase B	Between Bushings	200GΩ	300GΩ
3 & 4	To Tank(closed)	50GΩ	125GΩ
Phase C	Between Bushings	180GΩ	300GΩ
5 & 6	To Tank(closed)	50GΩ	125GΩ

2		4		5
A		B		C
1		3		6
	Mech.			

Lubricate	OK
Latch Wipe	OK
Inspect Prop & Pin	OK
Wiring	OK
Oil Breakdown	Replaced oil (13 gal) 31KV
Internal Inspection	See Remarks

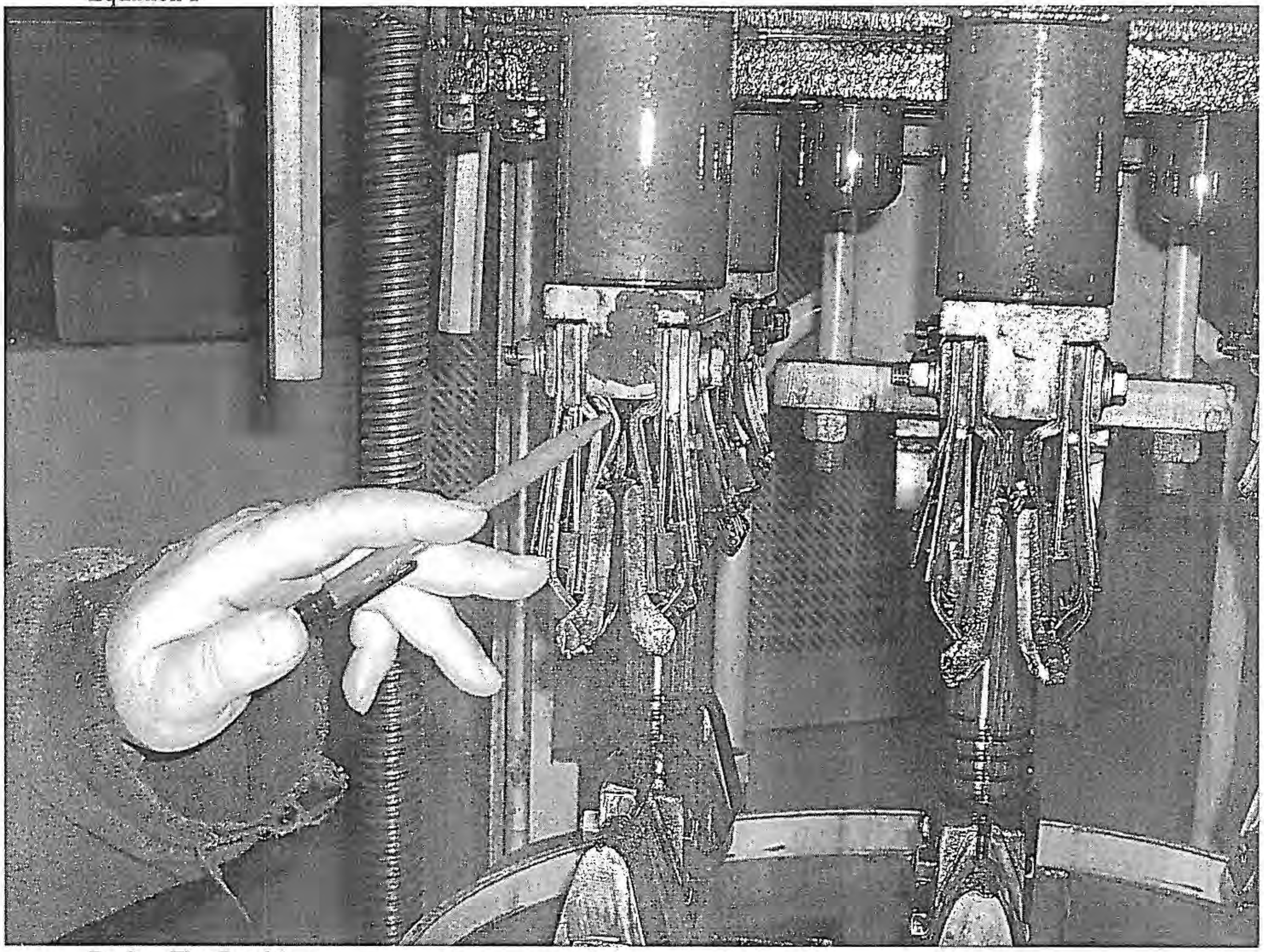
Remarks: Contacts are in fair shape, BUT the springs on the moving arching contacts are breaking & one side of every one has little or no tension, as well some of the flex leads going to these contacts are starting to break. Haven't seen any spare parts???

Tested By: Wayne Sullivan & Ken Sponagle

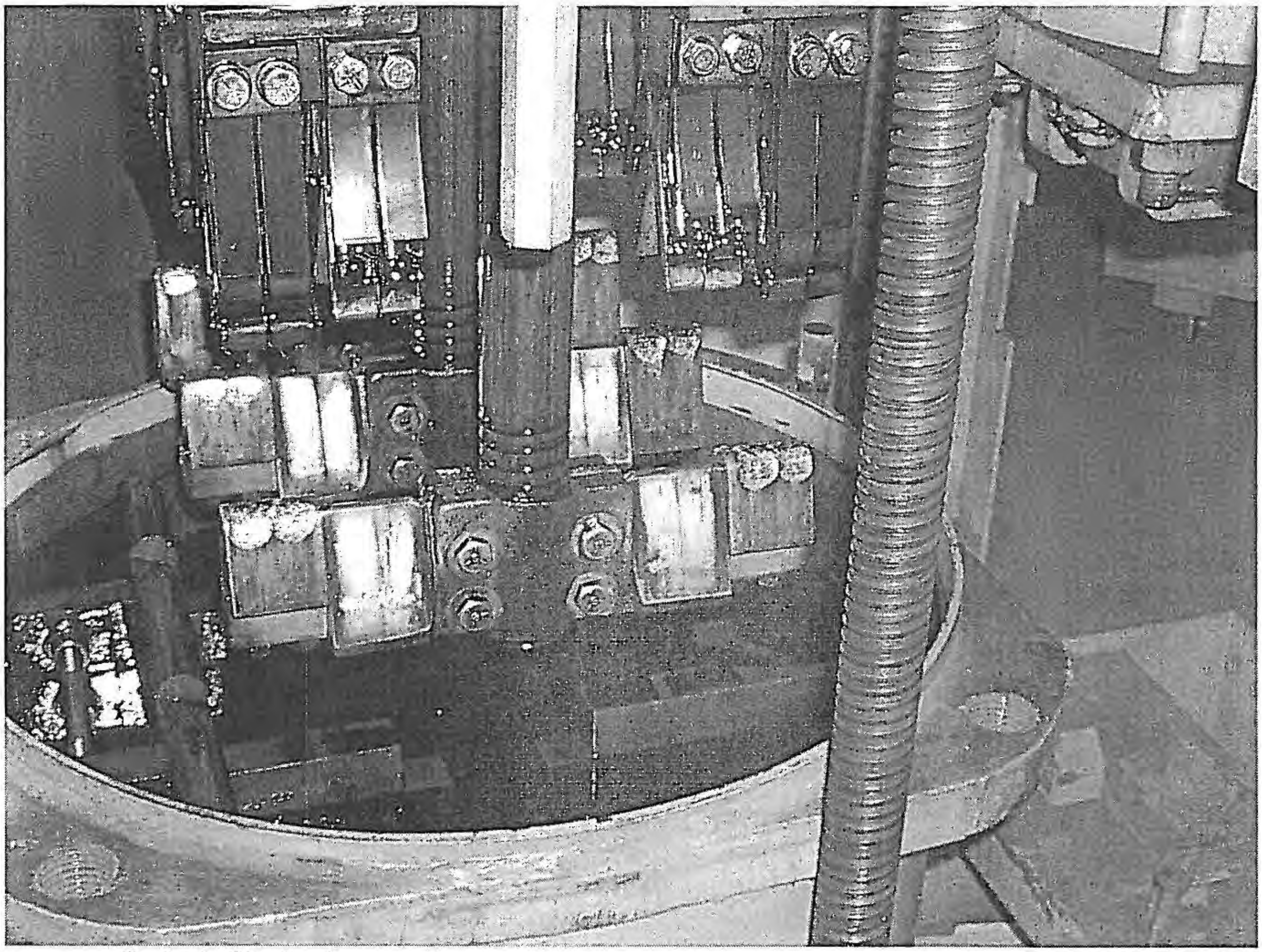


Broken Springs arching Contacts 1

Equation 1



Broken Flex Lead 1



Contacts side view 1

Springs laying in bottom of tank 1

OIL BREAKER - 4 KV, 12 KV, 23 KV, 25 KV *(for Frequency, see MP 0.0)*	Reference: MP 45.59	Revision: 2
	Page: 3 of 3	
	Date: 1992 09	
	Revised: 1998 05	

System Device Number: 16 V-301

Location Name and Number: 16V Weymouth

Manufacturer: GE

Type : FKR-255-250 Serial Number: 53608

Mechanism Type: Stored Energy ______ D.C. Solenoid ✓
Oil 13gal

1) Counter as Found: ——

2) Check Exterior Condition of Breaker for Rust, Oil Leaks, etc.: ☑

3) Check Bushings for Cracks, Broken Sheds, or Contamination and Check Connections: ☑

4) Check Breaker Oil Level: OK Replaced Oil

5) Check Bushing Oil Levels (where applicable): N/A

6) Operate Manually: ☑

7) Operate Electrically. ☐

8) Trip by Relays: ☑
AS per DWG's H16V19 560 34024
H16V19 560 34023

9) Position Indicator and Indicator Lights: ☐

10) Counter as Left: ______

Contact Resistance

Pole	
1-2	104 μΩ
3-4	100 μΩ
5-6	93 μΩ

2 4 6
1 3 5
mid

Meggar 5kV

Pole	
1-G	20 GΩ
2-G	25 GΩ
3-G	25 GΩ
4-G	20 GΩ
5-G	50 GΩ
6-G	50 GΩ
1&2-3&4	50 GΩ
3&4-5&6	50 GΩ

11) Comments, repairs or adjustments made: Internal inspection: A few of the stationary arcing contacts spring steel/arms were broken. However there was still good tension on the contacts. Arcing contacts had some pitting. Main contacts were good.

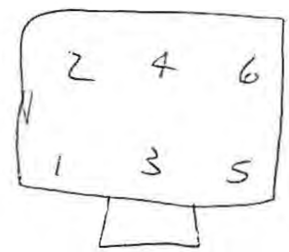
Date: Oct 5/04 Maintained By: DF/KS

W:\WP\S\13\07\mp\MP4559.doc

Yearly 12KV Breaker Maintenance

Location: Weymouth **System Number:** 16V-302
Serial #: 59170 **Type:** AH- 13.8 -500 (G.E)

1. Grounding ✓
2. Paint ✓
3. Bushings ✓
4. Oil Level N/A (air blast)
5. Air\SF6 Pressure —
6. Aux. Switch ✓
7. Position Indicator ✓
8. Counter N/A
9. Contact Condition ✓
10. Contact Resistance N/A



11. Remarks
Megger @ 5kv.
1 80 GΩ   4 45 GΩ
2 90 GΩ   5 100 GΩ
3 125 GΩ   6 110 GΩ

Date: Dec 17/96

Inspected By: RH & R. C

16V-312

BREAKER MFR. GE TYPE FKK 255-250 AGE

BREAKER SERIAL NO. 53610 KV 15 AMPS. 1200

DATE LAST INSP. DATE LAST TEST LAST TEST SHEET NO.

BUSHING MFR. BUSHING (TYPE-FORM-DWG.NO.)

	BUSH. NO.	BUSHING SERIAL NO.	SIDE	PHASE	FEET OF BUS	INS. IN PAR'L'L	TEST KV	MICROAMPERES METER READING	MICROAMPERES MULTIPLIER	MICRO-AMPERES	WATTS METER READING	WATTS MULTIPLIER	WATTS	% POWER FACTOR MEASURED	% POWER FACTOR COR. 20°C	COLLAR TEST (WATTS/CURRENT)	INSULATION RATING
CIRCUIT BREAKER OPEN	1						5	68	10	680	55/50	.002	.105	1.54	1.17		
	2						5	72	10	720	70/68	.002	.136	1.89	1.44		
	3						5	67	10	670	70/70	.002	.140	2.08	1.58		
	4						5	70	10	700	+75/75	.002	.150	2.14	1.63		
	5						5	70	10	700	67/65	.002	.131	1.87	1.42		
	6						5	72	10	720	70/71	.002	.142	1.97	1.50		
C.B. CLOSED	TANK 1						5	74	.02	1.48	+25/24	.01	.245	1.65	1.25	TLI = .004	
	TANK 2						5	70	.02	1.40	+35/30	.01	0.30	2.14	1.63	= .010	
	TANK 3						5	73	.02	1.46	+26/26	.01	0.26	1.78	1.35	= .013	

OTHER TESTS

LINE NO.																
1																
2																
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																
13																
14																
15																
16	OIL					10	89	10	89	+7/10	.002	.019	0.21			

KEY TO BUSHING NO.

TANK 3 (5) (6)

TANK 2 (3) (4) MECH.

TANK 1 (1) (2) MECH.

REMARKS

Oil Replaced in TANK

Contact Resistance TANK (1) 42 μΩ (2) 42 μΩ (3) 37

KEY TO INSULATION RATING

BUSHINGS-INSULATORS-ETC.	WOOD MEMBERS-OIL-ETC.	WINDINGS
G = GOOD	XG = GOOD	WG = GOOD
D = DETERIORATED	XD = DETERIORATED	WD = DETERIORATED
I = INVESTIGATE	XI = INVESTIGATE	WI = INVESTIGATE
B = BAD (REMOVE OR RECONDITION)	XB = BAD (REMOVE OR RECONDITION)	WB = BAD (REMOVE OR RECONDITION)

TEST SET NO. 4(?) TEST BY [signature] CHECKED BY [signature] SHEET NO.

doble

Yearly 12KV Breaker Maintenance

Location: Weymouth
System Number: 16V-312
Serial #: 53610
Type: FKR-255-250

1. Grounding ✓
2. Paint ✓
3. Bushings ✓
4. Oil Level ✓
5. Air\SF6 Pressure —
6. Aux. Switch ✓
7. Position Indicator ✓
8. Counter —
9. Contact Condition —
10. Contact Resistance —
11. Remarks

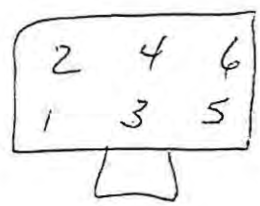
Date: Dec 9/97

Inspected By: E.H. & R.W.

Yearly 12KV Breaker Maintenance

Location: Weymouth System Number: 16V-312
Serial #: 53610 Type: FKR-255-250

1. Grounding ✓
2. Paint ✓
3. Bushings ✓
4. Oil Level ✓ K.V. Breakdown - 33kv.
5. Air\SF6 Pressure N/A
6. Aux. Switch ✓
7. Position Indicator ✓
8. Counter N/A



9. Contact Condition ✓
10. Contact Resistance N/A
11. Remarks Megger @ 5kv.

(1)	50 GΩ	(4)	15 GΩ
(2)	15 GΩ	(5)	15 GΩ
(3)	14 GΩ	(6)	15 GΩ

Date: Dec 17/96

Inspected By: EH & R. C.

16V-312

1 YR MTCE

94-10-20.

1 Year Maintenance

Breaker 16V-312

oil level OK.

Visual interna inspection OK.

Dielectric Test - 25 kV

greased Lift Rods

Remote operation O.K

Ron Hazlett

Breaker 16V-312 92-07-28

WES & GW.D

General Electric oil Blast

type - FKR 255 250 Annual maintenance

volts 15000 Amp 1200

Serial # 53610

Approx. 13 gals

weight with oil 1366

Dialectric Breakdown (oil)	48kv
Oil level	O.K.
Mechanism	O.K.
Contacts	O.K.

Annual Maintenance.

[signature]

12 KV BREAKER MAINTENANCE

YEARLY INSPECTION (VISUAL)

Breaker System No. 16V-312 Serial No. 53610

1. Location: Plant ✓ Substation
2. Type: Oil 13gal Air
3. Grounding ✓
4. Paint ✓
5. Bushings ✓
6. Tank Oil Level normal
7. Air Pressure N/A
8. Auxiliary Switch ✓
9. Position Indicator ✓
10. Counter N/A

REMARKS: General Electric Metalclad Switch
13.8/69KV TIE

SYSTEM NO. 16V Weymouth

DATE 92-03-19

INSPECTED BY Jim Davidson DDM

15V-301

ALFA-10 POWER FACTOR TEST REPORT
"BULK OIL CIRCUIT BREAKER" (O.C.B. TEST)

APPARATUS INFORMATION

DATE: 2000 / Oct / 05

COMPANY: NS Power

O.C.B. LOCATIONS: Sissiboo

O.C.B. DESIGNATION: 15V-301

O.C.B. NAME PLATE DATA

MFGR: GE S/N: 53607 YEAR:

Type: FKR-255-250

AVO MULTI-AMP CANADA LIMITED

TYPE: 04-A10 OIL CIRCUIT BREAKER TEST

ENVIRONMENT

WEATHER: INSIDE

AIR TEMP.: 18 °C

OIL TEMP.: 18 °C

WINDING TEMP.: °C

REL. HUMIDITY: Low %

BUSHING NAME PLATE DATA

MFGR:

TYPE: RATED VOLTAGE: & CURRENT:

FORM: DRAWING NO.:

246
135

Front

OPEN BREAKER TEST (BUSHING AND ION GRID)

POSN.	PHASE	NAME PLATE SERIAL NO.	NAME PLATE P.F. (%)	NAME PLATE CAP. (P.F.)	VOLTAGE (KV)	CURRENT (mA)	POWER (mW)	POWER FACTOR (%)		CAP. (Pf)	INSUL. RATING
1	1				5KV	750.2uA	121.5	1.62%		198.9	
2	2				5KV	790.8uA	126.0	1.59%		209.7	
3	3				5KV	750.7uA	119.6	1.59%		199.1	
4	4				5KV	725.7uA	118.0	1.62%		192.4	
5	5				5KV	756.5uA	115.1	1.52%		200.6	
6	6				5KV	747.0uA	109.2	1.46%		198.1	

CLOSED BREAKER TEST

	VOLTAGE (KV)	CURRENT (mA)	POWER (mW)	POWER FACTOR (%)		CAP. (Pf)	INSUL. RATING
PHASE 1	5KV	1.56mA	249.1	1.59%		413.9	
PHASE 2	5KV	1.495mA	240.4	1.60%		396.7	
PHASE 3	5KV	1.521mA	226.1	1.48%		403.5	

TANK LOSS INDEX RATING (TLI)

PHASE 1 TLI: -1.6 mW | PHASE 2 TLI: -2.8 mW | PHASE 3 TLI: -1.8 mW

Where TLI = (Closed Breaker mW) - (Sum Of Two Open Breaker mW).

Where TLI = (Closed Breaker mW) - (Sum Of Two Open Breaker mW).

OIL RESULTS:

DIELECTRIC STRENGTH TEST STD.USED: 1816 □ 877 □ AVG. BREAKDOWN	STD. DEV.	VOLTAGE (KV)	CURRENT (mA)	POWER (mW)	POWER FACTOR % 18°C Measured	Corr to 20°C	CAP. (pF)	INSUL. RATING
40.3KV		10	506.9uA	1.898	0.03	0.03	134.4pF	

REASON FOR TESTING: Major Maintenance OIL CELL S.N.:

WORK ORDER NO.: ALFA-10 SERIAL NO.:

TESTED BY: Todd McKay / Ken Sponagle LAST DATE TESTED: / / (M/D/Y)

CHECKED BY: DATE CHECKED: / / (M/D/Y)

COMPANY:

DEPARTMENT: SHEET NO.:

REMARKS:

YEARLY 12KV BREAKER MAINTENANCE

LOCATION : Siss.boo

VOLTS : 7500

SERIAL # : 53607

AMPS : 1200

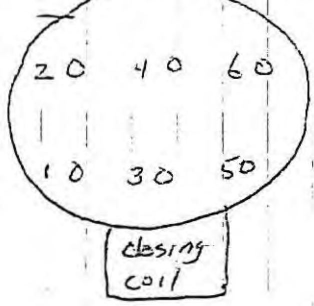
SYSTEM # : 15V-301

Type : FKR-255-250

Todd McKay/Ken Sponagle
Oct 5/2000

1. GROUNDING : OK
2. PAINT : OK
3. BUSHINGS : OK
4. OIL LEVEL : OK
5. AUX. SWITCH : OK
6. POSITION INDICATOR : OK
7. COUNTER : N/A
8. CONTACT CONDITION : REPLACED BURNT & PITTED CONTACTS
9. CONTACT RESISTANCE : SEE NEXT SHEET
10. REMARKS

CONTACT RESISTANCE :



1-2 ⇒ 37 $\mu\Omega$

3-4 ⇒ 36 $\mu\Omega$

5-6 = 37 $\mu\Omega$

BIDDLE TEST (OPEN BKR)

KV	Amp (1 min)
1.5 KV	0 μA
3.0 KV	0 μA
4.5 KV	0.05 μA
6 KV	0.1 μA
7 KV	0.1 μA

OVERALL TEST 2-4-6 tied together & at gnd potential

1-3-5 tied together & at HV potential

BIDDLE TEST (CLOSED BKR)

KV	Amp (1 min)
1.5 KV	0 μA
3.0 KV	0.05 μA
4.5 KV	0.1 μA
6.0 KV	0.15 μA
7.0 KV	0.17 μA

OVERALL TEST 1-2-3-4-5-6 tied together & at HV potential
tank grounded

ALFA-10 POWER FACTOR TEST REPORT
"BULK OIL CIRCUIT BREAKER" (O.C.B. TEST)

APPARATUS INFORMATION

DATE: 94 / 12 / 02

COMPANY: N.SPT

O.C.B. LOCATIONS: 15 V - 301 SUBSTATION

O.C.B. DESIGNATION:

O.C.B. NAME PLATE DATA

MFGR: [illegible] S/N: [illegible] YEAR:

AVO MULTI-AMP CANADA LIMITED

TYPE: 04-A10 OIL CIRCUIT BREAKER TEST

ENVIRONMENT

WEATHER: INSIDE

AIR TEMP.: 15° °C

OIL TEMP.: 15° °C

WINDING TEMP.: °C

REL. HUMIDITY: %

BUSHING NAME PLATE DATA

MFGR:

TYPE: RATED VOLTAGE: & CURRENT:

FORM: DRAWING NO.:

5 3 1
6 4 2

OPEN BREAKER TEST (BUSHING AND ION GRID)

POSN.	PHASE	NAME PLATE SERIAL NO.	NAME PLATE P.F. (%)	NAME PLATE CAP. (P.F.)	VOLTAGE (KV)	CURRENT (mA)	POWER (W)	POWER FACTOR (%)		CAP. (Pf)	INSUL. RATING
1					5KV	.754	.1	1.3%		199	
2						.762	.1	1.3%		202	
3						.732	.1	1.4		194	
4						.756	.1	1.37		200	
5						.794	.11	1.4		210	
6						.757	.10	1.35		201	

CLOSED BREAKER TEST

Contact Resistance		VOLTAGE (KV)	CURRENT (mA)	POWER (W)	POWER FACTOR (%)		CAP. (Pf)	INSUL. RATING
35 uΩ	PHASE 1	5KV	1.5ma	.197w	1.3%		404	
35 uΩ	PHASE 2		1.5ma	.209w	1.4%		398	
36 uΩ	PHASE 3		1.5	.216	1.38%		414	

TANK LOSS INDEX RATING (TLI)

PHASE 1 TLI: mW | PHASE 2 TLI: mW | PHASE 3 TLI: mW

Where TLI = (Closed Breaker mW) - (Sum Of Two Open Breaker mW).

Where TLI = (Closed Breaker mW) - (Sum Of Two Open Breaker mW).

OIL RESULTS:

DIELECTRIC STRENGTH TEST — STD.USED: 1816 ☐ 877 ☐

INSULATION POWER FACTOR TEST RESULTS

AVG. BREAKDOWN	STD. DEV.	VOLTAGE (KV)	CURRENT (mA)	POWER (mW)	POWER FACTOR % Measured	Corr to 20°C	CAP. (pF)	INSUL. RATING
30 KV		10 KV	.362	.57	.019		96.1	

REASON FOR TESTING: OIL CELL S.N.:

WORK ORDER NO.: ALFA-10 SERIAL NO.:

TESTED BY: K.S LAST DATE TESTED: / / (M/D/Y)

CHECKED BY: [illegible] DATE CHECKED: 10 / 04 / 94 (M/D/Y)

COMPANY: NSPT

DEPARTMENT: Maint. - U.S'hops SHEET NO.:

REMARKS: Changed oil K.V. Breakdown was 16KV.

Yearly 12KV Breaker Maintenance

Location: Sissihan **System Number:** 15U-301
Serial #: 53607 **Type:** FKR-255-250

1. Grounding OK
2. Paint OK
3. Bushings OK
4. Oil Level OK
5. ~~Air\SF6 Pressure~~
6. Aux. Switch OK
7. Position Indicator OK
8. Counter none
9. Contact Condition good.
10. Contact Resistance unable to obtain
11. Remarks oil KV Breakdown — 25 KV

Closing prep wipe — .410"
Trip latch clearance — .020"
Trip Latch wipe — .220"

20 40 60

10 30 50

Front of BK.
megger 5KV
#1 — 10 GΩ
#2 — 15 GΩ
#3 — 12 GΩ
#4 — 15 GΩ
#5 — 20 GΩ
#6 — 15 GΩ

Date: Dec. 13/96

Inspected By: EH & RC

Yearly 12KV Breaker Maintenance

Location: Sissiboo
Serial #: 53606
System Number: 15V-311
Type: FKR-255-250

1. Grounding ✓
2. Paint ✓
3. Bushings ✓
4. Oil Level ✓
5. Air\SF6 Pressure —
6. Aux. Switch ✓
7. Position Indicator ✓
8. Counter
9. Contact Condition ✓
10. Contact Resistance —
11. Remarks

Date: Dec 8/97
Inspected By: G.H. & R.W.

Yearly 12KV Breaker Maintenance

Location: Sissiboo
System Number: 15U-311
Serial #: 53606
Type: FKR-255-250

1. Grounding OK
2. Paint OK
3. Bushings OK
4. Oil Level OK
5. ~~Air\SF6 Pressure~~
6. Aux. Switch OK
7. Position Indicator OK
8. Counter none
9. Contact Condition good.
10. Contact Resistance unable to obtain
11. Remarks oil KV Breakdown — 32 KV

Closing prop wipe — .340"
Trip Latch clearance — .060"
Trip Latch wipe — .260"

2°	4°	6°
1°	3°	5°

Front of BK.

#1 - 15 GΩ
#2 - 20 GΩ
#3 - 15 GΩ
#4 - 15 GΩ
#5 - 25 GΩ
#6 - 20 GΩ.

Date: Dec 18/96

Inspected By: EH + RC

ALFA-10 POWER FACTOR TEST REPORT
"BULK OIL CIRCUIT BREAKER" (O.C.B. TEST)

APPARATUS INFORMATION

DATE: 04 / [illegible] / [illegible]

COMPANY: N.S.P.I.

O.C.B. LOCATIONS: 15V-311 S1551300

O.C.B. DESIGNATION:

O.C.B. NAME PLATE DATA

MFGR: [illegible] S/N: 53 206 YEAR:

AVO MULTI-AMP CANADA LIMITED

TYPE: 04-A10 OIL CIRCUIT BREAKER TEST

ENVIRONMENT

WEATHER: [illegible]

AIR TEMP.: [illegible] °C

OIL TEMP.: [illegible] °C

WINDING TEMP.: °C

REL. HUMIDITY: %

BUSHING NAME PLATE DATA

MFGR:

TYPE: RATED VOLTAGE: & CURRENT:

FORM: DRAWING NO.:

OPEN BREAKER TEST (BUSHING AND ION GRID)

POSN.	PHASE	NAME PLATE SERIAL NO.	P.F. (%)	CAP. (P.F.)	EQUIVALENT 10 KV TEST RESULTS VOLTAGE (KV)	CURRENT (mA)	POWER (W)	POWER FACTOR (%)		CAP. (Pf)	INSUL. RATING
1					5KV	777	[illegible]	1.04		206	
2					5KV	[illegible]	[illegible]	1.02		203	
3					5KV	780	99.0	1.25		207	
4					5KV	773	97.0	1.17		205	
5					5KV	783	99.1	1.12		207	
6					5KV	776	[illegible]	1.25		206	

CLOSED BREAKER TEST
Contact Resistance

Contact Resistance	PHASE	VOLTAGE (KV)	CURRENT (mA)	POWER (W)	POWER FACTOR (%)		CAP. (Pf)	INSUL. RATING
19 M.Ω	PHASE 1	5KV	155	174	1.18			413
20 M.Ω	PHASE 2		157	190	1.28			417
17 M.Ω	PHASE 3		[illegible]	157	1.29			[illegible]

TANK LOSS INDEX RATING (TLI)

PHASE 1 TLI: mW | PHASE 2 TLI: mW | PHASE 3 TLI: mW

Where TLI = (Closed Breaker mW) - (Sum Of Two Open Breaker mW).

Where TLI = (Closed Breaker mW) - (Sum Of Two Open Breaker mW).

OIL RESULTS:

DIELECTRIC STRENGTH TEST STD.USED: 1816 ☐ 877 ☐ AVG. BREAKDOWN	STD. DEV.	INSULATION POWER FACTOR TEST RESULTS VOLTAGE (KV)	CURRENT (mA)	POWER (mW)	POWER FACTOR % Measured	Corr to 20°C	CAP. (pF)	INSUL. RATING
33KV		10KV	.50mA	.09	[illegible]		133	

REASON FOR TESTING: OIL CELL S.N.:

WORK ORDER NO.: ALFA-10 SERIAL NO.:

TESTED BY: K.S / RH LAST DATE TESTED: / / (M/D/Y)

CHECKED BY: [illegible] DATE CHECKED: 10 / 24 / 94 (M/D/Y)

COMPANY: NSPI

DEPARTMENT: Maint. U. Shop SHEET NO.:

REMARKS: [illegible] specified

12 KV BREAKER MAINTENANCE

YEARLY INSPECTION (VISUAL)

Breaker System No. 15V-311 Serial No. 53606
SISSIBOO TIE B-31 & 15V-T1
7500 VOLTS

1. Location: Plant ✓ Substation ______
2. Type: Oil ✓ CGE Air ______
3. Grounding ✓
4. Paint ✓
5. Bushings ✓
6. Tank Oil Level NORMAL
7. Air Pressure N/A
8. Auxiliary Switch ✓
9. Position Indicator OK
10. Counter N/A

REMARKS: Oil dielectric 26.6 kv.
Check bushings (ok) cleaned

SYSTEM NO. 15V-311

DATE 92-12-13

INSPECTED BY G.A. Davidson & W. Dennings

Annual Breaker Inspection

15v-311

G.E. Oil Blast
35 gals
oil level O.K.
no leaks

91.03 19

The Breaker was in service & is in a cubical thus a visual inspection only.

DPM

12 KV BREAKER MAINTENANCE

YEARLY INSPECTION (VISUAL)

Breaker System No. 15V-311 Serial No. 53606

1. Location: Plant ✓ Substation
2. Type: Oil 35 gal Air –
3. Grounding ✓
4. Paint ✓
5. Bushings ✓
6. Tank Oil Level Normal
7. Air Pressure n/A
8. Auxiliary Switch OK
9. Position Indicator ✓
10. Counter n/A

REMARKS: General Electric Metalclad
6.9/69 KV Tie

SYSTEM NO. 15V-311 Tie 6.9/69 Bkr.

DATE 92-03-19

INSPECTED BY Gerard Davidson

15V - 311

5 YR MAINT

CHANGED oil
cleaned TANK
CHANGED 7 ARC CONTACTS
" 3 TIP CONTACTS.
cleaned & CHECKED BREAKER

HATCH™

Suite E200, Bally Rou Place, 280 Torbay Rd.
St. John's, Newfoundland, Canada A1A 3W8
Tel (709) 754 6933 ◆ Fax (709) 754 2717

CI Number: 43136

Title: **HYD – Weymouth Headcover Replacement**

Start Date: 2012/07
Final Cost Date: 2013/12
Function: Generation
Forecast Amount: $438,158

DESCRIPTION:

The scope of this project includes detailed engineering design, procurement and installation of a new turbine headcover for Weymouth Falls Unit 1.

Summary of Related CIs +/- 2 years:
2013 CI 17581 - HYD Weymouth Electrical Replacement $1,641,359
2013 CI 20571 - HYD Weymouth Falls Tailrace Deck Refurbishment $371,469
2013 CI 40308 - HYD Weymouth Falls Pipeline Replacement $6,752,759
2013 CI 43039 - HYD Weymouth Surge Tank $2,738,175

JUSTIFICATION:

Justification Criteria: Health & Safety

Sub Criteria: Equipment Replacement

Why do this project?

During a planned outage in 2010, the headcover of Weymouth Falls Unit 1 was removed and inspected. Significant cracks and erosion defects in the headcover were discovered and repaired. At the time of the repair, it was understood that the repairs were of a temporary nature and it was recommended that a new replacement headcover be purchased and installed within 3 to 5 years. The new headcover must be installed to ensure the pressure boundary of the generating unit is not compromised.

Why do this project now?

The turbine headcover must be replaced now to mitigate the risk of headcover failure, and compromise of the pressure boundary, which may result in flooding of the generating station.

Why do this project this way?

Replacing the headcover, which is approximately 50 years old, with a new headcover to match the existing machine is the most viable and economically feasible option.

CI Number : 43136 - HYD - Weymouth Headcover Replacement **Project Number**

Parent CI Number : -

Cost Centre : 411 - 411-Sissiboo/Weymouth System **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		[redacted]	0	[redacted]
095		095 - T&CS Regular Labour AO		1,050	0	1,050
095		095-Hydro Regular Labour AO		18,586	0	18,586
001	025	001 - HYDRO Regular Labour	025 - HGP - Generator	96,000	0	96,000
001	025	001 - T&CS Regular Labour	025 - HGP - Generator	3,360	0	3,360
011	025	011 - Travel Expense	025 - HGP - Generator	60,000	0	60,000
012	025	012 - Materials	025 - HGP - Generator	[redacted]	0	[redacted]
			Total Cost:	438,158	0	438,158
			Original Cost:	65,339		

Capital Project Detailed Estimate

Location: Hydro
FP#: 43136
Title: HYD - Weymouth #1 Headcover Replacement

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Hydro Regular Labour	hr	[redacted]		$ 96,000.00		
1.2	Project Management	hr	[redacted]		$ 3,360.00		
1.3		hr			$ -		
				Sub-Total	$ 99,360.00		
2	**012 Materials**						
2.1	Supply of Headcover	lot	1	[redacted]		Cost Support 1 p.1	
2.2	Contingency	%	[redacted]				
2.3	Wear Ring and Face Plates	lot	1	[redacted]		Cost Support 1 p.2	
2.4					$ -		
				Sub-Total	[redacted]		
3	**011 Travel Expenses**						
3.1	Travel & Lodging during installation	lot	1	$ 60,000.00	$ 60,000.00		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 60,000.00		
4	**094 Interest Capitalized**						
4.1	Interest Capitalized	lot	1	[redacted]			
4.2					$ -		
4.3					$ -		
				Sub-Total	[redacted]		
5	**095 Administrative Overhead**						
5.1	Hydro Regular Labour AO	lot	1	$ 18,585.60	$ 18,585.60		
5.2	T&C Regular Labour AO	lot	1	$ 1,049.66	$ 1,049.66		
				Sub-Total	$ 19,635.26		
Cost Estimate				**Total**	$ 438,158.21		
6	**Original Cost**						
6.1					$ 65,339.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

FLEETWAY
FACILITY SERVICES

C.1-1

IRVING

FLEETWAY FACILITY SERVICES
P.O. Box 5250, Saint John, NB E2L 5C9
Tel: (506) 648-2226 Fax: (506) 648-3522

INSPECTION AND TEST PLAN

CUSTOMER	ITP No.	DATE
NS POWER	7491	October 19 , 2010

DESCRIPTION	PO#
Weymouth #1 Head cover	

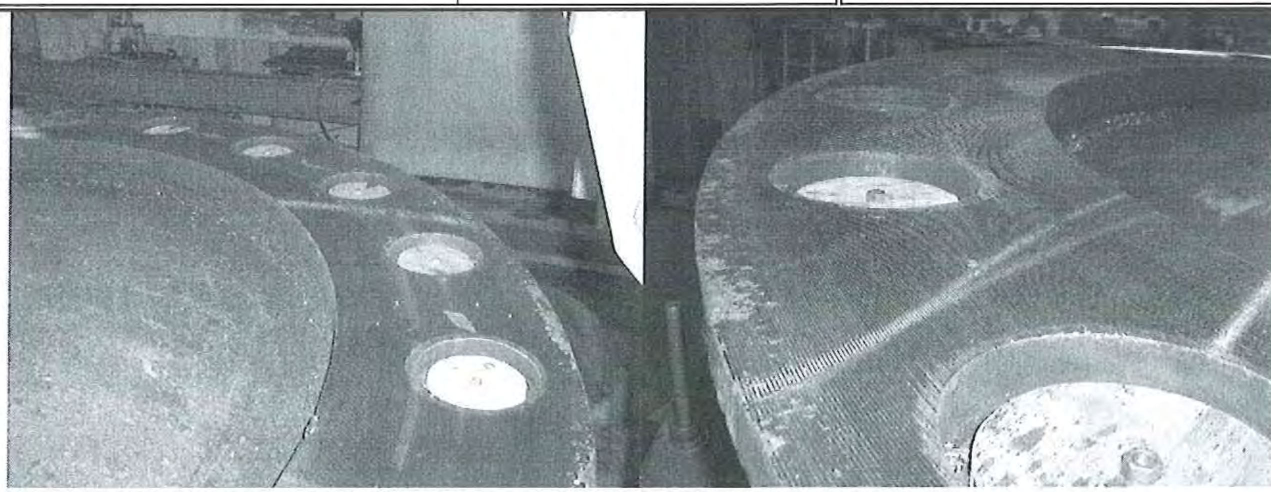
JOB#	CUSTOMER DWN#	REV	ST#
441281001	520-138	F	

Op No.	Process	Detailed operation	Records	Fleetway	Customer
1	Receiving Inspection		Visual	GT ✓	
2	Machining	Machine face prior to applying Belzona		LA ✓	
3		Fluorescent magnetic particle exam for cracks on machined surface	Report 441281001-001	October 20, 2010 TA ✓	
4		Band around machined surface for Belzona		✓	
5		Apply Belzona (Belzona rep to apply)		✓	
6	Machining	Machine Belzona using tooling supplied by Fundy grinding		✓	
7	Inspection	Record finished height	14.865" MK	Oct 28 2010 GT ✓	
8		Sand blast & paint as per drawing		N/A	
9		Spot check welds after sand blasting		N/A	
10		Assemble data package		Oct 28 2010 GT	
11	Ship	Ship to customer with data package		Oct 28 2010 GT	

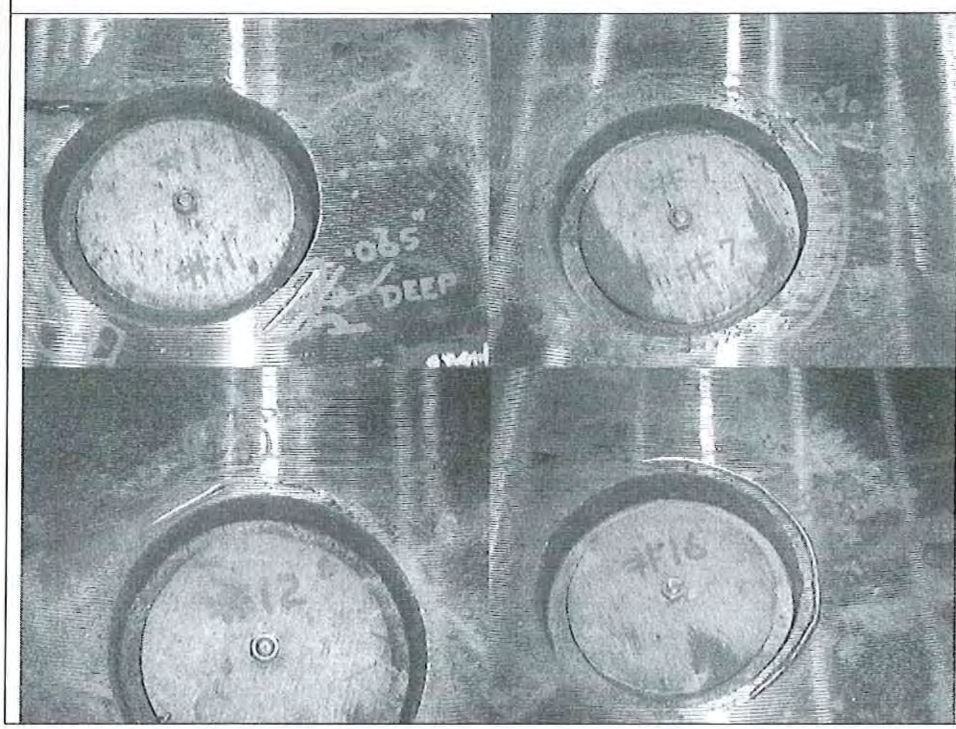
FLEETWAY FACILITY SERVICES

IRVING

MACHINE SHOP INSPECTION REPORT		REPORT NUMBER: 7491 - 1
. CUSTOMER NS POWER	DISCRIPTION. Weymouth #1 Head cover	
WORK ORDER No. 441281001	ST No.	CUSTOMER DWN No. 520-138 F



SURFACE MACHINED TO 14.687" PRIOR TO BELZONA



After mag partial inspection surface cracks were found around all holes (see attached report) They were ground out prior to Belzona being applied

INSPECTED BY:		DATE:
Graham Tugwell	FFS 3 QA	October 22, 2010

Form FFS-01

FLEETWAY FACILITY SERVICES

Fleetway Facility Services
45 Gifford Rd. P.O. Box 5250
Saint John, N.B., E2L 5C9
Tel:506-648-2226 Fax:506-648-3522

ᐧ \GNETIC PARTICLE EXAMINATION REPORT

NDE REPORT No.: 441281001-001

PROJECT No.	CUSTOMER	CUSTOMER'S REF NO.	PAGE
441281001	NOVA SCOTIA POWER	N/A	1 of 6

IDENTIFICATION	DRAWING NO.	DATE OF EXAMINATION
Weymouth # 1 Headcover	N/A	OCT 20/10

LOCATION	PART/WELD NO.	EQUIPMENT USED / SERIAL NO.	CAL. DUE DATE
MACHINE SHOP	N/A	CONTOUR PROBE/Z	DEC 30/10

METHOD
Amps: ______ Ampere Turns: ______

☐ Wet ☒ AC ☒ Yoke ☐ Direct ☐ Central Conductor
☒ Dry ☐ DC ☐ Prods ☐ Coil ☐ Other: ______

EXAMINATION
☒ Initial
☐ Repair No. ______

NDE PROCEDURE NO.: SOP 520.13

CODE/SPEC: INFO

RESULTS: ☐ Acceptable ☐ Rejectable ☒ N/A (for information only)

A dry powder method of magnetic particle inspection was performed on the Weymouth # 1 Headcover concentrating on the machined surface. Numerous indications were observed during this inspection. For more information on the indications observed refer to the following pages. A total of 26 linear indications have been recorded varying in lengths from 1" to approx. 90% of the circumference of the hole.

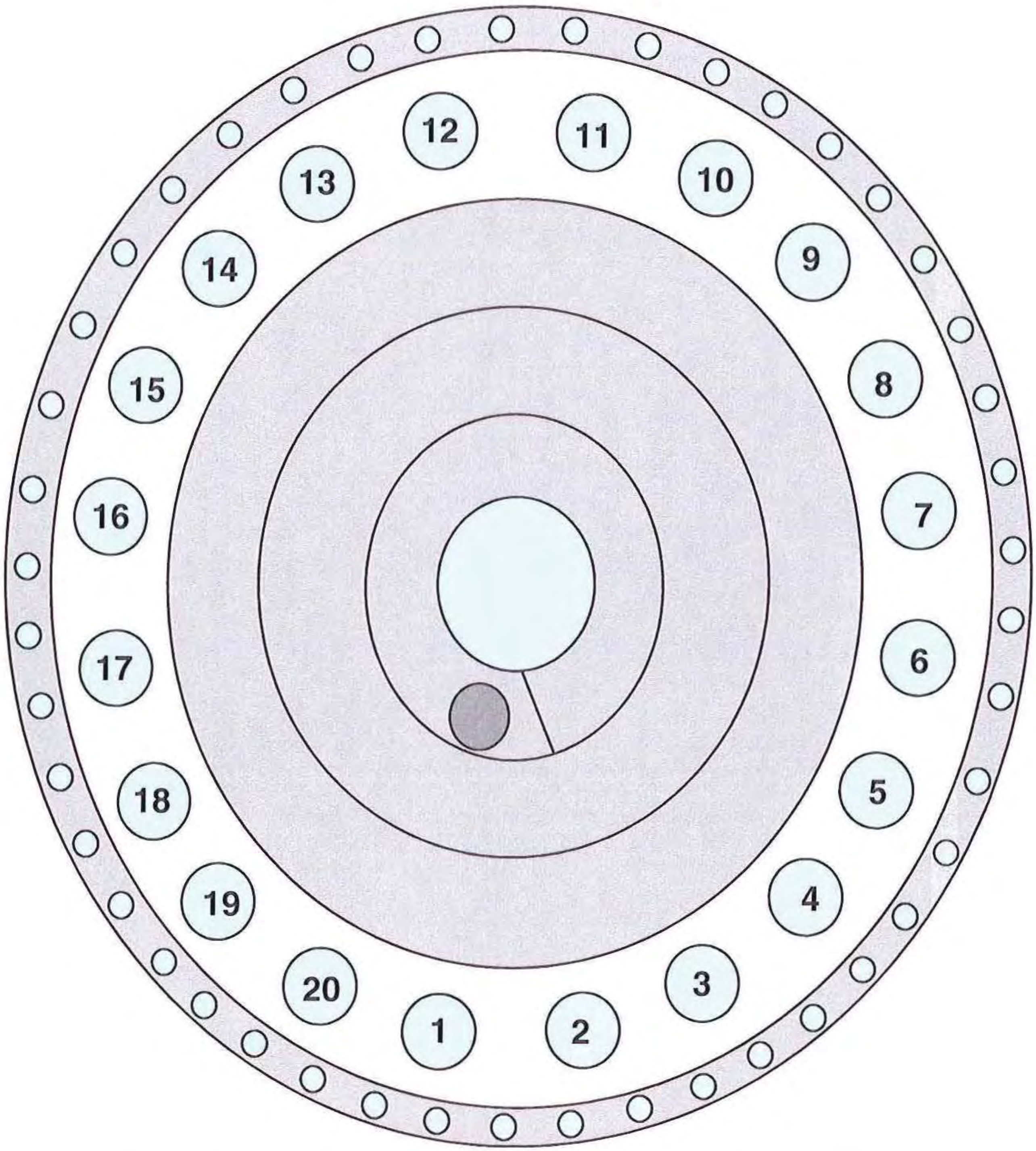
T⁻⁻CHNICIAN	Certified	Level	CUSTOMER'S REPRESENTATIVE
Name: T. ARSENEAU	CGSB	II	Date:
Signature:	Date: OCT 20/10		AUTHORIZED INSPECTOR
Reviewed By:	Date:		Date:

FFS-011.XLS REV 1

FLEETWAY FACILITY SERVICES

Fleetway Facility Services
45 Gifford Rd. P.O. Box 5250
Saint John, N.B., E2L 5C9
Tel:506-648-2226 Fax:506-648-3522

INSPECTION REPORT		REPORT No.:	441281001-001
PROJECT No.	CUSTOMER: NOVA SCOTIA POWER	PAGE	
441281001	LAYOUT VIEW OF CASTING	2 OF 6	



INSPECTOR	T. ARSENEAU	CUSTOMER'S REPRESENTATIVE	AUTHORIZED INSPECTOR
Date:	OCT 20/10	Name:	Name:
Signature:	[signature]	Signature:	Signature:

FFS-009A.XLS REV 0

FLEETWAY FACILITY SERVICES

Fleetway Facility Services
45 Gifford Rd. P.O. Box 5250
Saint John, N.B., E2L 5C9
Tel:506-648-2226 Fax:506-648-3522

INSPECTION REPORT		REPORT No.:	441281001-001
PROJECT No.	CUSTOMER NOVA SCOTIA POWER	PAGE	
441281001	PHOTOS OF 20 HOLES AROUND CIRCUMFERENCE OF CASTING	3 OF 6	

HOLE #1 WITH 7" AND 2" LINEAR INDICATION AROUND HOLE

HOLE #2 WITH 8" LINEAR INDICATION AROUND HOLE

HOLE #3 WITH 5" LINEAR INDICATION AROUND HOLE

HOLE #4 WITH 7", 1", 2" & 4" LINEAR INDICATION AROUND HOLE

HOLE #5 WITH 5" LINEAR INDICATION AROUND HOLE

HOLE #6 WITH 2" LINEAR INDICATION AROUND HOLE

INSPECTOR	T. ARSENEAU	CUSTOMER'S REPRESENTATIVE	AUTHORIZED INSPECTOR
Date:	OCT 20/10	Name:	Name:
Signature:		Signature:	Signature:

FFS-008A.XLS REV 0

FLEETWAY FACILITY SERVICES

Fleetway Facility Services
45 Gifford Rd. P.O. Box 5250
Saint John, N.B., E2L 5C9
Tel:506-648-2226 Fax:506-648-3522

INSPECTION REPORT		REPORT No.:	441281001-001
PROJECT No.	CUSTOMER NOVA SCOTIA POWER	PAGE	
441281001	PHOTOS OF 20 HOLES AROUND CIRCUMFERENCE OF CASTING	4 OF 6	

HOLE #7 WITH LINEAR INDICATION 90% AROUND HOLE

HOLE #8 WITH LINEAR INDICATION 90% AROUND HOLE

HOLE #9 WITH LINEAR INDICATION 90% AROUND HOLE

HOLE #10 WITH LINEAR INDICATION 60% AROUND HOLE

HOLE #11 WITH 5" & 2" LINEAR INDICATION AROUND HOLE

HOLE #12 WITH 4" LINEAR INDICATION AROUND HOLE

INSPECTOR	T.ARSENEAU	CUSTOMER'S REPRESENTATIVE	AUTHORIZED INSPECTOR
Date:	OCT 20/10	Name:	Name:
Signature:		Signature:	Signature:

FFS-008A.XLS REV 0

FLEETWAY FACILITY SERVICES

Fleetway Facility Services
45 Gifford Rd. P.O. Box 5250
Saint John, N.B., E2L 5C9
Tel:506-648-2226 Fax:506-648-3522

INSPECTION REPORT		REPORT No.:	441281001-001
PROJECT No.	CUSTOMER NOVA SCOTIA POWER	PAGE	
441281001	PHOTOS OF 20 HOLES AROUND CIRCUMFERENCE OF CASTING	5 OF 6	

HOLE #13 WITH NO INDICATIONS

HOLE #14 WITH NO INDICATIONS

HOLE #15 WITH LINEAR INDICATION 60% AROUND HOLE

HOLE #16 WITH ½" & 1" LINEAR INDICATION AROUND HOLE

HOLE #17 WITH 6" & 3" LINEAR INDICATION AROUND HOLE

HOLE #18 WITH 3" LINEAR INDICATION AROUND HOLE

INSPECTOR	T.ARSENEAU	CUSTOMER'S REPRESENTATIVE	AUTHORIZED INSPECTOR
Date:	OCT 20/10	Name:	Name:
Signature:		Signature:	Signature:

FLEETWAY
FACILITY SERVICES

Fleetway Facility Services
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INSPECTION REPORT		REPORT No.:	441281001-001
PROJECT No.	CUSTOMER NOVA SCOTIA POWER	PAGE	
441281001	PHOTOS OF 20 HOLES AROUND CIRCUMFERENCE OF CASTING	6 OF 6	

HOLE #19 WITH 5" LINEAR INDICATION AROUND HOLE

HOLE #19 WITH 9" & 4" LINEAR INDICATION AROUND HOLE

INSPECTOR	T.ARSENEAU	CUSTOMER'S REPRESENTATIVE	AUTHORIZED INSPECTOR
Date:	OCT 20/10	Name:	Name:
Signature:		Signature:	Signature:

Belzona® 1311
(CERAMIC R-METAL)

BELZONA®

INSTRUCTIONS FOR USE

1. TO ENSURE AN EFFECTIVE MOLECULAR WELD

APPLY ONLY TO BLAST CLEANED SURFACES

a) Brush away loose contamination and degrease with a rag soaked in **Belzona® 9111** (Cleaner/Degreaser) or any other effective cleaner which does not leave a residue e.g. methyl ethyl ketone (MEK).

b) Select an abrasive to give the necessary standard of cleanliness and a minimum depth of profile of 3 mils (75 microns).

Use only an angular abrasive.

c) Blast clean the metal surface to achieve the following standard of cleanliness:
ISO 8501-1 Sa 2½ very thorough blast cleaning
American Standard near white finish SSPC SP 10
Swedish Standard Sa 2½ SIS 05 5900

d) After blasting, metal surfaces should be coated before any oxidation of the surface takes place.

SALT CONTAMINATED SURFACES

Metal surfaces that have been immersed for any periods in salt solutions e.g. sea water, should be blasted to the required standard, left 24 hours to allow any ingrained salts to sweat to the surface and then washed prior to a further brush blast to remove these. This process may need to be repeated to ensure complete removal of salts. The soluble salt contamination of the prepared substrate, immediately prior to application, should be less than 20mgs/m².

WHERE BELZONA® 1311 SHOULD NOT ADHERE

Brush on a thin layer of **Belzona® 9411** (Release Agent) and allow to dry for 15-20 minutes before proceeding to step 2.

2. COMBINING THE REACTIVE COMPONENTS

Transfer the entire contents of the Base and Solidifier modules on to the Belzona® Working Surface.

Mix thoroughly together to achieve a uniform material free of any streakiness.

1. MIXING AT LOW TEMPERATURES

To ease mixing when the material temperature is below 41°F (5°C), warm the Base and Solidifier modules until the contents attain a temperature of 68-77°F (20-25°C).

2. WORKING LIFE

From the commencement of mixing, **Belzona® 1311** must be used within the times shown below.

Temperature	41°F (5°C)	59°F (15°C)	77°F (25°C)
Use all material within	35 min.	25 min.	15 min.

3. MIXING SMALL QUANTITIES

For mixing small quantities of **Belzona® 1311** use:
3 parts Base to 1 part Solidifier by volume
5 parts Base to 1 part Solidifier by weight

4. VOLUME CAPACITY OF MIXED BELZONA® 1311

25.2 cu.in. (413 cm³) per kg.

3. APPLYING BELZONA® 1311

FOR BEST RESULTS
Do not apply when:

i) The temperature is below 41°F (5°C) or the relative humidity is above 90%.
ii) Rain, snow, fog or mist is present.
iii) There is moisture on the metal surface or is likely to be deposited by subsequent condensation.
iv) The working environment is likely to be contaminated by oil/grease from adjacent equipment or smoke from kerosene heaters or tobacco smoking.

a) Apply the **Belzona® 1311** directly on to the prepared surface with the plastic applicator or spatula provided.

b) Press down firmly to fill all cracks, remove entrapped air, and ensure maximum contact with the surface.

c) Contour the **Belzona® 1311** to the correct profile with the plastic applicator.

CLEANING
Mixing tools should be cleaned immediately after use with **Belzona® 9111** or any other effective solvent e.g. Methyl ethly ketone (MEK). Brushes, injection guns, spray equipment and any other application tools should be cleaned using a suitable solvent such as **Belzona® 9121**, MEK, acetone or cellulose thinners.

4. COMPLETION OF THE MOLECULAR REACTION

Allow **Belzona® 1311** to solidify as below subjecting it to the conditions indicated.

Temperature	Movement or use involving no loading or immersion	Machining and/or light loading	Full mechanical or thermal loading	Immersion in chemicals
41°F/ 5°C	4 hours	6 hours	4 days	5 days
50°F/10°C	3 hours	4 hours	2 days	4 days
59°F/15°C	2½ hours	3 hours	1½ days	3 days
68°F/20°C	1¾ hours	2 hours	1 day	2 days
77°F/25°C	1 hour	1½ hours	20 hours	1½ days
86°F/30°C	¾ hour	1 hour	16 hours	1 day

These times are for a thickness of approximately 0.25 inch (6 mm); they will be reduced for thicker sections and extended for thinner sections.

5. MACHINING OF SOLIDIFIED BELZONA® 1311

Belzona® 1311 is extremely difficult to machine down by turning, using conventional or carbide tipped tools. However, it can be machined using diamond tipped tool.

Alternatively it can be machined by grinding, but this should be carried out as soon as possible after the Solidified times shown.

6. APPLICATION OF A FURTHER LAYER OF BELZONA® 1311

Where this is required it should be applied as soon as possible after the first layer and certainly while the first layer is still soft (less than 2 hours at 68°F (20°C).

If the above overcoating time is exceeded the surface of **Belzona® 1311** must be roughened by abrading or flash blasting before applying further **Belzona® 1311**.

HEALTH & SAFETY INFORMATION
Please read and make sure you understand the relevant Material Safety Data Sheets.

The technical data contained herein is based on the results of long term tests carried out in our laboratories and to the best of our knowledge is true and accurate on the date of publication. It is however subject to change without prior notice and the user should contact Belzona to verify the technical data is correct before specifying or ordering. No guarantee of accuracy is given or implied. We assume no responsibility for rates of coverage, performance or injury resulting from use. Liability, if any, is limited to the replacement of products. No other warranty or guarantee of any kind is made by Belzona, express or implied, whether statutory, by operation of law or otherwise, including merchantability or fitness for a particular purpose.

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ISO 9001:2000
Q 09335

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Printed in England Publication No. 10-2-07

FLEETWAY FACILITY SERVICES

IRVING

MACHINE SHOP INSPECTION REPORT		REPORT NUMBER: 7491 - 2
. CUSTOMER NS POWER	DISCRIPTION. Weymouth #1 Head cover	
WORK ORDER No. 441281001	ST No.	CUSTOMER DWN No. 520-138 F

OUTSIDE & INSIDE DIAMETER BANDED & BELZONA APPLIED

INSPECTED BY:		DATE:
Graham Tugwell	FFS 3 QA	October 22, 2010

Form FFS-01

FLEETWAY FACILITY SERVICES

IRVING

MACHINE SHOP INSPECTION REPORT		REPORT NUMBER: 7491 - 3
. CUSTOMER NS POWER	DISCRIPTION. Weymouth #1 Head cover	
WORK ORDER No. 441281001	ST No.	CUSTOMER DWN No. 520-138 F

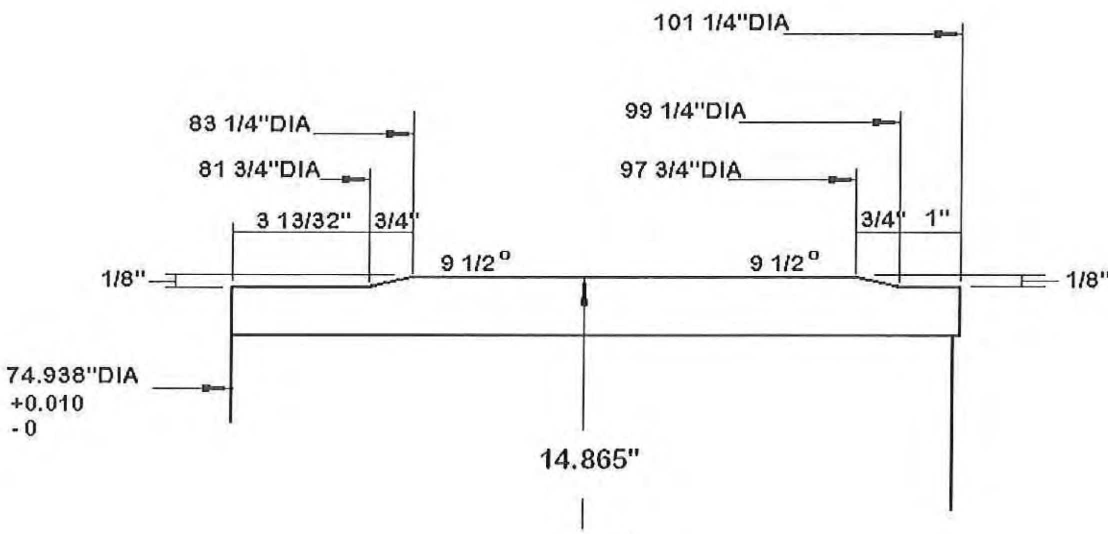



FIG 1

BELZONA ON TOP SURFACE WAS MACHINED AS PER FIG 1
HEIGHT 14.865" – ACTUAL MACHINED DIMENSION WAS 14.865" / 14.871"
ANGLES & STEPS AS PER FIG 1
NO MACHINING WAS REQUIRED ON THE INSIDE DIAMETER AS IT WAS OVERSIZE & MEARURED 74.958" / 74.965"

INSPECTED BY: Graham Tugwell	FFS 3 QA	DATE: October 28, 2010

Form FFS-01

CI Number: 20571

Title: **HYD - Weymouth Falls Tailrace Deck Refurbishment**

Start Date: 2013/03
Final Cost Date: 2014/01
Function: Generation
Forecast Amount: $371,469

DESCRIPTION:

The concrete tailrace deck at the Weymouth Generating Station is in poor physical condition. The steel tailrace gates and their supporting structure are corroding. This project consists of refurbishment of the tailrace deck, and refurbishment and re-coating of the steel tailrace gates and their steel support structures.

Summary of Related CIs +/- 2 years:
2013 CI 17581 - HYD Weymouth Electrical Replacement $1,641,359
2013 CI 40308 - HYD Weymouth Falls Pipeline Replacement $6,752,759
2013 CI 43039 - HYD Weymouth Surge Tank $2,738,175
2013 CI 43136 - HYD Weymouth Headcover Replacement $438,158

JUSTIFICATION:

Justification Criteria: Health & Safety

Sub Criteria: Maintenance

Why do this project?

To permit regular inspection and maintenance of the Weymouth Falls Unit 1 and Unit 2 turbines and draft tubes, it is necessary to de-water the draft tubes. This is accomplished by installing tailrace gates and pumping the draft tubes dry. In order to carry out that work, crews must have safe access to and a safe work environment at the tailrace deck. The current deck has suffered considerable degradation. NS Power operational staff, through general inspection, has found that some edges are spalled and may no longer adequately support safety guardrails. The concrete supporting sub-structure is also showing signs of degradation and requires repairs. In addition, the tailrace gates and their steel support structure require refurbishment and re-coating to ensure their long term reliability.

Why do this project now?

The concrete tailrace deck requires refurbishment to preserve and maintain its structural integrity and safe work conditions. The concrete sub-structure requires reconstruction to ensure the deck has adequate support and the tailrace gates can be properly installed when the units are de-watered. The tailrace gates and their steel support structure are corroding, and the rate of corrosion is expected to increase as the remnants of the existing coating system are lost.

Why do this project this way?

Restoration and reconstruction of the existing concrete is much more cost-effective than replacement. Similarly, the structural steel components such as gates and support structures can also be refurbished and re-coated as opposed to more expensive replacement. No other options could be identified for returning these items to an acceptable condition.

CI Number : 20571 - HYD - Weymouth Falls Tailrace Deck Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 411 - 411-Sissiboo/Weymouth System **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		2,940	0	2,940
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
095		095-Hydro Overtime Labour AO		194	0	194
095		095-Hydro Regular Labour AO		620	0	620
095		095-Hydro Term Labour AO		[redacted]	0	[redacted]
001	003	001 - HYDRO Regular Labour	003 - HGP - Bldg.,Struct.Grnd.	3,200	0	3,200
002	003	002 - HYDRO Overtime Labour	003 - HGP - Bldg.,Struct.Grnd.	2,000	0	2,000
004	003	004 - HYDRO Term Labour	003 - HGP - Bldg.,Struct.Grnd.	2,000	0	2,000
011	003	011 - Travel Expense	003 - HGP - Bldg.,Struct.Grnd.	2,000	0	2,000
012	003	012 - Materials	003 - HGP - Bldg.,Struct.Grnd.	10,000	0	10,000
013	003	013 - POWER PRODUCTION Contracts	003 - HGP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
028	003	028 - Consulting	003 - HGP - Bldg.,Struct.Grnd.	105,403	0	105,403
041	003	041 - Meals & Entertainment	003 - HGP - Bldg.,Struct.Grnd.	1,250	0	1,250
066	003	066 - Other Goods & Services	003 - HGP - Bldg.,Struct.Grnd.	2,000	0	2,000
			Total Cost:	371,469	0	371,469
			Original Cost:	46,499		

Capital Project Detailed Estimate

Location: Hydro
FP#: 20571
Title: HYD - Weymouth Falls Tailrace Deck

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Site Support	hr	[redacted]		$ 3,200.00		
1.2		hr			$ -		
				Sub-Total	$ 3,200.00		
2	**012 Materials**						
2.1	Miscellaneous	lot	1	$ 10,000.00	$ 10,000.00		
2.2					$ -		
				Sub-Total	$ 10,000.00		
3	**013 Power Production Contracts**						
3.1	Tailrace Refurbishment	lot	1	[redacted]			17618
3.2	Contingency on Refurbishment	%	[redacted]				
				Sub-Total	[redacted]		
4	**002 Overtime Labour**						
4.1	Site Support	hr	[redacted]		$ 2,000.00		
4.2					$ -		
				Sub-Total	$ 2,000.00		
5	**004 Term Labour**						
5.1	Site Support	hr	[redacted]		$ 2,000.00		
5.2					$ -		
				Sub-Total	$ 2,000.00		
6	**011 Travel Expenses**						
6.1	Travel to site	lot	1	$ 2,000.00	$ 2,000.00		
6.2					$ -		
				Sub-Total	$ 2,000.00		
7	**028 Consulting**						
7.1	Project Management	lot	1	[redacted]			
7.2	Design	lot	1				17618
7.3	Contingency on Design	%	[redacted]				
7.4	Site Supervision	month	2	[redacted]			
				Sub-Total	$ 105,402.64		
8	**041 Meals and Entertainment**						
8.1	Meals	lot	1	$ 1,250.00	$ 1,250.00		
8.2					$ -		
				Sub-Total	$ 1,250.00		
9	**066- Other Goods and Services**						
9.1	Other Goods and Services	lot	1	$ 2,000.00	$ 2,000.00		
9.2					$ -		
				Sub-Total	$ 2,000.00		
9	**094 Interest Capitalized**						
9.1	Interest Capitalized	lot	1	$ 2,939.58	$ 2,939.58		
9.2					$ -		
				Sub-Total	$ 2,939.58		
10	**095 Administrative Overhead**						
10.1	Hydro Regular Labour AO	lot	1	$ 619.52	$ 619.52		
10.2	Hydro OT Labour AO	lot	1	$ 193.60	$ 193.60		
10.3	Hydro Term Labour AO	lot	1	[redacted]			
10.4	Thermal & Hydro Contracts AO	lot	1				
				Sub-Total	$ 28,299.65		
Cost Estimate				**Total**	$ 371,469.07		
11	**Original Cost**						
11.1					$ 46,499.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 31246

Title: **HYD – Methals Intake Replacement**

Start Date: 2012/07
Final Cost Date: 2014/02
Function: Generation
Forecast Amount: $6,622,092

DESCRIPTION:

This item covers the replacement of the intake structure, the steel penstock and the headgate and associated hoist at the Methals development.

The Penstock and Intake are expected to have a life of approximately 50 years.

The headgate expected life is 40 years.

The depreciation class for the project is Black River.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015

JUSTIFICATION:

Justification Criteria: Health & Safety

Sub Criteria: Equipment Replacement

Why do this project?

The intake structure is in poor condition with leakage through the downstream concrete walls. This condition raises concerns about the structural integrity of the intake. In addition, the headgate cannot be considered to reliably close under full flow, and the steel penstock is damaged and requires replacement. NS Power personnel have been maintaining the wicket gates in good working condition to mitigate some of the risk associated with the headgate. The condition of the penstock and concrete structure is monitored regularly.

Why do this project now?

The concrete in the intake structure has deteriorated to the point where repairs are not considered a viable option. The headgate and hoist must be replaced to ensure the headgate can close under full flow, to protect the plant in the event of an emergency situation. The integrity of the steel penstock is compromised at the existing damaged locations.

Why do this project this way?

This structure has not been upgraded since its original construction in 1948. Replacement of such structures in this condition and of this vintage is the most economical path forward.

CI Number : 31246-H662 - HYD Methals Intake Replacement **Project Number** H662

Parent CI Number : -

Cost Centre : 460 - 460-Black River Hydro System **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		100,558	0	100,558
095		095-Hydro Term Labour AO		[redacted]	0	[redacted]
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
095		095-Hydro Regular Labour AO		3,125	0	3,125
095		095-Hydro Overtime Labour AO		1,549	0	1,549
001	007	001 - HYDRO Regular Labour	007 - HGP - Environmental	2,800	0	2,800
001	027	001 - HYDRO Regular Labour	027 - HGP - Waterways	13,440	0	13,440
002	027	002 - HYDRO Overtime Labour	027 - HGP - Waterways	16,000	0	16,000
004	027	004 - HYDRO Term Labour	027 - HGP - Waterways	28,800	0	28,800
011	027	011 - Travel Expense	027 - HGP - Waterways	22,250	0	22,250
012	027	012 - Materials	027 - HGP - Waterways	[redacted]	0	[redacted]
013	027	013 - POWER PRODUCTION Contracts	027 - HGP - Waterways	[redacted]	0	[redacted]
028	027	028 - Consulting	027 - HGP - Waterways	174,890	0	174,890
041	027	041 - Meals & Entertainment	027 - HGP - Waterways	5,000	0	5,000
066	027	066 - Other Goods & Services	027 - HGP - Waterways	800	0	800
			Total Cost:	6,622,092	0	6,622,092
			Original Cost:	647,017		

Location: Hydro
FP#: 31246
Title: HYD - Methals Intake Replacement

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Management	hr	[redacted]	[redacted]	$ 13,440.00		
1.2	Environmental Staff Support	hr	[redacted]	[redacted]	$ 2,800.00		
1.3		hr			$ -		
				Sub-Total	$ 16,240.00		
2	**012 Materials**						
2.1	Meterials during construction	lot	1	[redacted]	[redacted]	Cost Support 1	
2.2	Contingency	%	[redacted]	[redacted]	[redacted]		
2.3					$ -		
				Sub-Total	[redacted]		
3	**013 Power Production Contracts**						
3.1	Construction	lot	1	[redacted]	[redacted]	Cost Support 1	
3.2	Contingency	%	[redacted]	[redacted]	[redacted]		
3.3					$ -		
				Sub-Total	[redacted]		
4	**002 Overtime Labour**						
4.1	Site Supervision	hr	[redacted]	[redacted]	$ 16,000.00		
4.2					$ -		
				Sub-Total	$ 16,000.00		
5	**004 Term Labour**						
5.1	Site Supervision	hr	[redacted]	[redacted]	$ 28,800.00		
5.2					$ -		
				Sub-Total	$ 28,800.00		
6	**011 Travel Expenses**						
6.1	Travel to site during construction	lot	1	$ 22,250.00	$ 22,250.00		
6.2					$ -		
				Sub-Total	$ 22,250.00		
7	**028 Consulting**						
7.1	Design - Phase 1	lot	1	[redacted]	[redacted]	Cost Support 2	
7.2	Design - Phase 2	lot	1	[redacted]	[redacted]	Cost Support 2 p.9	
7.3	Archaeology	lot	1	$ 10,000.00	$ 10,000.00		
				Sub-Total	$ 174,890.00		
8	**041 Meals and Entertainment**						
8.1	Meals during travel	lot	1	$ 5,000.00	$ 5,000.00		
8.2					$ -		
				Sub-Total	$ 5,000.00		
9	**066- Other Goods and Services**						
9.1	Other Goods and Services	lot	1	$ 800.00	$ 800.00		
9.2					$ -		
				Sub-Total	$ 800.00		
10	**094 Interest Capitalized**						
10.1	Interest Capitalized	lot	1	$ 100,558.36	$ 100,558.36		
10.2					$ -		
				Sub-Total	$ 100,558.36		
11	**095 Administrative Overhead**						
11.1	Hydro Regular Labour AO	lot	1	$ 3,125.02	$ 3,125.02		
11.2	Hydro OT Labour AO	lot	1	$ 1,548.80	$ 1,548.80		
11.3	Hydro Term Labour AO	lot	1	[redacted]	[redacted]		
11.4	Thermal & Hydro Contracts AO	lot	1	[redacted]	[redacted]		
				Sub-Total	[redacted]		
Cost Estimate				**Total**	$ 6,622,091.59		
12	**Original Cost**						
12.1					$ 647,017.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 & 2

Removed due to confidentiality

CI Number: 20758

Title: **HYD - Nictaux Pipeline and Intake**

Start Date: 2012/05
Final Cost Date: 2014/03
Function: Generation
Forecast Amount: $4,379,301

DESCRIPTION:

The woodstave pipeline at the Nictaux Generating Station has deteriorated to the point where it is no longer considered reliable. The steel bands are in poor condition, and the woodstaves show areas of crushing, displacement and decay. The headgate at the intake structure is not considered reliable to close under full flow. This item consists of replacing the woodstave pipeline, re-coating the steel pipeline, and refurbishing the intake structure including the installation of a new headgate and associated hoist at the Nictaux development.

The new pipeline is expected to have a life of at least 60 years. The headgate is expected to last approximately 40 years, and the re-coated steel pipe 50 years.

The project depreciation class is the Lequille System.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015

JUSTIFICATION:

Justification Criteria: HYDRO

Sub Criteria: Equipment Replacement

Why do this project?

The pipeline (woodstave and steel) for Nictaux Generating Station was constructed in 1954. The woodstave section of pipeline is in poor physical condition. Based on its deteriorated condition, water-tightness, and age, the woodstave pipeline is reaching the end of its useful life and needs to be replaced to ensure its reliability. The coating on the steel pipeline is deteriorating, and it needs to be re-coated to ensure its long-term service. The headgate at the intake structure cannot be considered reliable to close under full flow to protect the plant in an emergency situation.

Why do this project now?

The strength of woodstave pipe comes from the banding hardware. Failure of one band can cause the pipe to rupture because the unbanded wood must span a greater distance, and the stresses in the wood fibres are greatly increased. The pipeline has already experienced localized failures due to banding failure, as well as the condition of the wood. The life of the pipe can no longer be extended by patching and addition of bands. The pipeline forms an integral part of the Nictaux Generating Station. A loss of this pipeline would result in an extended outage of the plant.

The buried steel pipeline has not been coated since its original construction, and is corroding and needs to be re-coated to ensure its long-term service. The rate of corrosion is expected to increase as the remnants of the original coating system are lost. Continued unchecked, this could compromise the structural integrity of the steel pipeline.

The headgate and hoist must be replaced to ensure the headgate can close under full flow, to protect the plant in the event of an emergency situation.

Why do this project this way?

Replacement of aged woodstave pipelines, re-coating steel pipelines, and installing headgates capable of closing under full flow are necessary to keep the unit operational. Replacement of the woodstave pipe with FRP pipe is the most cost-efficient option. Re-coating of the steel pipeline is much more cost effective than full replacement. The headgate and hoist cannot be refurbished and must be replaced to remain in-service.

CI Number : 20758-H650 - HYD - Nictaux Pipeline Replacement & Intake Refurbishment **Project Number** H650

Parent CI Number : -

Cost Centre : 431 - 431-Nictaux/Paradise System **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		100,947	0	100,947
095		095-Hydro Overtime Labour AO		2,420	0	2,420
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
095		095-Hydro Regular Labour AO		3,230	0	3,230
095		095-Hydro Term Labour AO		[redacted]	0	[redacted]
001	027	001 - HYDRO Regular Labour	027 - HGP - Waterways	16,800	0	16,800
002	027	002 - HYDRO Overtime Labour	027 - HGP - Waterways	25,000	0	25,000
004	027	004 - HYDRO Term Labour	027 - HGP - Waterways	25,000	0	25,000
011	027	011 - Travel Expense	027 - HGP - Waterways	20,000	0	20,000
012	027	012 - Materials	027 - HGP - Waterways	[redacted]	0	[redacted]
013	027	013 - POWER PRODUCTION Contracts	027 - HGP - Waterways	[redacted]	0	[redacted]
028	027	028 - Consulting	027 - HGP - Waterways	200,300	0	200,300
041	027	041 - Meals & Entertainment	027 - HGP - Waterways	5,000	0	5,000
			Total Cost:	4,379,301	0	4,379,301
			Original Cost:	325,311		

HYD Nictaux Pipeline Replacement
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Hydro	**CI Number:**	20758
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Pipeline	6.48%	7,582,390	1	13.69%	14.6 years
B	Refurbish Pipeline	6.48%	-2,217,227	4	-6.38%	0.0 years
C	Decomission	6.48%	-1,600,404	3	-7.01%	0.0 years
D		6.48%	0	2	#NUM!	0.0 years

Recommendation :

It is recommended the woodstave pipeline be replaced, the steel pipeline be re-coated, and the intake structure be refurbished to include the installation of a new headgate and associated hoist.

Notes/Comments :

Replace Pipeline

This option considers replacing the pipeline and the intake in 2013.

Refurbish Pipeline

This option looks at refurbishing the pipeline and replacing the intake in 2013. This option assumes NS Power would have ongoing maintenance due to small failures, and that the refurbished woodstave pipeline would no longer function past 2022. Cost for replacing the intake is the same as in the "replace pipeline" option. Estimated cost for refurbishment was developed using recent costs for similar work.

Decomission

This option considers the decommissioning of the Nictaux generating station.

Test 4

HYD Nictaux Pipeline Replacement
Avoided Cost Calculations

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Hydro	**CI Number:**	20758
Originator :		**Project No. :**	

Replace Pipeline

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$5,100**	**$5,202**		
Events/Outages (#)	**1**	**1**	**1**	**1**		
Probability of Occurance (%)	**120%**	**140%**	**120%**	**140%**		
Capacity Factor (%)	**100%**	**100%**				
Energy Replaced (MW)	[redacted]					
Duration (Hours)	**72**	**72**				
Totals	**$18,705**	**$21,879**	**$6,120**	**$7,283**	**$24,825**	**$29,162**
Total Capital Cost of Alternative						**$4,755,532**

Refurbish Pipeline

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$5,100**	**$5,202**		
Events/Outages (#)	**1**	**1**	**1**	**1**		
Probability of Occurance (%)	**120%**	**140%**	**120%**	**140%**		
Capacity Factor (%)	**100%**	**100%**				
Energy Replaced (MW)	[redacted]					
Duration (Hours)	**72**	**72**				
Totals	**$18,705**	**$21,879**	**$6,120**	**$7,283**	**$24,825**	**$29,162**
Total Capital Cost of Alternative						**$3,200,471**

Decomission

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	**100%**	**100%**				
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$1,936,743**

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$5,100**	**$5,202**		
Events/Outages (#)	**1**	**1**	**1**	**1**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	**100%**	**100%**				
Energy Replaced (MW)	**5**	**5**				
Duration (Hours)	**72**	**72**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

HYD Nictaux Pipeline Replacement
Replace Pipeline

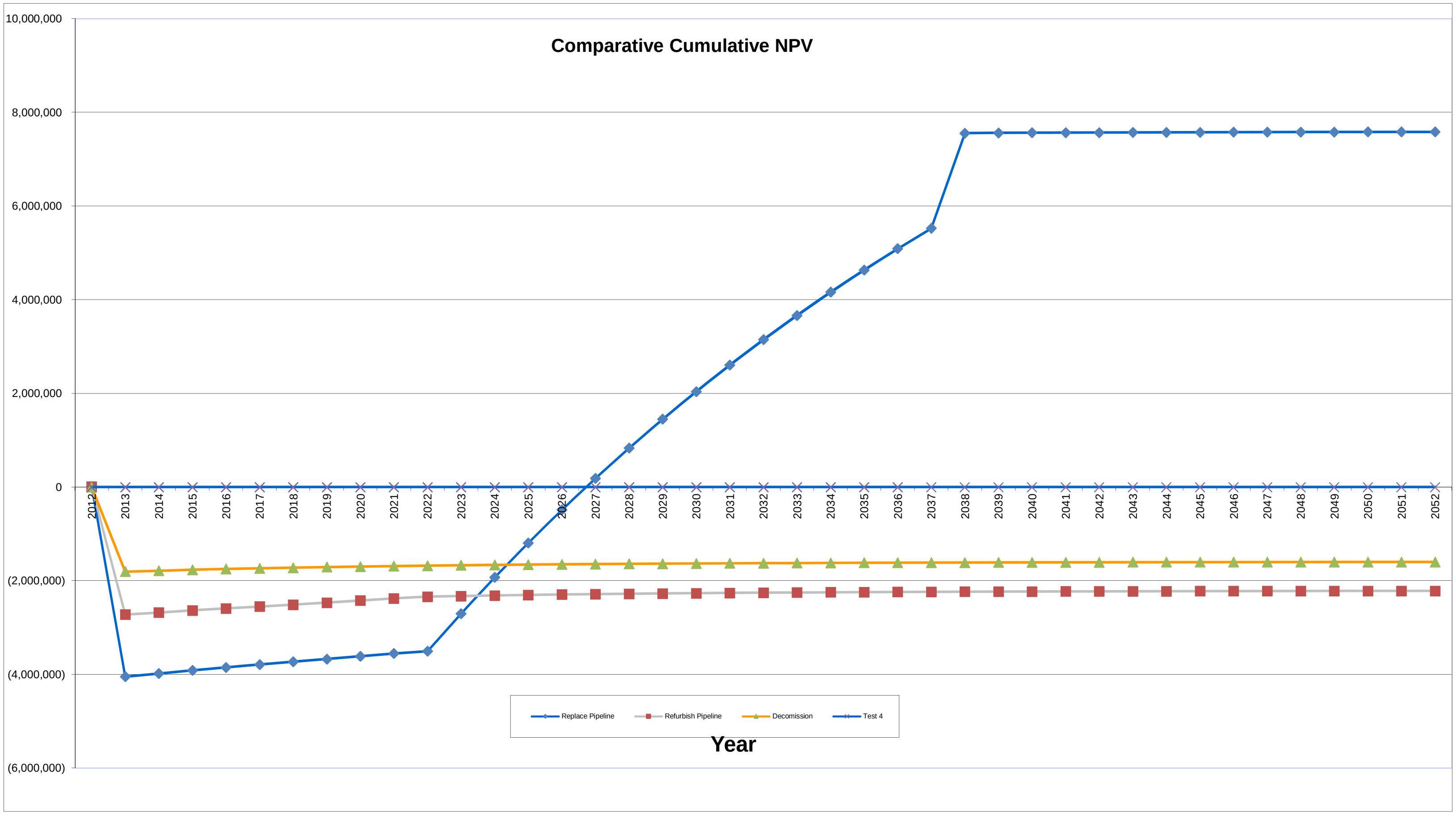
Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	20,998.9	(7,600.0)	-	-	13,398.9	(6,509.6)	6,889.2	6,889.214	1.0	6,889.2
2013	-	24,825.3	(4,365,363.0)	96,207.6	4,358,588.1	(4,340,537.7)	22,128.5	(4,318,409.2)	(4,055,605.922)	0.9	(4,048,716.7)
2014	-	29,162.3	-	188,002.7	4,170,585.5	29,162.3	49,240.5	78,402.8	69,150.533	0.9	(3,979,566.2)
2015	-	36,119.6	-	179,399.2	3,991,186.2	36,119.6	44,416.7	80,536.3	66,709.457	0.8	(3,912,856.7)
2016	-	41,176.3	-	171,226.2	3,819,960.0	41,176.3	40,315.5	81,491.8	63,393.051	0.8	(3,849,463.7)
2017	-	44,210.4	-	163,459.5	3,656,500.5	44,210.4	36,967.2	81,177.6	59,305.630	0.7	(3,790,158.0)
2018	-	54,113.5	-	156,076.5	3,500,424.1	54,113.5	31,608.5	85,722.0	58,814.452	0.7	(3,731,343.6)
2019	-	64,395.0	-	149,056.0	3,351,368.1	64,395.0	26,244.9	90,639.9	58,404.090	0.6	(3,672,939.5)
2020	-	79,757.9	-	142,378.2	3,208,989.9	79,757.9	19,412.3	99,170.2	60,011.797	0.6	(3,612,927.7)
2021	-	90,924.0	-	136,024.4	3,072,965.6	90,924.0	13,981.1	104,905.1	59,618.929	0.6	(3,553,308.8)
2022	-	73,217.7	-	129,977.1	2,942,988.4	73,217.7	17,595.4	90,813.1	48,469.465	0.5	(3,504,839.3)
2023	-	2,272,386.8	-	124,220.0	2,818,768.5	2,272,386.8	(665,931.7)	1,606,455.1	805,230.305	0.5	(2,699,609.0)
2024	-	2,317,834.5	-	118,737.5	2,700,031.0	2,317,834.5	(681,720.1)	1,636,114.4	770,188.732	0.5	(1,929,420.3)
2025	-	2,364,191.2	-	113,515.1	2,586,516.0	2,364,191.2	(697,709.6)	1,666,481.6	736,742.914	0.4	(1,192,677.4)
2026	-	2,411,475.0	-	108,539.2	2,477,976.8	2,411,475.0	(713,910.1)	1,697,564.9	704,812.812	0.4	(487,864.5)
2027	-	2,459,704.5	-	103,796.8	2,374,180.0	2,459,704.5	(730,331.4)	1,729,373.1	674,323.150	0.4	186,458.6
2028	-	2,508,898.6	-	99,276.0	2,274,903.9	2,508,898.6	(746,983.0)	1,761,915.6	645,203.066	0.4	831,661.7
2029	-	2,559,076.6	-	94,965.4	2,179,938.5	2,559,076.6	(763,874.5)	1,795,202.1	617,385.783	0.3	1,449,047.5
2030	-	2,610,258.1	-	90,854.1	2,089,084.5	2,610,258.1	(781,015.2)	1,829,242.8	590,808.319	0.3	2,039,855.8
2031	-	2,662,463.3	-	86,932.0	2,002,152.4	2,662,463.3	(798,414.7)	1,864,048.6	565,411.216	0.3	2,605,267.0
2032	-	2,715,712.5	-	83,189.7	1,918,962.7	2,715,712.5	(816,082.1)	1,899,630.4	541,138.300	0.3	3,146,405.3
2033	-	2,770,026.8	-	79,618.1	1,839,344.7	2,770,026.8	(834,026.7)	1,936,000.1	517,936.453	0.3	3,664,341.7
2034	-	2,825,427.3	-	76,208.6	1,763,136.0	2,825,427.3	(852,257.8)	1,973,169.5	495,755.413	0.3	4,160,097.2
2035	-	2,881,935.9	-	72,953.4	1,690,182.6	2,881,935.9	(870,784.6)	2,011,151.3	474,547.584	0.2	4,634,644.7
2036	-	2,939,574.6	-	69,844.8	1,620,337.9	2,939,574.6	(889,616.2)	2,049,958.3	454,267.863	0.2	5,088,912.6
2037	-	2,998,366.1	-	66,875.5	1,553,462.3	2,998,366.1	(908,762.1)	2,089,604.0	434,873.485	0.2	5,523,786.1
2038	-	15,036,805.8	-	64,039.0	1,489,423.4	15,036,805.8	(4,641,557.7)	10,395,248.1	2,031,728.883	0.2	7,555,515.0
2039	-	-	-	61,328.6	1,428,094.8	-	19,011.9	19,011.9	3,489.697	0.2	7,559,004.7
2040	-	-	-	58,738.5	1,369,356.3	-	18,208.9	18,208.9	3,138.912	0.2	7,562,143.6
2041	-	-	-	56,262.7	1,313,093.6	-	17,441.4	17,441.4	2,823.640	0.2	7,564,967.2
2042	-	-	-	53,896.0	1,259,197.6	-	16,707.8	16,707.8	2,540.253	0.2	7,567,507.5
2043	-	-	-	51,633.1	1,207,564.4	-	16,006.3	16,006.3	2,285.497	0.1	7,569,793.0
2044	-	-	-	49,469.2	1,158,095.3	-	15,335.4	15,335.4	2,056.455	0.1	7,571,849.4
2045	-	-	-	47,399.6	1,110,695.7	-	14,693.9	14,693.9	1,850.508	0.1	7,573,699.9
2046	-	-	-	45,419.9	1,065,275.7	-	14,080.2	14,080.2	1,665.309	0.1	7,575,365.2
2047	-	-	-	43,526.1	1,021,749.7	-	13,493.1	13,493.1	1,498.751	0.1	7,576,864.0
2048	-	-	-	41,714.0	980,035.6	-	12,931.3	12,931.3	1,348.945	0.1	7,578,212.9
2049	-	-	-	39,980.0	940,055.6	-	12,393.8	12,393.8	1,214.192	0.1	7,579,427.1
2050	-	-	-	38,320.5	901,735.1	-	11,879.4	11,879.4	1,092.969	0.1	7,580,520.1
2051	-	-	-	36,732.2	865,002.9	-	11,387.0	11,387.0	983.908	0.1	7,581,504.0
2052	-	-	-	35,211.7	829,791.2	-	10,915.6	10,915.6	885.782	0.1	7,582,389.8
Total	-	54,893,038.2	(4,372,963.0)	3,625,004.5	84,901,701.0	50,520,075.2	(15,893,090.4)	34,626,984.7	7,582,389.8		

HYD Nictaux Pipeline Replacement
Refurbish Pipeline

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	20,998.9	(7,600.0)	-	-	13,398.9	(6,509.6)	6,889.2	6,889.214	1.0	6,889.2
2013	-	24,825.3	(2,945,605.0)	67,227.9	3,006,094.7	(2,920,779.7)	13,144.8	(2,907,634.9)	(2,730,686.394)	0.9	(2,723,797.2)
2014	-	14,162.3	-	131,202.6	2,807,664.1	14,162.3	36,282.5	50,444.8	44,491.834	0.9	(2,679,305.3)
2015	-	21,119.6	-	124,871.3	2,682,792.8	21,119.6	32,163.0	53,282.6	44,134.827	0.8	(2,635,170.5)
2016	-	26,176.3	-	118,879.5	2,563,913.3	26,176.3	28,738.0	54,914.3	42,718.242	0.8	(2,592,452.3)
2017	-	29,210.4	-	113,206.8	2,450,706.5	29,210.4	26,038.9	55,249.3	40,363.257	0.7	(2,552,089.0)
2018	-	39,113.5	-	107,834.0	2,342,872.5	39,113.5	21,303.4	60,416.8	41,452.411	0.7	(2,510,636.6)
2019	-	49,395.0	-	102,743.4	2,240,129.1	49,395.0	16,538.0	65,933.0	42,484.128	0.6	(2,468,152.5)
2020	-	64,757.9	-	97,918.2	2,142,210.9	64,757.9	10,279.7	75,037.6	45,408.215	0.6	(2,422,744.3)
2021	-	75,924.0	-	93,343.0	2,048,867.9	75,924.0	5,399.9	81,323.9	46,217.411	0.6	(2,376,526.9)
2022	-	58,217.7	-	89,003.2	1,959,864.7	58,217.7	9,543.5	67,761.2	36,166.019	0.5	(2,340,360.8)
2023	-	-	-	84,885.1	1,874,979.6	-	26,314.4	26,314.4	13,190.005	0.5	(2,327,170.8)
2024	-	-	-	80,976.2	1,794,003.3	-	25,102.6	25,102.6	11,816.875	0.5	(2,315,354.0)
2025	-	-	-	77,264.5	1,716,738.9	-	23,952.0	23,952.0	10,589.047	0.4	(2,304,764.9)
2026	-	-	-	73,738.7	1,643,000.1	-	22,859.0	22,859.0	9,490.844	0.4	(2,295,274.1)
2027	-	-	-	70,388.6	1,572,611.5	-	21,820.5	21,820.5	8,508.316	0.4	(2,286,765.7)
2028	-	-	-	67,204.4	1,505,407.1	-	20,833.4	20,833.4	7,629.050	0.4	(2,279,136.7)
2029	-	-	-	64,176.7	1,441,230.4	-	19,894.8	19,894.8	6,841.993	0.3	(2,272,294.7)
2030	-	-	-	61,297.2	1,379,933.2	-	19,002.1	19,002.1	6,137.300	0.3	(2,266,157.4)
2031	-	-	-	58,557.6	1,321,375.6	-	18,152.9	18,152.9	5,506.202	0.3	(2,260,651.2)
2032	-	-	-	55,950.4	1,265,425.2	-	17,344.6	17,344.6	4,940.880	0.3	(2,255,710.3)
2033	-	-	-	53,468.6	1,211,956.6	-	16,575.3	16,575.3	4,434.364	0.3	(2,251,276.0)
2034	-	-	-	51,105.3	1,160,851.3	-	15,842.6	15,842.6	3,980.437	0.3	(2,247,295.5)
2035	-	-	-	48,854.4	1,111,996.9	-	15,144.9	15,144.9	3,573.554	0.2	(2,243,722.0)
2036	-	-	-	46,709.9	1,065,287.1	-	14,480.1	14,480.1	3,208.762	0.2	(2,240,513.2)
2037	-	-	-	44,666.2	1,020,620.8	-	13,846.5	13,846.5	2,881.642	0.2	(2,237,631.6)
2038	-	-	-	42,718.2	977,902.6	-	13,242.6	13,242.6	2,588.247	0.2	(2,235,043.3)
2039	-	-	-	40,860.9	937,041.7	-	12,666.9	12,666.9	2,325.051	0.2	(2,232,718.3)
2040	-	-	-	39,089.6	897,952.1	-	12,117.8	12,117.8	2,088.902	0.2	(2,230,629.4)
2041	-	-	-	37,400.0	860,552.1	-	11,594.0	11,594.0	1,876.983	0.2	(2,228,752.4)
2042	-	-	-	35,788.0	824,764.1	-	11,094.3	11,094.3	1,686.777	0.2	(2,227,065.6)
2043	-	-	-	34,249.6	790,514.5	-	10,617.4	10,617.4	1,516.029	0.1	(2,225,549.6)
2044	-	-	-	32,781.2	757,733.3	-	10,162.2	10,162.2	1,362.726	0.1	(2,224,186.9)
2045	-	-	-	31,379.3	726,354.1	-	9,727.6	9,727.6	1,225.064	0.1	(2,222,961.8)
2046	-	-	-	30,040.6	696,313.5	-	9,312.6	9,312.6	1,101.429	0.1	(2,221,860.4)
2047	-	-	-	28,762.0	667,551.5	-	8,916.2	8,916.2	990.375	0.1	(2,220,870.0)
2048	-	-	-	27,540.7	640,010.8	-	8,537.6	8,537.6	890.609	0.1	(2,219,979.4)
2049	-	-	-	26,373.8	613,637.0	-	8,175.9	8,175.9	800.971	0.1	(2,219,178.4)
2050	-	-	-	25,258.7	588,378.3	-	7,830.2	7,830.2	720.423	0.1	(2,218,458.0)
2051	-	-	-	24,193.0	564,185.3	-	7,499.8	7,499.8	648.033	0.1	(2,217,809.9)
2052	-	-	-	23,174.2	541,011.1	-	7,184.0	7,184.0	582.968	0.1	(2,217,227.0)
Total	-	423,900.8	(2,953,205.0)	2,465,083.6	56,414,436.0	(2,529,304.2)	632,766.7	(1,896,537.5)	(2,217,227.0)		

HYD Nictaux Pipeline Replacement
Decomission

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	-	(1,936,743.0)	38,734.9	1,936,743.0	(1,936,743.0)	12,007.8	(1,924,735.2)	(1,807,602.548)	0.9	(1,807,602.5)
2014	-	-	-	75,920.3	1,822,087.8	-	23,535.3	23,535.3	20,757.912	0.9	(1,786,844.6)
2015	-	-	-	72,883.5	1,749,204.3	-	22,593.9	22,593.9	18,714.872	0.8	(1,768,129.8)
2016	-	-	-	69,968.2	1,679,236.1	-	21,690.1	21,690.1	16,872.912	0.8	(1,751,256.9)
2017	-	-	-	67,169.4	1,612,066.7	-	20,822.5	20,822.5	15,212.243	0.7	(1,736,044.6)
2018	-	-	-	64,482.7	1,547,584.0	-	19,989.6	19,989.6	13,715.020	0.7	(1,722,329.6)
2019	-	-	-	61,903.4	1,485,680.7	-	19,190.0	19,190.0	12,365.157	0.6	(1,709,964.4)
2020	-	-	-	59,427.2	1,426,253.4	-	18,422.4	18,422.4	11,148.150	0.6	(1,698,816.3)
2021	-	-	-	57,050.1	1,369,203.3	-	17,685.5	17,685.5	10,050.924	0.6	(1,688,765.4)
2022	-	-	-	54,768.1	1,314,435.2	-	16,978.1	16,978.1	9,061.690	0.5	(1,679,703.7)
2023	-	-	-	52,577.4	1,261,857.8	-	16,299.0	16,299.0	8,169.818	0.5	(1,671,533.9)
2024	-	-	-	50,474.3	1,211,383.4	-	15,647.0	15,647.0	7,365.726	0.5	(1,664,168.1)
2025	-	-	-	48,455.3	1,162,928.1	-	15,021.2	15,021.2	6,640.775	0.4	(1,657,527.3)
2026	-	-	-	46,517.1	1,116,411.0	-	14,420.3	14,420.3	5,987.175	0.4	(1,651,540.2)
2027	-	-	-	44,656.4	1,071,754.5	-	13,843.5	13,843.5	5,397.904	0.4	(1,646,142.3)
2028	-	-	-	42,870.2	1,028,884.4	-	13,289.8	13,289.8	4,866.630	0.4	(1,641,275.6)
2029	-	-	-	41,155.4	987,729.0	-	12,758.2	12,758.2	4,387.645	0.3	(1,636,888.0)
2030	-	-	-	39,509.2	948,219.8	-	12,247.8	12,247.8	3,955.804	0.3	(1,632,932.2)
2031	-	-	-	37,928.8	910,291.0	-	11,757.9	11,757.9	3,566.465	0.3	(1,629,365.7)
2032	-	-	-	36,411.6	873,879.4	-	11,287.6	11,287.6	3,215.445	0.3	(1,626,150.3)
2033	-	-	-	34,955.2	838,924.2	-	10,836.1	10,836.1	2,898.974	0.3	(1,623,251.3)
2034	-	-	-	33,557.0	805,367.2	-	10,402.7	10,402.7	2,613.650	0.3	(1,620,637.7)
2035	-	-	-	32,214.7	773,152.6	-	9,986.6	9,986.6	2,356.409	0.2	(1,618,281.2)
2036	-	-	-	30,926.1	742,226.5	-	9,587.1	9,587.1	2,124.486	0.2	(1,616,156.8)
2037	-	-	-	29,689.1	712,537.4	-	9,203.6	9,203.6	1,915.389	0.2	(1,614,241.4)
2038	-	-	-	28,501.5	684,035.9	-	8,835.5	8,835.5	1,726.872	0.2	(1,612,514.5)
2039	-	-	-	27,361.4	656,674.5	-	8,482.0	8,482.0	1,556.910	0.2	(1,610,957.6)
2040	-	-	-	26,267.0	630,407.5	-	8,142.8	8,142.8	1,403.675	0.2	(1,609,553.9)
2041	-	-	-	25,216.3	605,191.2	-	7,817.1	7,817.1	1,265.522	0.2	(1,608,288.4)
2042	-	-	-	24,207.6	580,983.5	-	7,504.4	7,504.4	1,140.967	0.2	(1,607,147.4)
2043	-	-	-	23,239.3	557,744.2	-	7,204.2	7,204.2	1,028.670	0.1	(1,606,118.8)
2044	-	-	-	22,309.8	535,434.4	-	6,916.0	6,916.0	927.426	0.1	(1,605,191.3)
2045	-	-	-	21,417.4	514,017.1	-	6,639.4	6,639.4	836.147	0.1	(1,604,355.2)
2046	-	-	-	20,560.7	493,456.4	-	6,373.8	6,373.8	753.851	0.1	(1,603,601.3)
2047	-	-	-	19,738.3	473,718.1	-	6,118.9	6,118.9	679.656	0.1	(1,602,921.7)
2048	-	-	-	18,948.7	454,769.4	-	5,874.1	5,874.1	612.762	0.1	(1,602,308.9)
2049	-	-	-	18,190.8	436,578.6	-	5,639.1	5,639.1	552.453	0.1	(1,601,756.5)
2050	-	-	-	17,463.1	419,115.5	-	5,413.6	5,413.6	498.079	0.1	(1,601,258.4)
2051	-	-	-	16,764.6	402,350.9	-	5,197.0	5,197.0	449.057	0.1	(1,600,809.3)
2052	-	-	-	16,094.0	386,256.8	-	4,989.2	4,989.2	404.860	0.1	(1,600,404.5)
Total	-	-	(1,936,743.0)	1,550,486.2	38,218,774.7	(1,936,743.0)	480,650.7	(1,456,092.3)	(1,600,404.5)		


Comparative Cumulative NPV
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
(2,000,000)
(4,000,000)
(6,000,000)
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052
Replace Pipeline
Refurbish Pipeline
Decomission
Test 4
Year

Location: Hydro
FP#: 20758
Title: HYD - Nictaux Pipeline & Intake Replacement

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Environmental Staff support	hr	[redacted]		$ 3,360.00		
1.2	Project Management	hr			$ 13,440.00		
1.3		hr			$ -		
				Sub-Total	$ 16,800.00		
2	**012 Materials**						
2.1	Materials for construction	lot	1	[redacted]		Cost Support Item 1	
2.2	Contingency	%					
2.3							
				Sub-Total	[redacted]		
3	**013 Power Production Contracts**						
3.1	Intake Construction	lot	1	[redacted]		Cost Support Item 1	
3.2	Contingency	%					
3.5							
				Sub-Total	[redacted]		
4	**002 Overtime Labour**						
4.1	Site Supervision	lot	1	$ 25,000.00	$ 25,000.00		
4.2							
4.3							
				Sub-Total	$ 25,000.00		
5	**004 Term Labour**						
5.1	Site Supervision	lot	1	$ 25,000.00	$ 25,000.00		
5.2							
5.3							
				Sub-Total	$ 25,000.00		
6	**011 Travel Expenses**						
6.1	Travel to site	lot	1	$ 20,000.00	$ 20,000.00		
6.2							
6.3							
				Sub-Total	$ 20,000.00		
7	**028 Consulting**						
7.1	Archaeology	lot	1	[redacted]			
7.2	Design - Phase One	lot	1			Cost Support 2	
7.3	Design - Phase Two	lot	1			Cost Support 2	
				Sub-Total	$ 200,300.00		
8	**041 Meals and Entertainment**						
8.1	Meals during travel	lot	1	$ 5,000.00	$ 5,000.00		
8.2							
8.3							
				Sub-Total	$ 5,000.00		
9	**094 Interest Capitalized**						
9.1	Interest Capitalized	lot	1	$ 100,946.74	$ 100,946.74		
9.2							
9.3							
				Sub-Total	$ 100,946.74		
10	**095 Administrative Overhead**						
10.1	Hydro Regular Labour AO	lot	1	$ 3,230.24	$ 3,230.24		
10.1	Hydro OT Labour AO	lot	1	$ 2,420.00	$ 2,420.00		
10.2	Hydro Term Labour AO	lot	1	[redacted]			
10.3	Thermal & Hydro Contracts AO	lot	1				
				Sub-Total	$ 254,441.50		
Cost Estimate				**Total**	$ 4,379,300.74		
11	**Original Cost**						
11.1					$ 325,311.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 & 2

Removed due to confidentiality

CI Number: 41806

Title: **HYD - Big Falls - Unit #6 Refurbishment**

Start Date: 2013/04
Final Cost Date: 2014/03
Function: Generation
Forecast Amount: $1,010,112

DESCRIPTION:

This project consists of dismantling the machine, realigning the headcover and seal ring, and a general replacement of wear items such as the turbine runner shaft and wicket gate bushings in Big Falls Unit 6.

The life of this project is expected to be approximately 10 years based on normal operation.
The depreciation class for this project is the Mersey Hydro System.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015

JUSTIFICATION:

Justification Criteria: Hydro

Sub Criteria: Maintenance

Why do this project?

This machine requires realignment due to the risk of the wicket gates binding that can cause a runaway situation with this unit. The unit must be refurbished for it to operate safely and provide reliable service. A failure of any one of the mechanical components could lead to an environmental or safety incident, and would result in significant downtime (months) to repair.

Why do this project now?

This machine is currently showing symptoms of misalignment such as frequent issues with wicket gate alignment. Hydro personnel are aware of the condition of the equipment, and monitor its operation regularly.

Why do this project this way?

Past experience has shown that the only way to bring the machine back into alignment is to cut the headcover support steel away from the rest of the unit, and re-align it with the bottom seal ring. Assessment and refurbishment / replacement of the damaged components, and realignment of the unit is the most cost effective measure.

CI Number : 41806 - HYD - Big Falls - Unit #6 Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 470 - 470-Mersey Hydro System **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		21,420	0	21,420
095		095-Hydro Overtime Labour AO		[redacted]	0	[redacted]
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
095		095-Hydro Regular Labour AO		[redacted]	0	[redacted]
001	025	001 - HYDRO Regular Labour	025 - HGP - Generator	278,400	0	278,400
002	025	002 - HYDRO Overtime Labour	025 - HGP - Generator	20,800	0	20,800
011	025	011 - Travel Expense	025 - HGP - Generator	3,500	0	3,500
012	025	012 - Materials	025 - HGP - Generator	468,051	0	468,051
013	025	013 - POWER PRODUCTION Contracts	025 - HGP - Generator	[redacted]	0	[redacted]
028	025	028 - Consulting	025 - HGP - Generator	30,000	0	30,000
041	025	041 - Meals & Entertainment	025 - HGP - Generator	10,000	0	10,000
			Total Cost:	1,010,112	0	1,010,112
			Original Cost:	403,604		

Big Falls #6 Refurbishment
Summary of Alternatives

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Hydro	**CI Number:**	41806
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Big Falls #6	6.48%	9,642,621	1	69.60%	3.0 years
B	Decommission	6.48%	-1,934,002	4	-7.90%	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

It is recommended that the Big Falls #6 unit be dismantled, the headcover and seal ring re-aligned, and a general replacement of wear items be completed.

Notes/Comments :

Refurbish Big Falls #6

This option consists of refurbishing the Big Falls #6 generating unit.

Decommission

Decommission costs are based on an estimate of $2.5 million to decommission the Big Falls Powerhouse.

Test 3

Test 4

Big Falls #6 Refurbishment
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Hydro	CI Number:	41806
Originator :		Project No. :	

Refurbish Big Falls #6

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	25%	25%	25%	25%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	[redacted]					
Duration (Hours)	1	1				
Totals	$300,690	$301,470	$0	$0	$300,690	$301,470

Total Capital Cost of Alternative $1,010,112

Decommission

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative $2,500,000

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	0%	25%	0%	25%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative $0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0

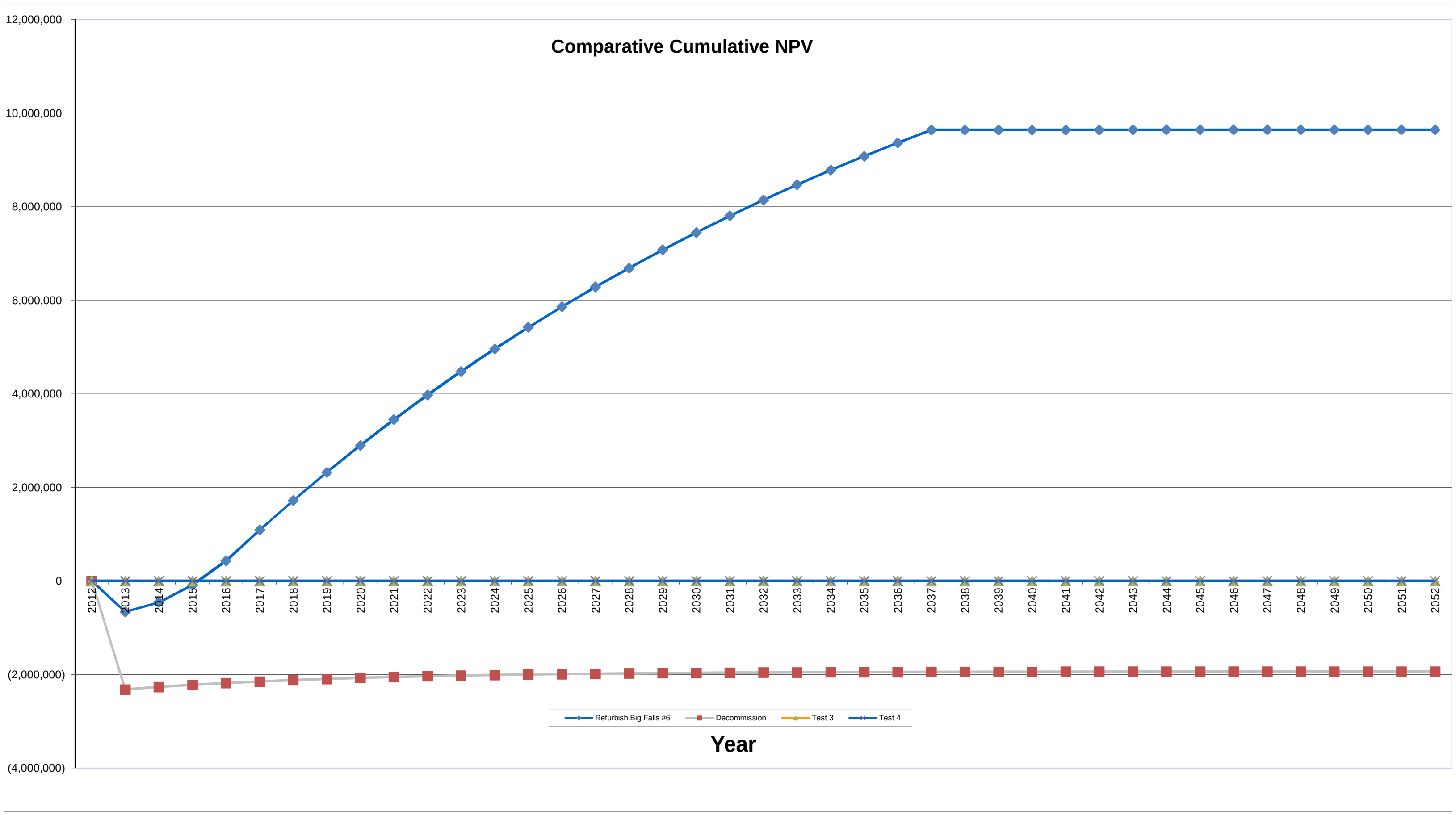
Total Capital Cost of Alternative $0

Big Falls #6 Refurbishment
Refurbish Big Falls #6

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	300,690.0	(918,971.0)	37,595.5	902,291.7	(618,281.0)	(81,559.3)	(699,840.3)	(657,250.469)	0.9	(657,250.5)
2014	-	301,470.0	-	72,183.3	830,108.3	301,470.0	(71,078.9)	230,391.1	203,202.795	0.9	(454,047.7)
2015	-	614,998.8	-	66,408.7	763,699.7	614,998.8	(170,062.9)	444,935.9	368,547.340	0.8	(85,500.3)
2016	-	940,948.2	-	61,096.0	702,603.7	940,948.2	(272,754.2)	668,194.0	519,792.959	0.8	434,292.6
2017	-	1,279,689.5	-	56,208.3	646,395.4	1,279,689.5	(379,279.2)	900,410.3	657,809.674	0.7	1,092,102.3
2018	-	1,305,283.3	-	51,711.6	594,683.8	1,305,283.3	(388,607.2)	916,676.1	628,937.722	0.7	1,721,040.0
2019	-	1,331,389.0	-	47,574.7	547,109.1	1,331,389.0	(397,982.4)	933,406.5	601,443.093	0.6	2,322,483.1
2020	-	1,358,016.7	-	43,768.7	503,340.3	1,358,016.7	(407,416.9)	950,599.9	575,245.730	0.6	2,897,728.8
2021	-	1,385,177.1	-	40,267.2	463,073.1	1,385,177.1	(416,922.1)	968,255.0	550,271.950	0.6	3,448,000.8
2022	-	1,412,880.6	-	37,045.8	426,027.3	1,412,880.6	(426,508.8)	986,371.8	526,453.769	0.5	3,974,454.6
2023	-	1,441,138.2	-	34,082.2	391,945.1	1,441,138.2	(436,187.4)	1,004,950.9	503,728.306	0.5	4,478,182.9
2024	-	1,469,961.0	-	31,355.6	360,589.5	1,469,961.0	(445,967.7)	1,023,993.3	482,037.266	0.5	4,960,220.1
2025	-	1,499,360.2	-	28,847.2	331,742.3	1,499,360.2	(455,859.0)	1,043,501.2	461,326.482	0.4	5,421,546.6
2026	-	1,529,347.4	-	26,539.4	305,202.9	1,529,347.4	(465,870.5)	1,063,476.9	441,545.514	0.4	5,863,092.1
2027	-	1,559,934.4	-	24,416.2	280,786.7	1,559,934.4	(476,010.6)	1,083,923.7	422,647.294	0.4	6,285,739.4
2028	-	1,591,133.1	-	22,462.9	258,323.8	1,591,133.1	(486,287.7)	1,104,845.3	404,587.815	0.4	6,690,327.2
2029	-	1,622,955.7	-	20,665.9	237,657.9	1,622,955.7	(496,709.8)	1,126,245.9	387,325.856	0.3	7,077,653.1
2030	-	1,655,414.8	-	19,012.6	218,645.2	1,655,414.8	(507,284.7)	1,148,130.1	370,822.737	0.3	7,448,475.8
2031	-	1,688,523.1	-	17,491.6	201,153.6	1,688,523.1	(518,019.8)	1,170,503.4	355,042.102	0.3	7,803,517.9
2032	-	1,722,293.6	-	16,092.3	185,061.3	1,722,293.6	(528,922.4)	1,193,371.2	339,949.727	0.3	8,143,467.7
2033	-	1,756,739.5	-	14,804.9	170,256.4	1,756,739.5	(539,999.7)	1,216,739.7	325,513.349	0.3	8,468,981.0
2034	-	1,791,874.2	-	13,620.5	156,635.9	1,791,874.2	(551,258.7)	1,240,615.6	311,702.510	0.3	8,780,683.5
2035	-	1,827,711.7	-	12,530.9	144,105.0	1,827,711.7	(562,706.1)	1,265,005.7	298,488.424	0.2	9,079,171.9
2036	-	1,864,266.0	-	11,528.4	132,576.6	1,864,266.0	(574,348.6)	1,289,917.3	285,843.852	0.2	9,365,015.8
2037	-	1,901,551.3	-	10,606.1	121,970.5	1,901,551.3	(586,193.0)	1,315,358.3	273,742.988	0.2	9,638,758.8
2038	-	-	-	9,757.6	112,212.9	-	3,024.9	3,024.9	591.204	0.2	9,639,350.0
2039	-	-	-	8,977.0	103,235.8	-	2,782.9	2,782.9	510.807	0.2	9,639,860.8
2040	-	-	-	8,258.9	94,977.0	-	2,560.2	2,560.2	441.344	0.2	9,640,302.1
2041	-	-	-	7,598.2	87,378.8	-	2,355.4	2,355.4	381.326	0.2	9,640,683.5
2042	-	-	-	6,990.3	80,388.5	-	2,167.0	2,167.0	329.470	0.2	9,641,012.9
2043	-	-	-	6,431.1	73,957.4	-	1,993.6	1,993.6	284.666	0.1	9,641,297.6
2044	-	-	-	5,916.6	68,040.8	-	1,834.1	1,834.1	245.955	0.1	9,641,543.6
2045	-	-	-	5,443.3	62,597.6	-	1,687.4	1,687.4	212.508	0.1	9,641,756.1
2046	-	-	-	5,007.8	57,589.8	-	1,552.4	1,552.4	183.610	0.1	9,641,939.7
2047	-	-	-	4,607.2	52,982.6	-	1,428.2	1,428.2	158.641	0.1	9,642,098.3
2048	-	-	-	4,238.6	48,744.0	-	1,314.0	1,314.0	137.068	0.1	9,642,235.4
2049	-	-	-	3,899.5	44,844.5	-	1,208.9	1,208.9	118.428	0.1	9,642,353.8
2050	-	-	-	3,587.6	41,256.9	-	1,112.1	1,112.1	102.323	0.1	9,642,456.1
2051	-	-	-	3,300.6	37,956.3	-	1,023.2	1,023.2	88.409	0.1	9,642,544.5
2052	-	-	-	3,036.5	34,919.8	-	941.3	941.3	76.386	0.1	9,642,620.9
Total	-	35,152,747.3	(918,971.0)	904,967.3	10,877,067.7	34,233,776.3	(10,616,811.8)	23,616,964.5	9,642,620.9		

Big Falls #6 Refurbishment
Decommission

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	-	(2,500,000.0)	100,000.0	2,500,000.0	(2,500,000.0)	31,000.0	(2,469,000.0)	(2,318,745.304)	0.9	(2,318,745.3)
2014	-	-	-	192,000.0	2,208,000.0	-	59,520.0	59,520.0	52,496.075	0.9	(2,266,249.2)
2015	-	-	-	176,640.0	2,031,360.0	-	54,758.4	54,758.4	45,357.240	0.8	(2,220,892.0)
2016	-	-	-	162,508.8	1,868,851.2	-	50,377.7	50,377.7	39,189.201	0.8	(2,181,702.8)
2017	-	-	-	149,508.1	1,719,343.1	-	46,347.5	46,347.5	33,859.941	0.7	(2,147,842.8)
2018	-	-	-	137,547.4	1,581,795.7	-	42,639.7	42,639.7	29,255.396	0.7	(2,118,587.5)
2019	-	-	-	126,543.7	1,455,252.0	-	39,228.5	39,228.5	25,277.014	0.6	(2,093,310.4)
2020	-	-	-	116,420.2	1,338,831.8	-	36,090.2	36,090.2	21,839.644	0.6	(2,071,470.8)
2021	-	-	-	107,106.5	1,231,725.3	-	33,203.0	33,203.0	18,869.715	0.6	(2,052,601.1)
2022	-	-	-	98,538.0	1,133,187.3	-	30,546.8	30,546.8	16,303.660	0.5	(2,036,297.4)
2023	-	-	-	90,655.0	1,042,532.3	-	28,103.0	28,103.0	14,086.558	0.5	(2,022,210.9)
2024	-	-	-	83,402.6	959,129.7	-	25,854.8	25,854.8	12,170.956	0.5	(2,010,039.9)
2025	-	-	-	76,730.4	882,399.3	-	23,786.4	23,786.4	10,515.852	0.4	(1,999,524.1)
2026	-	-	-	70,591.9	811,807.4	-	21,883.5	21,883.5	9,085.823	0.4	(1,990,438.2)
2027	-	-	-	64,944.6	746,862.8	-	20,132.8	20,132.8	7,850.260	0.4	(1,982,588.0)
2028	-	-	-	59,749.0	687,113.8	-	18,522.2	18,522.2	6,782.719	0.4	(1,975,805.3)
2029	-	-	-	54,969.1	632,144.7	-	17,040.4	17,040.4	5,860.351	0.3	(1,969,944.9)
2030	-	-	-	50,571.6	581,573.1	-	15,677.2	15,677.2	5,063.414	0.3	(1,964,881.5)
2031	-	-	-	46,525.8	535,047.2	-	14,423.0	14,423.0	4,374.850	0.3	(1,960,506.6)
2032	-	-	-	42,803.8	492,243.5	-	13,269.2	13,269.2	3,779.923	0.3	(1,956,726.7)
2033	-	-	-	39,379.5	452,864.0	-	12,207.6	12,207.6	3,265.899	0.3	(1,953,460.8)
2034	-	-	-	36,229.1	416,634.9	-	11,231.0	11,231.0	2,821.776	0.3	(1,950,639.0)
2035	-	-	-	33,330.8	383,304.1	-	10,332.5	10,332.5	2,438.048	0.2	(1,948,201.0)
2036	-	-	-	30,664.3	352,639.8	-	9,505.9	9,505.9	2,106.503	0.2	(1,946,094.5)
2037	-	-	-	28,211.2	324,428.6	-	8,745.5	8,745.5	1,820.044	0.2	(1,944,274.4)
2038	-	-	-	25,954.3	298,474.3	-	8,045.8	8,045.8	1,572.540	0.2	(1,942,701.9)
2039	-	-	-	23,877.9	274,596.3	-	7,402.2	7,402.2	1,358.693	0.2	(1,941,343.2)
2040	-	-	-	21,967.7	252,628.6	-	6,810.0	6,810.0	1,173.927	0.2	(1,940,169.3)
2041	-	-	-	20,210.3	232,418.3	-	6,265.2	6,265.2	1,014.287	0.2	(1,939,155.0)
2042	-	-	-	18,593.5	213,824.9	-	5,764.0	5,764.0	876.357	0.2	(1,938,278.6)
2043	-	-	-	17,106.0	196,718.9	-	5,302.9	5,302.9	757.183	0.1	(1,937,521.5)
2044	-	-	-	15,737.5	180,981.4	-	4,878.6	4,878.6	654.215	0.1	(1,936,867.2)
2045	-	-	-	14,478.5	166,502.9	-	4,488.3	4,488.3	565.249	0.1	(1,936,302.0)
2046	-	-	-	13,320.2	153,182.6	-	4,129.3	4,129.3	488.382	0.1	(1,935,813.6)
2047	-	-	-	12,254.6	140,928.0	-	3,798.9	3,798.9	421.968	0.1	(1,935,391.6)
2048	-	-	-	11,274.2	129,653.8	-	3,495.0	3,495.0	364.586	0.1	(1,935,027.1)
2049	-	-	-	10,372.3	119,281.5	-	3,215.4	3,215.4	315.006	0.1	(1,934,712.0)
2050	-	-	-	9,542.5	109,739.0	-	2,958.2	2,958.2	272.169	0.1	(1,934,439.9)
2051	-	-	-	8,779.1	100,959.8	-	2,721.5	2,721.5	235.158	0.1	(1,934,204.7)
2052	-	-	-	8,076.8	92,883.1	-	2,503.8	2,503.8	203.179	0.1	(1,934,001.5)
Total	-	-	(2,500,000.0)	2,407,116.9	29,031,844.8	(2,500,000.0)	746,206.3	(1,753,793.7)	(1,934,001.5)		



Comparative Cumulative NPV
12,000,000
10,000,000
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6,000,000
4,000,000
2,000,000
0
(2,000,000)
(4,000,000)
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2052
Refurbish Big Falls #6
Decommission
Test 3
Test 4
Year

Location: Hydro
FP#: 41806
Title: HYD - Big Falls #6 Refurbishment

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Disassembly	hr	[redacted]		$ 48,000.00		
1.2	Repairs	hr			$ 166,400.00		
1.3	Reassembly	hr			$ 64,000.00		
				Sub-Total	$ 278,400.00		
2	**012 Materials**						
2.1	Turbine Bearing Housing	lot	1	[redacted]		Cost Support 1. Note, exchange is assumed to be 1.0	
2.2	Turbine Runner Shaft	lot	1			Cost Support 2	
2.3	Materials for refurbishment	lot	1				41988
2.4							
				Sub-Total	$ 468,051.00		
3	**013 Power Production Contracts**						
3.1	Construction related to refurbishment	lot	1	[redacted]			41988
3.2					$ -		
3.3					$ -		
				Sub-Total	[redacted]		
4	**002 Overtime Labour**						
4.1	Overtime Labour	hr	[redacted]		$ 20,800.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 20,800.00		
5	**011 Travel Expenses**						
5.4	Travel to site	lot	1	$ 3,500.00	$ 3,500.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 3,500.00		
6	**028 Consulting**						
6.1	Non destructive examination	lot	1	[redacted]			
6.2	Metallurgical Sampling	lot	1				
6.3	Weld procedure design	lot	1				
				Sub-Total	$ 30,000.00		
7	**041 Meals and Entertainment**						
7.1	Meals	lot	1	$ 10,000.00	$ 10,000.00		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 10,000.00		
8	**094 Interest Capitalized**						
8.1	Interest Capitalized	lot	1	$ 21,420.10	$ 21,420.10		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 21,420.10		
9	**095 Administrative Overhead**						
9.1	Hydro Regular Labour AO	lot	1	$ 53,898.24	[redacted]		
9.2	Hydro Term Labour AO	lot	1	$ 2,013.41			
9.3	Thermal & Hydro Contracts AO	lot	1	$ 13,808.87			
				Sub-Total			
Cost Estimate				**Total**	$ 1,010,111.62		
10	**Original Cost**						
10.1					$ 403,604.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 & 2

Removed due to confidentiality

CI Number: 27507

Title: **HYD - Sheet Harbour - Ruth Falls Penstock Butterfly Valve Replacements**

Start Date: 2013/04
Final Cost Date: 2013/12
Function: Generation
Forecast Amount: $733,528

DESCRIPTION:

This project consists of replacing the three existing turbine isolation valves at the Ruth Falls Generating Station with new, lockable butterfly valves of modern design, and installing adaptors to match the new valves to the existing flanges on the penstock and scrollcase. At this time, the valves are not being used for isolation due to their condition.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015

JUSTIFICATION:

Justification Criteria: HYDRO
Sub Criteria: Equipment Replacement

Why do this project?

The existing turbine isolation valves are no longer acceptable to use for isolation. Consequently, when a unit must be isolated for servicing, all three units in the generating station must be taken out of service until the valve is pulled and replaced with a blank. This sequence is reversed when it is time to put the repaired unit back in service. In addition, during a recent inspection, cracks were observed in the trunnion area of the isolation valve for Unit 3, raising concerns about its structural integrity and long term reliability. The valves on Units 1 and 2 are approximately eight years older than the valve on Unit 3.

Why do this project now?

Units 1 and 2 at the Ruth Falls Generating Station are scheduled to be out of service in 2013 to replace the runners (CI 12079). To minimize the disruption to generation, the turbine isolation valves will be replaced during the same outage.

Why do this project this way?

The outdated turbine isolation valves cannot be used for unit isolation in their current condition. New valves will restore this ability to the station.

CI Number : 27507 - HYD - Sheet Harbour - Ruth Falls Penstock Butterfly Valve Replacements **Project Number**

Parent CI Number : -

Cost Centre : 450 - 450-Sheet Harbour Hydro System **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		11,497	0	11,497
095		095-Thermal & Hydro Contracts AO		2,552	0	2,552
095		095-Hydro Regular Labour AO		13,629	0	13,629
001	027	001 - HYDRO Regular Labour	027 - HGP - Waterways	70,400	0	70,400
011	027	011 - Travel Expense	027 - HGP - Waterways	2,000	0	2,000
012	027	012 - Materials	027 - HGP - Waterways	515,449	0	515,449
013	027	013 - POWER PRODUCTION Contracts	027 - HGP - Waterways	20,000	0	20,000
028	027	028 - Consulting	027 - HGP - Waterways	90,000	0	90,000
041	027	041 - Meals & Entertainment	027 - HGP - Waterways	8,000	0	8,000
			Total Cost:	733,528	0	733,528
			Original Cost:	87,591		

Ruth Falls Butterfly Valves
Summary of Alternatives

Division :	Power Production		**Date :**	**31-Oct-12**
Department :	Hydro		**CI Number:**	27507
Originator :			**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Butterfly Valves	6.48%	2,805,780	1	54.96%	2.6 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

It is recommended to replace the current butterfly valves at Ruth Falls to allow for isolation of one unit during annual maintenance or repairs.

Notes/Comments :

Replace Butterfly Valves

This option looks at replacing the three butterfly valves. The avoided replacement energy is based on two units not operating while work on one unit is being completed. The model estimates one, three weeks outage per unit per year.

Test 2

Test 3

Test 4

Ruth Falls Butterfly Valves
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Hydro	CI Number:	27507
Originator :		Project No. :	

Replace Butterfly Valves

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	3	3	3	3		
Probability of Occurance (%)	100%	100%	100%	100%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	[redacted]					
Duration (Hours)	504	504				
Totals	$335,737	$336,607	$0	$0	$335,737	$336,607
Total Capital Cost of Alternative						$733,528

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

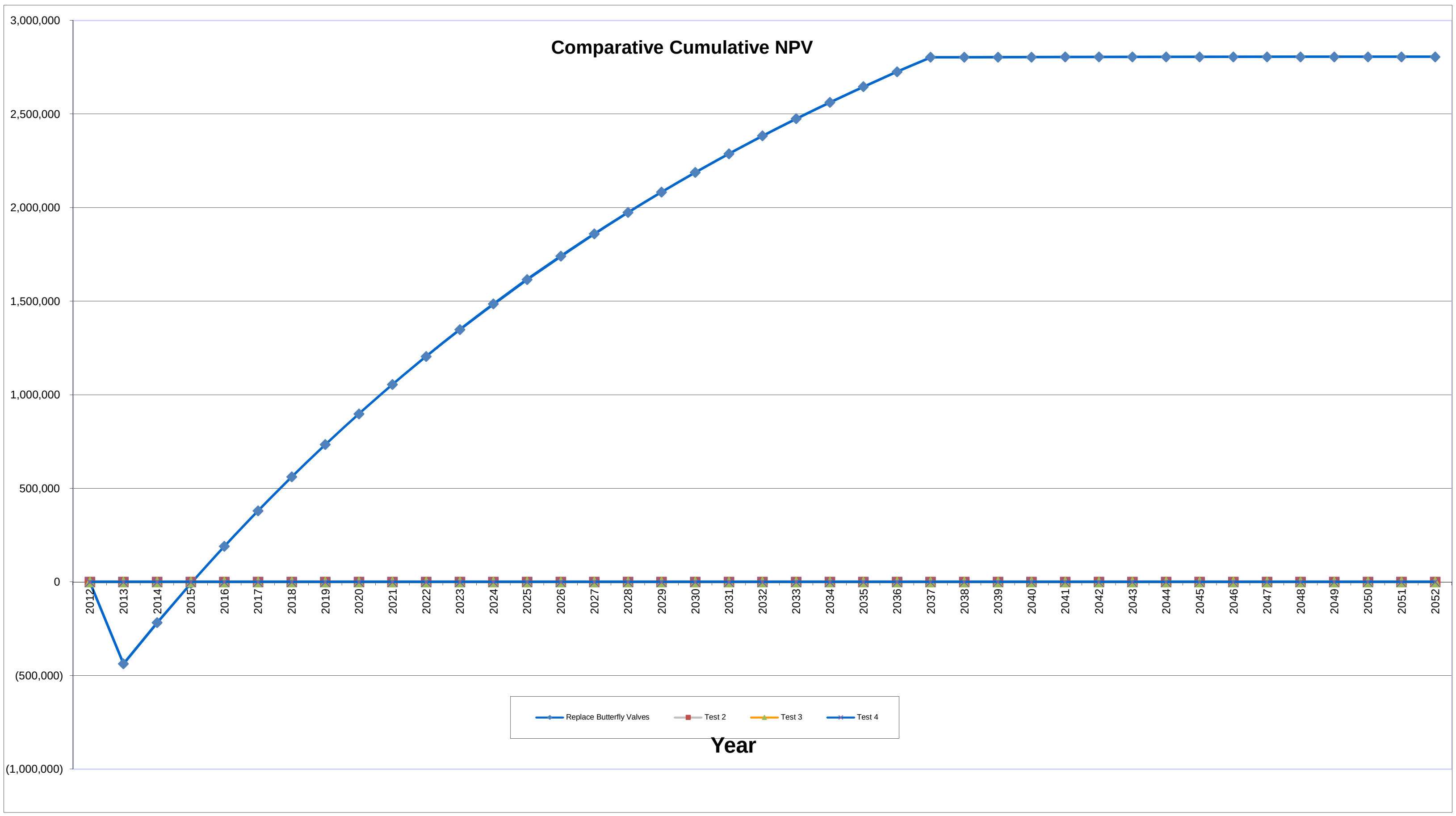
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Ruth Falls Butterfly Valves
Replace Butterfly Valves

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	335,736.6	(705,849.0)	28,428.1	682,275.3	(370,112.4)	(95,265.6)	(465,378.0)	(437,056.762)	0.9	(437,056.8)
2014	-	336,607.5	-	54,582.0	627,693.3	336,607.5	(87,427.9)	249,179.6	219,774.039	0.9	(217,282.7)
2015	-	343,339.6	-	50,215.5	577,477.8	343,339.6	(90,868.5)	252,471.1	209,125.802	0.8	(8,156.9)
2016	-	350,206.4	-	46,198.2	531,279.6	350,206.4	(94,242.5)	255,963.9	199,116.168	0.8	190,959.2
2017	-	357,210.6	-	42,502.4	488,777.2	357,210.6	(97,559.5)	259,651.0	189,692.351	0.7	380,651.6
2018	-	364,354.8	-	39,102.2	449,675.0	364,354.8	(100,828.3)	263,526.5	180,807.310	0.7	561,458.9
2019	-	371,641.9	-	35,974.0	413,701.0	371,641.9	(104,057.0)	267,584.8	172,419.027	0.6	733,877.9
2020	-	379,074.7	-	33,096.1	380,605.0	379,074.7	(107,253.4)	271,821.3	164,489.884	0.6	898,367.8
2021	-	386,656.2	-	30,448.4	350,156.6	386,656.2	(110,424.4)	276,231.8	156,986.121	0.6	1,055,353.9
2022	-	394,389.3	-	28,012.5	322,144.0	394,389.3	(113,576.8)	280,812.5	149,877.359	0.5	1,205,231.3
2023	-	402,277.1	-	25,771.5	296,372.5	402,277.1	(116,716.7)	285,560.4	143,136.198	0.5	1,348,367.5
2024	-	410,322.6	-	23,709.8	272,662.7	410,322.6	(119,850.0)	290,472.7	136,737.855	0.5	1,485,105.4
2025	-	418,529.1	-	21,813.0	250,849.7	418,529.1	(122,982.0)	295,547.1	130,659.856	0.4	1,615,765.2
2026	-	426,899.7	-	20,068.0	230,781.7	426,899.7	(126,117.8)	300,781.9	124,881.768	0.4	1,740,647.0
2027	-	435,437.7	-	18,462.5	212,319.2	435,437.7	(129,262.3)	306,175.4	119,384.965	0.4	1,860,031.9
2028	-	444,146.4	-	16,985.5	195,333.6	444,146.4	(132,419.9)	311,726.6	114,152.419	0.4	1,974,184.4
2029	-	453,029.4	-	15,626.7	179,707.0	453,029.4	(135,594.8)	317,434.5	109,168.527	0.3	2,083,352.9
2030	-	462,089.9	-	14,376.6	165,330.4	462,089.9	(138,791.2)	323,298.8	104,418.950	0.3	2,187,771.8
2031	-	471,331.7	-	13,226.4	152,104.0	471,331.7	(142,012.6)	329,319.1	99,890.483	0.3	2,287,662.3
2032	-	480,758.4	-	12,168.3	139,935.6	480,758.4	(145,262.9)	335,495.5	95,570.927	0.3	2,383,233.2
2033	-	490,373.5	-	11,194.9	128,740.8	490,373.5	(148,545.4)	341,828.2	91,448.995	0.3	2,474,682.2
2034	-	500,181.0	-	10,299.3	118,441.5	500,181.0	(151,863.3)	348,317.7	87,514.211	0.3	2,562,196.5
2035	-	510,184.6	-	9,475.3	108,966.2	510,184.6	(155,219.9)	354,964.8	83,756.834	0.2	2,645,953.3
2036	-	520,388.3	-	8,717.3	100,248.9	520,388.3	(158,618.0)	361,770.3	80,167.789	0.2	2,726,121.1
2037	-	530,796.1	-	8,019.9	92,229.0	530,796.1	(162,060.6)	368,735.5	76,738.599	0.2	2,802,859.7
2038	-	-	-	7,378.3	84,850.7	-	2,287.3	2,287.3	447.044	0.2	2,803,306.7
2039	-	-	-	6,788.1	78,062.6	-	2,104.3	2,104.3	386.251	0.2	2,803,693.0
2040	-	-	-	6,245.0	71,817.6	-	1,936.0	1,936.0	333.726	0.2	2,804,026.7
2041	-	-	-	5,745.4	66,072.2	-	1,781.1	1,781.1	288.343	0.2	2,804,315.0
2042	-	-	-	5,285.8	60,786.4	-	1,638.6	1,638.6	249.132	0.2	2,804,564.2
2043	-	-	-	4,862.9	55,923.5	-	1,507.5	1,507.5	215.253	0.1	2,804,779.4
2044	-	-	-	4,473.9	51,449.6	-	1,386.9	1,386.9	185.981	0.1	2,804,965.4
2045	-	-	-	4,116.0	47,333.7	-	1,276.0	1,276.0	160.690	0.1	2,805,126.1
2046	-	-	-	3,786.7	43,547.0	-	1,173.9	1,173.9	138.838	0.1	2,805,264.9
2047	-	-	-	3,483.8	40,063.2	-	1,080.0	1,080.0	119.958	0.1	2,805,384.9
2048	-	-	-	3,205.1	36,858.2	-	993.6	993.6	103.645	0.1	2,805,488.5
2049	-	-	-	2,948.7	33,909.5	-	914.1	914.1	89.550	0.1	2,805,578.1
2050	-	-	-	2,712.8	31,196.7	-	841.0	841.0	77.373	0.1	2,805,655.5
2051	-	-	-	2,495.7	28,701.0	-	773.7	773.7	66.851	0.1	2,805,722.3
2052	-	-	-	2,296.1	26,404.9	-	711.8	711.8	57.760	0.1	2,805,780.1
Total	-	10,575,963.3	(705,849.0)	684,298.5	8,224,784.6	9,870,114.3	(3,066,416.1)	6,803,698.2	2,805,780.1		


Comparative Cumulative NPV
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
(500,000)
(1,000,000)
Year
Replace Butterfly Valves
Test 2
Test 3
Test 4

Location: Hydro
FP#: 27507
Title: HYD - Ruth Falls Penstock Butterfly Valve Replacement

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Hydro Labour	hr	[redacted]		$ 70,400.00		
1.2		hr			$ -		
				Sub-Total	$ 70,400.00		
2	**012 Materials**						
2.1	Supply of 66 inch valves	ea	2	[redacted]		Cost Support 1 (item 1)	
2.2	Shaft locking device	ea	2	[redacted]		Cost Support 1 (item 2)	
2.3	Supply of 90 inch valve	ea	1	[redacted]			
2.4	Supply of locking device	ea	1	[redacted]		Cost Support 1 (item 4)	
2.5	Adapters for 90 inch valves	ea	1	[redacted]		Cost Support 1 (item 5)	
2.6	Adapters for 66 inch valves	ea	2	[redacted]		Cost Support 1 (item 6)	
2.7	Contingency	%	[redacted]				
2.8	Freight	lot	1	[redacted]		Cost Support 1 (item 7)	
				Sub-Total	$ 515,449.15		
3	**013 Power Production Contracts**						
3.1	Miscellaneous	lot	1	$ 20,000.00	$ 20,000.00		
3.2					$ -		
				Sub-Total	$ 20,000.00		
4	**011 Travel Expenses**						
4.1	Travel Expenses	lot	1	$ 2,000.00	$ 2,000.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 2,000.00		
5	**028 Consulting**						
5.1	Design	lot	1	[redacted]			
5.2	Site Supervision	months	3	[redacted]			
5.3							
				Sub-Total	$ 90,000.00		
6	**041 Meals and Entertainment**						
6.1	Meals during travel	lot	1	$ 8,000.00	$ 8,000.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 8,000.00		
7	**094 Interest Capitalized**						
7.1	Interest Capitalized	lot	1	$ 11,497.41	$ 11,497.41		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 11,497.41		
8	**095 Administrative Overhead**						
8.1	Hydro Regular Labour AO	lot	1	$ 13,629.44	$ 13,629.44		
8.2	Thermal & Hydro Contracts AO	lot	1	$ 2,552.00	$ 2,552.00		
				Sub-Total	$ 16,181.44		
Cost Estimate				**Total**	$ 733,528.00		
9	**Original Cost**				$ 87,591.00		
9.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

NSPI – Ruth Falls Hydro Unit #3

3285

Unit 3 penstock, butterfly valve to scroll

3289

Control side of butterfly valve – cracks noted at gusset/stiffener to upstream and downstream flange, both sides, 4 areas in total

3291

Close-up of crack (MPI) indication in area of photo 3289

3274

Crack through coating in area opposite flange (from area above in photo 3291)

3287

Penstock at concrete wall top side

3288

As above, side view, corrosion noted at lower areas per report info

3275

General corrosion just below area viewed in photo 3288. Flange and penstock corroded significantly

3279

Penstock opposite side at concrete wall – significant corrosion noted

3284

Scroll case – draft tube access area

3282

Draft tube access hatch, general surface corrosion noted

3283

View upward from hatch – note 5 rivets missing at joint above hatch

3294

Top side view of scroll – good general condition, minor corrosion/pitting at edge of checker plate on scroll

SHH-RUF-TSV-RP-2006-47

AMC - Atlantic Metallurgical Consulting

October 3, 2006

Mr. Jamie Yates
Nova Scotia Power Inc.
P.O. Box 910, Lakeside
Halifax, NS B3J 2W5

Re: Examination of Butterflys and Valves at Ruth Falls (Our Reference 06-AMC-160)

Dear Mr. Yates:

As requested the three Butterfly Valves were examined internally and externally. Sites were selected for replication on the external bodies of the valves. Core Samples from the butterfly were obtained by drilling with a 1 ¼ inch hole saw using a portable hand drill. Replicas and cores were analyzed both visually, and with the use of a metallurgical microscope in order to determine the effect of corrosion on the service life of the valves in question. Mechanical testing was also performed on the core samples to determine the hardness and tensile properties of the materials. Attached is a report outlining and discussing the results acquired from the available samples.

Valve 2

Replica

The outside surface of the #2 butterfly valve body was the first examined. Rough and smooth areas were observed on the outside surface of the valve. One of the rougher areas selected for examination is shown in Figure 1 with the coating still intact. The underside showed similar rough textures on the external surface, but nothing extraordinary, and nothing that appeared to be active corrosion. Two sites were selected for in-situ metallography (replication). One area was smooth (2A), and a second area at the first site was slightly rougher (2B). The surface was prepared for replication by initially grinding using an angle grinder and then proceeding to a 0.25μm surface finish. The surface was then etched with 9% Nital to enhance the microstructure appearance.

Replication of various sites on valve #2 was performed using an acetate film that softens to a gel-like state in acetone and solidifies on the surface to copy the surface. One of the rougher sites (2C and 2D) was selected for examination, one that had the greatest surface depression. This site was initially prepared by removing the paint/coating using a wire wheel on an angle grinder. Photographs were taken of the exposed metal surface. The surface was then "levelled" using the angle grinder, leaving some depressions so that we could investigate the origin/nature of the depressions. Again, the surface was prepared for replication by grinding using an angle grinder and progressing to a 0.25μm surface finish before finishing with a 9% Nital etch. The photograph in Figure 2 shows the prepared surface with the acetate replication film in place.

The examination of the replicas in the laboratory revealed that the microstructure of the body of the #2 valve was gray cast iron with type A flakes. The flake size as shown in Figure 3 was determined according to the method in ASTM A247 to range from No. 6 to No. 7. This flake type and size is typical for gray cast iron and likely would not adversely affect the strength. The flake size is finer than that apparent in the valve body of the Hell's Gate valves previously reported, No. 3 to No. 5. The areas identified in Figure 3 as possible graphitization are areas that were only shallow that were not polished out prior to replication. In the dark areas it is clear that graphitization may have taken place, but does not appear to be extensive or deep.

Core Sample

NSP technicians removed a "core" sample from the #2 Valve butterfly for metallography and mechanical testing. This core, taken using a hole saw and portable drill is shown in a composite photograph in Figure 4. The sample was then polished in stages starting with 120 grit, and finishing with 0.05 μm alumina slurry. Upon completion of polishing the core samples were examined under the metallurgical microscope and notes were made regarding the general microstructure and the nature of the corrosion. The metallography of the valve butterfly was very similar to the valve body identified by replication. The graphite flakes evident in the microstructure are as expected for a cast iron. As shown in Figure 5, the microstructure was typical of a gray cast iron with Type A flake morphology and a flake size for the most part of 6-7. The maximum flake size was 2-3. The micrograph clearly shows the microstructure as having a matrix of pearlite and ferrite, however, the presence of a harder phase Steadite was observed. Steadite is a eutectic iron phosphide compound that is beneficial in improving fluidity during casting, but can lead to lower strength if a network forms at the grain boundaries. The Steadite does not appear to have formed a continuous network in the #2 Valve.

The depth of corrosion was measured using the metallurgical microscope eye piece, and also using vernier callipers. The results of the measurements are compiled in Table 2 that follows. Examination of the core to determine the depth of corrosion shows that the corrosion/graphitization depth was approximately 4.77-5.1 mm, or 11.4-12.2 %. Sections were subsequently removed from the core sample to perform hardness testing and tensile testing. The average hardness value was Rockwell B 58.4, which appears low in comparison to that of other gray iron castings examined and reference information.

A tensile specimen was prepared as a round specimen with threaded ends. The tensile results of Valve #1, #2 and #3 are shown in appendix A. In summary, the Ultimate Strength of the material from the #2 Valve Butterfly was determined to be 99 MPa (14.4 ksi) with a slightly lower Yield Strength at 94 MPa (13.6 ksi) which is only a slight difference. The lack of ductility of the specimen was typical for a gray cast iron. Given the size of the flakes and the low hardness, the lower strength is somewhat expected.

Valve 1

Replica

The one site selected for replication from valve #1 is shown in Figure 6. This site was selected to represent the rough and smooth area, hopefully indicating the nature of the rough area. Again, the angle grinder was used for initial surface preparation followed by grinding and polishing to -0.25 μm. An etch with 9% Nital was used to bring out the microstructure prior to replication with the acetate film. The prepared surface of Valve #1 is shown in Figure 7. The microstructure of the #1 valve body is shown in Figures 8-10. Figure 8 illustrates primarily Type A graphite flakes in a matrix of pearlite. The flake size appeared generally to be 7 to 8, which is fairly fine. There were some notable features in the microstructure that also should be mentioned. There was some Steadite, but as shown in Figure 10, this does not appear to be continuous in this instance. The morphology of the graphite flakes shown in Figure 9 is Type B flakes (Rosettes). This type of flake is generally of lower strength than the Type A flakes, but may be formed due to the faster cooling conditions at the surface of the casting. There was no notable graphitization evident in the replica from the #1 valve body.

Core Sample

The "core" sample from the #1 valve butterfly shown in the composite photograph in Figure 11 was prepared for metallography and tensile testing as the #2 core previous. Upon completion of polishing the core samples were examined under the metallurgical microscope and notes were made regarding the general microstructure and the nature of the corrosion.

The graphite flakes evident in the microstructure are as expected for a cast iron. As shown in Figure 12, the microstructure was similar to the microstructure seen in the #2 Butterfly, that of a gray cast iron. Although there was some Steadite apparent, it did not appear to be continuous. The matrix material was pearlitic with Type A graphite flake morphology and a flake size for the most part of 6-7 and a maximum flake size of 1-2. This flake size appears to be quite large. It was noted that the flake size was relatively smaller at the surfaces and there was a tendency for more rosette formation. In the core mid thickness the randomly distributed flakes tended to be larger.

The depth of corrosion was measured using the metallurgical microscope eye piece, and then with the vernier callipers. The corrosion measurements are shown in Table 2, while the hardness results appear in Table 1. The corrosion/graphitization depth was measured as 1.97-3.2 mm resulting in a reduction in thickness of 4.9-8.0 %. Sections were subsequently removed from the core sample to perform hardness testing and tensile testing. The average hardness value was Rockwell B 61.5, which appears to be low in comparison to that of other gray iron castings examined and reference information.

A tensile specimen was prepared as a round specimen with threaded ends. As mentioned earlier the tensile results of Valve #1, #2 and #3 are shown in appendix A. In summary, the Ultimate Strength of the material from the #1 Valve Butterfly was determined to be 56 MPa (8122 psi) with no Yield Strength difference. The lack of ductility of the specimen was also typical for a gray cast iron.

Valve 3

Replica

The final valve inspection was on Valve #3. The site selected, and shown in Figure 13 was chosen because there was a break in the paint with what appeared to be corrosion underneath. The corrosion blister was opened at the lower portion, revealing red corrosion product. This area was ground and polished as were the previous locations from an angle grinder to 0.25 μm then etched with 9% Nital to reveal the microstructure. Figure 14 shows the site on Valve #3 prepared for Replication. The microstructure apparent in the replica from the #3 Valve Body was not easily discernible. In fact, no graphite was identified in the microstructure as seen in Figure 15. There appears to be a script-like cementite phase that is similar to unresolved pearlite. At this point it is uncertain what the microstructure is, but it may be a cast steel. Further investigation is required to confirm the material of the #3 Valve body.

Core Sample

The "core" sample from the #3 Valve Butterfly shown in the composite photograph in Figure 16 was prepared for metallography. As with previous samples a longitudinal section of this core sample was ground and polished in stages starting with 120 grit, and finishing with 0.05 μm alumina powder. The microstructure of the Butterfly material is shown in Figure 17. The graphite flakes evident in the microstructure are as expected for a cast iron, similar to that seen in the #1 and #2 Butterflies. The matrix material was pearlitic with Type A graphite flake morphology and a flake size for the majority of 2-7 and a maximum flake size of 1-2. This flake size appears to be quite large. As with the #1 Butterfly it was noted that the flake size was relatively smaller at the surfaces and at mid thickness randomly distributed flakes tended to be larger.

The depth of corrosion was measured using the metallurgical microscope eye piece, and then with the vernier callipers. The corrosion measurements are shown in Table 2, while the hardness results appear in Table 1. The corrosion/graphitization depth was measured as 2.75-2.9 mm resulting in a reduction in thickness of 6.53-6.88 %. Sections were subsequently removed from the core sample to perform hardness testing and tensile testing. The average hardness value was Rockwell B 53.7, which appears to be low in comparison to that of other gray iron castings examined and reference information.

A tensile specimen was prepared as a round specimen with threaded ends. As mentioned earlier the tensile results of Valve #3 are shown with the results for valves #1 and #2 in appendix A. In summary, the Ultimate Strength of the material from the #3 Valve Butterfly was determined to be 88 MPa (12.8 ksi) with a slightly lower Yield Strength of 80 MPa (11.6 ksi). The lack of ductility of the specimen was similar to that of the other Butterfly samples, and also typical for a gray cast iron.

Discussion

In our examination and testing we were able to determine some properties of the materials in question. For comparison purposes a cast iron fitting was purchased to perform some mechanical tests as well as metallography. The results of these tests are included in the appendix, but are summarised as follows:

Tensile Stress at Maximum Load	29,843 psi (205 MPa), 0% elongation
Hardness HRB	72.3, 69.5, 78.1
Microstructure	Type A, Size 4-6

The material in the sample fitting appears to have better properties than any of the low strength cast iron in the #1, #2, or #3 Butterflies. The lower strength is likely due to the coarser flake size noted in the Butterflies. The material properties and corrosion assessment are given in Tables 1 and 2 as follows:

Table 1 Rockwell Hardness

Sample ID	HRB1	HRB2	HRB3	HRB4	HRB5
1B	67.4	60.9	61.3	54.5	63.6
2B	55.7	62.7	56.3	53.8	63.7
3B	57.4	46.3	58.8	48.0	58.1

Table 2 Depth of Corrosion

Vernier Callipers

Sample ID	Original Thickness (mm)	Remaining (mm)	Difference (mm)
1A	40.18	38.21	1.97
2A	41.94	37.17	4.77
3A	42.13	39.38	2.75

Metallurgical Microscope Eye Piece

Sample ID	Painted Side (mm)	Scale Side (mm)	Total (mm)
1A	1.4	1.8	3.2
2A	1.9	3.2	5.1
3A	0.9	2.0	2.9

In summary, from the replication of the microstructures, the body of valves #1 and #2 appear to be a gray cast iron with no graphitization present on the external surface. The examination of the #3 Valve body was less conclusive, and no clear identification of the material was possible. However, as there was no graphite apparent in the microstructure the material in the #3 Valve body may not be cast iron. Further identification work should be undertaken to positively identify the material in valve #3. As shown in the case of the Hell's Gate valves the extent of the graphitization on the interior of the valve bodies will likely be more significant in assessing the service life of the valve bodies.

The cores from the Butterflies of valves 1, 2, and 3 show that they have experienced some corrosion, up to 12% in the case of the #2 butterfly as shown in Table 2. With the relatively low strength and ductility of the material, this would be significant. The strength of the lowest ASTM class (Class 20) gray cast iron is 20 ksi (138 MPa). The strength of the gray cast iron comprising the butterfly cores was determined to be only 40-72 % of the value of this, the lowest strength cast iron. Without looking further at the loading conditions on the butterfly I have concerns as to capability of the butterflies to handle the loading safely where personnel could be at risk.

Please let me know if there are questions with respect to the examination.

Yours sincerely,

J. Scott MacIntyre, P.Eng.
Manager, Forensic & Failure Investigations

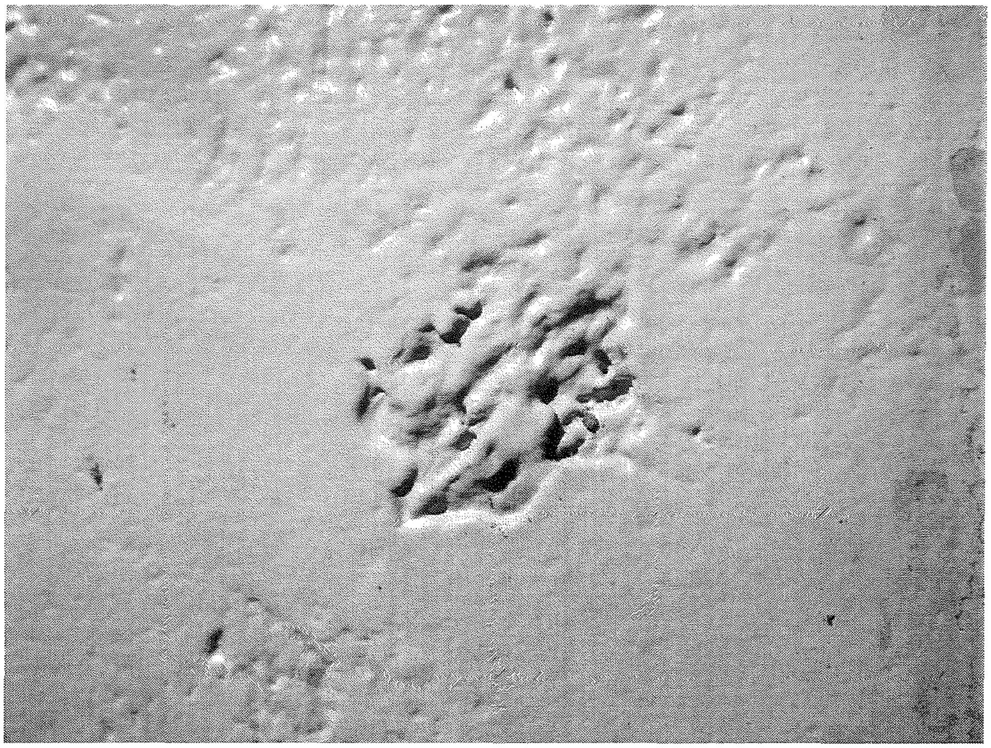


Figure 1 – Photograph showing area of Valve 2 selected to be polished For Replication. (Location 2B & 2A)

Figure 2– Photograph of the area on Valve 2 shown in Figure 1 after polishing

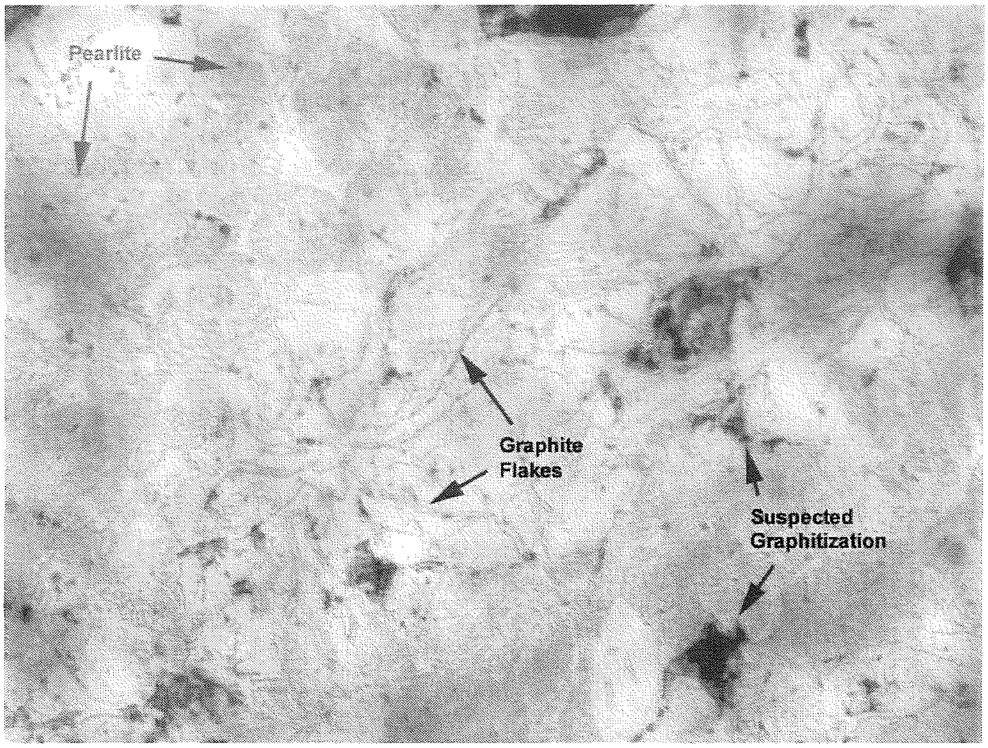


Figure 3 Microstructure of the Ruth Falls #2 Valve Body From a Replica. 100X

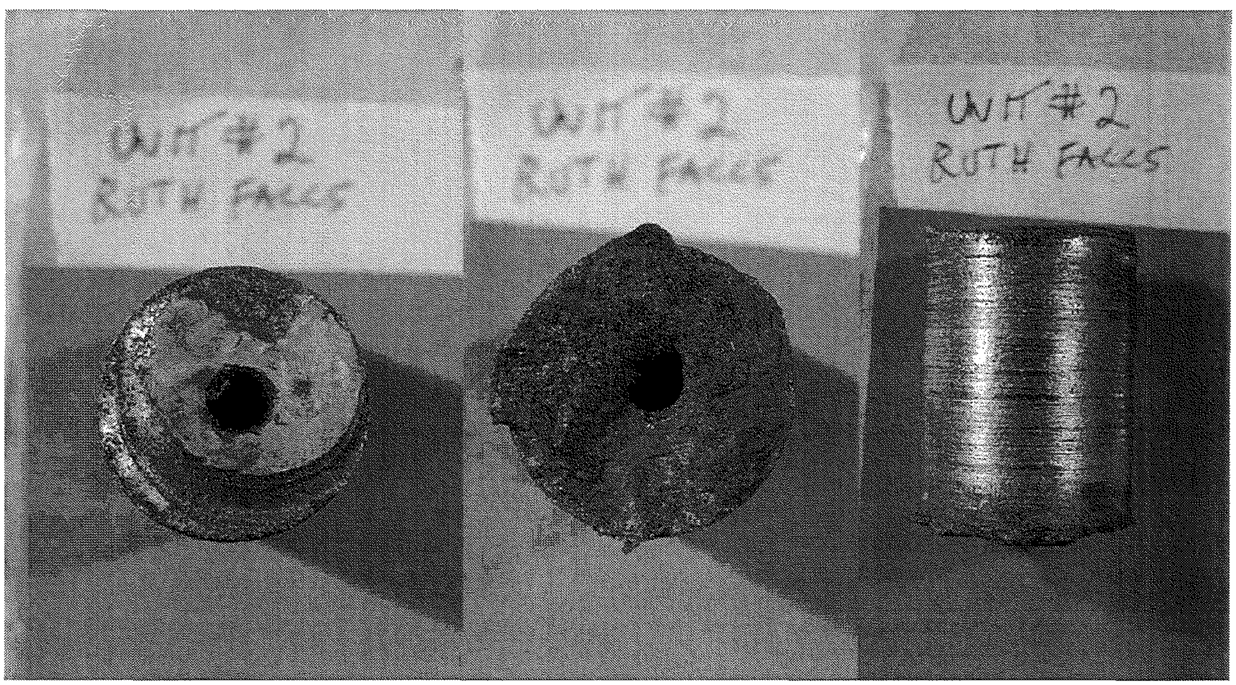


Figure 4 Composite Photograph of the Core of the Ruth Falls #2 Butterfly

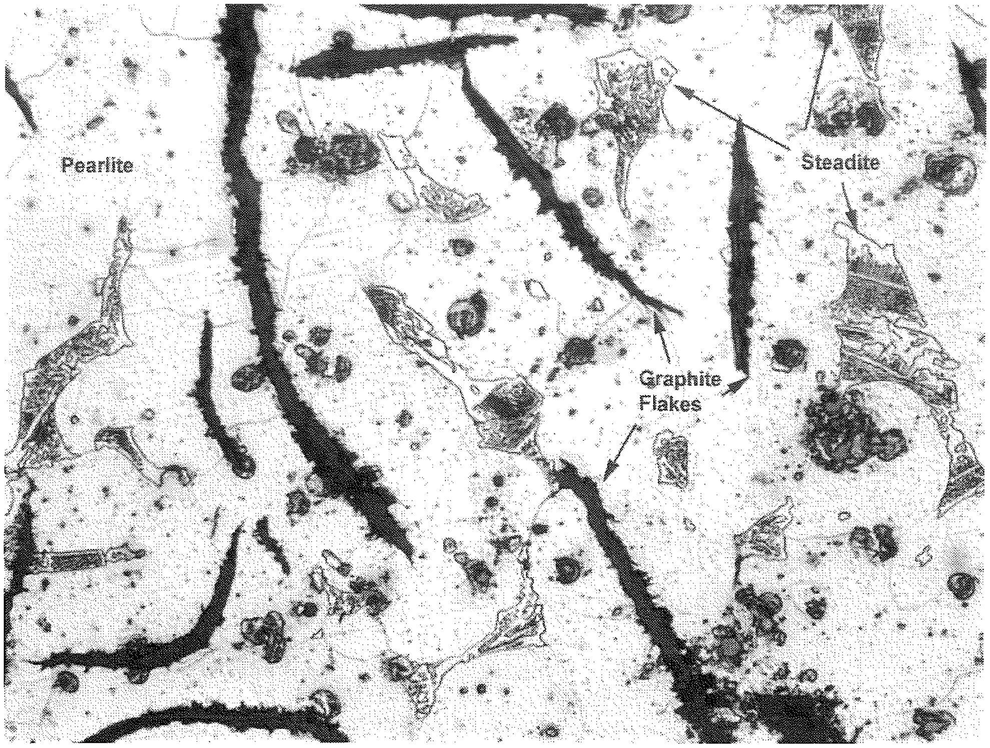


Figure 5 Microstructure of the Ruth Falls #2 Butterfly Core. 100X

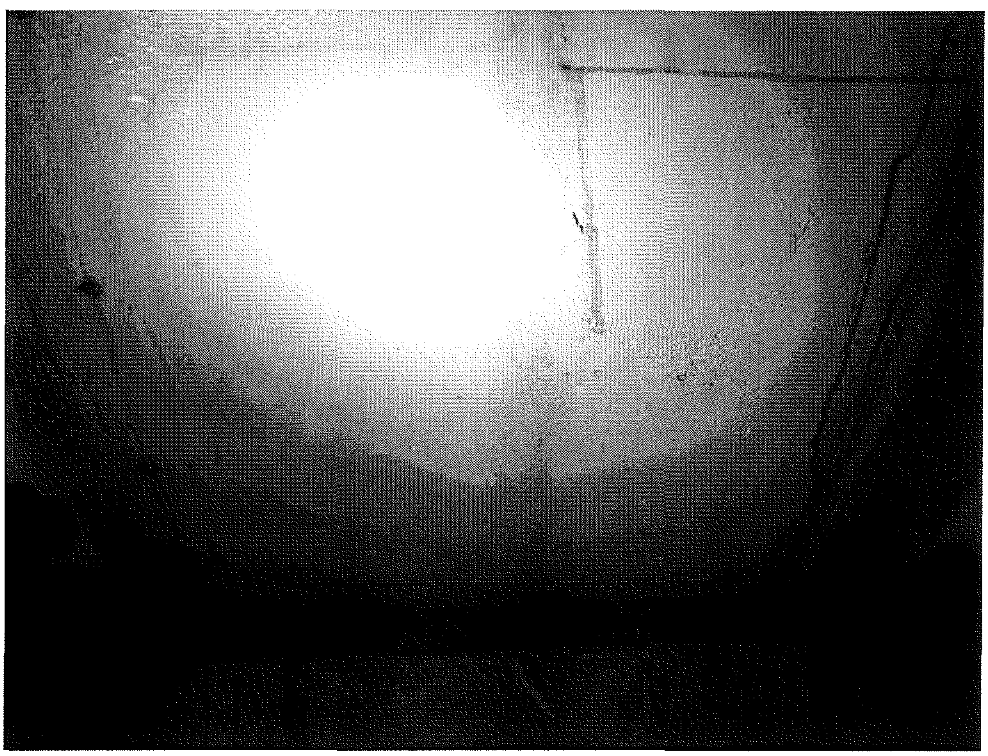


Figure 6 - Photograph showing the area of Valve 1 that was selected to be polished and have Replicas made.

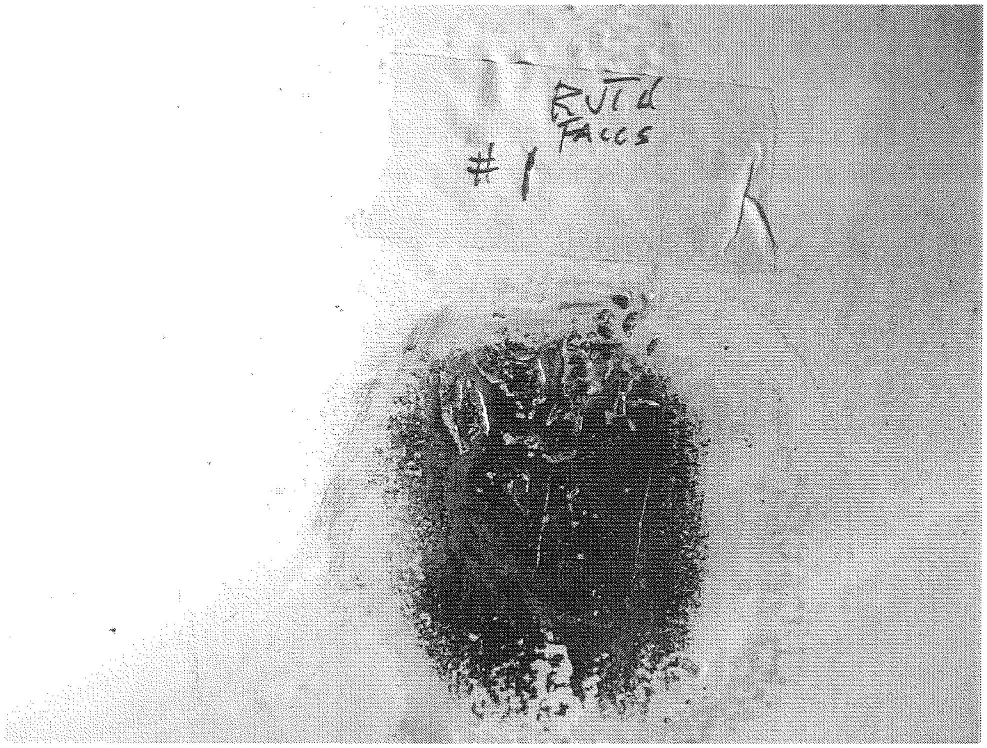


Figure 7 - Photograph of the area of Valve 1 shown in Figure 3 after polishing

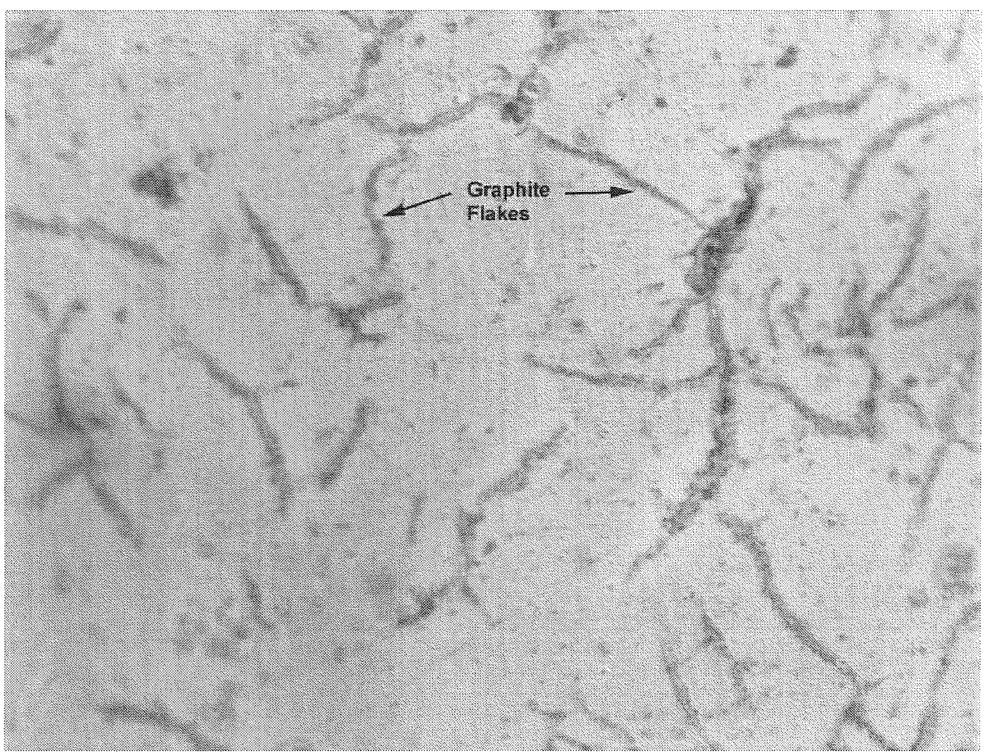


Figure 8 Microstructure of the Ruth Falls #1 Valve Body From a Replica Showing Type A Flakes. 100X

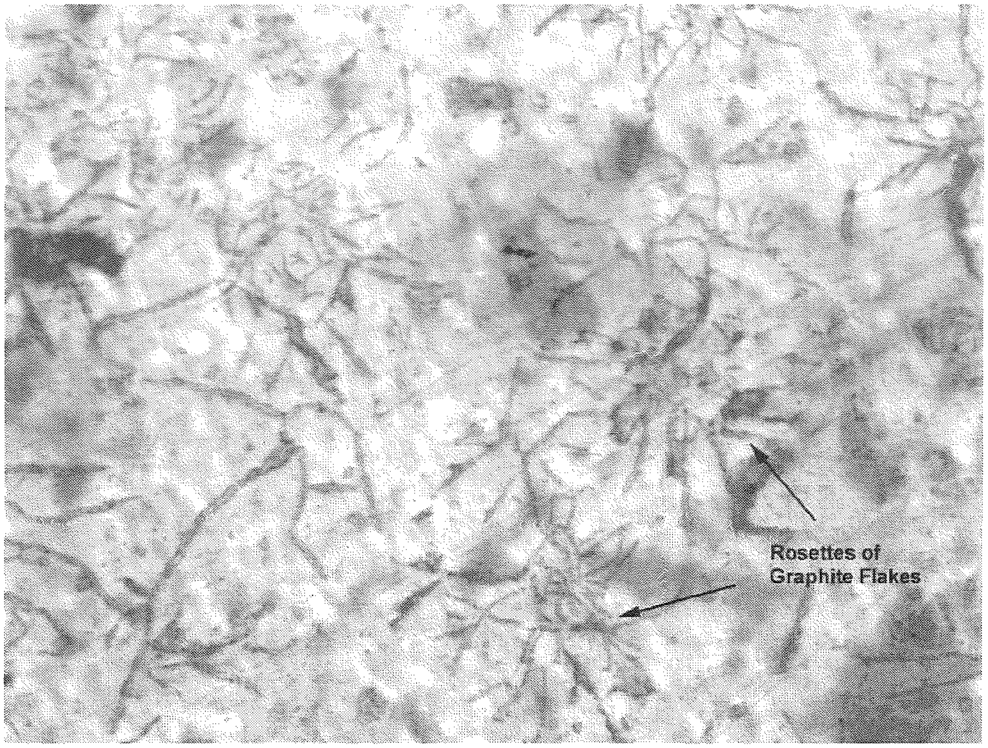


Figure 9 Replica Microstructure of the Ruth Falls #2 Valve Body Showing Type B Rosettes. 50X

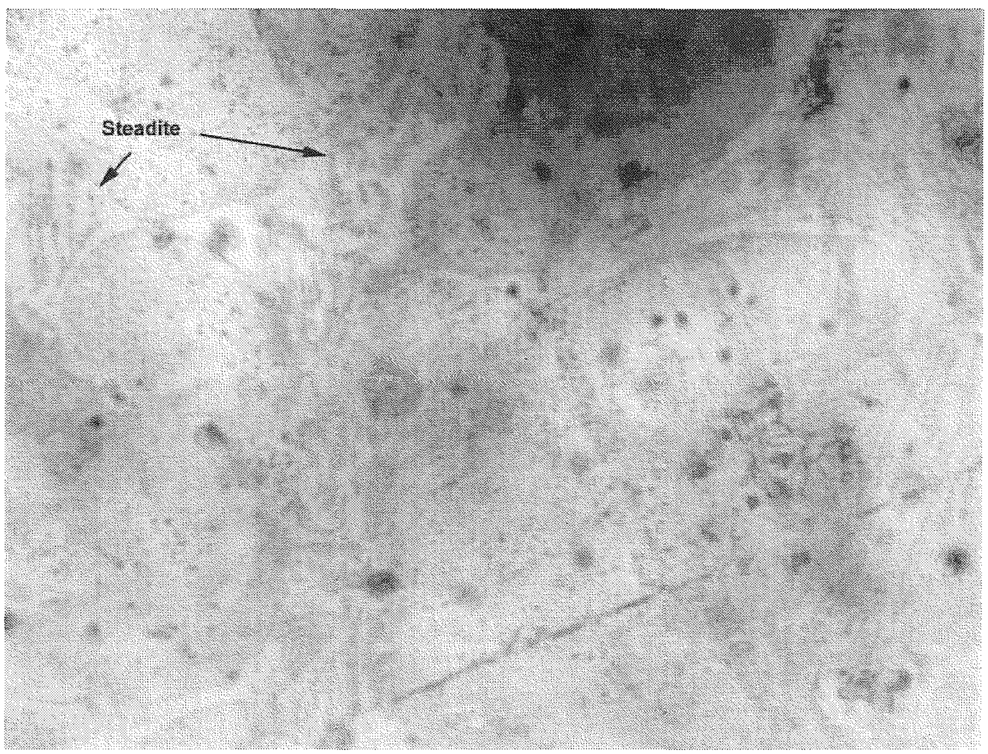


Figure 10 Replica Microstructure of the Ruth Falls #2 Valve Body Showing the Pearlite Matrtix. 200X

Figure 11 Photographs showing the painted side, scale side, and profile of the core sample taken from Valve 1

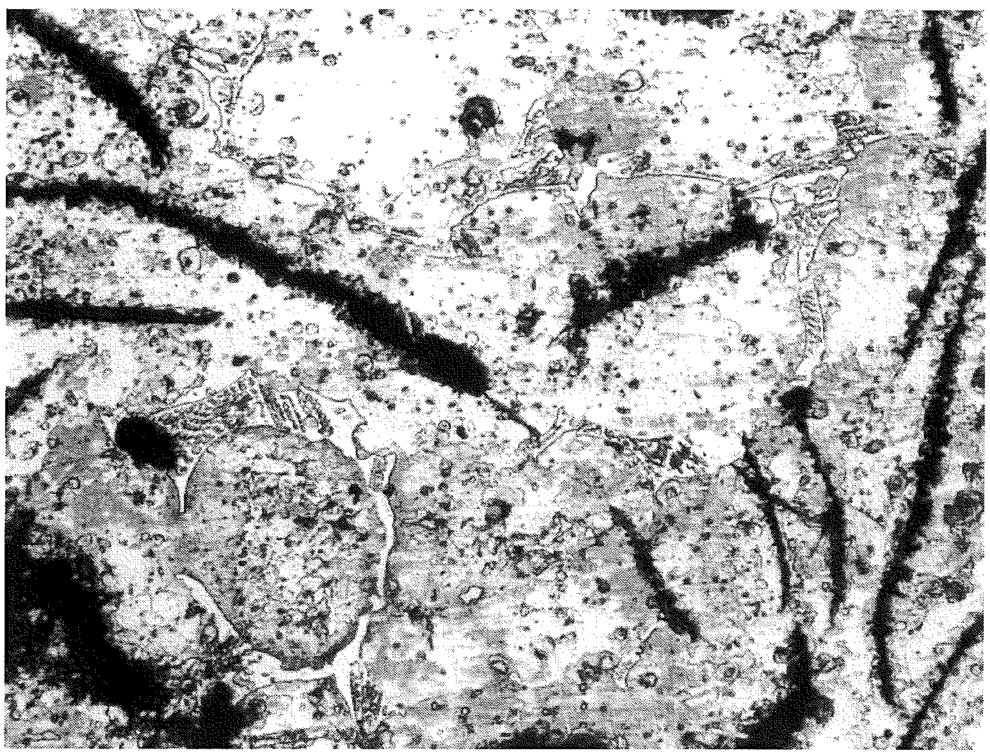


Figure 12 Micrograph of the Core Sample from Ruth Falls #1 Valve Butterfly. 100X

Figure 13 - Photograph showing the area of Valve 3 that was selected to be polished and have Replicas made.

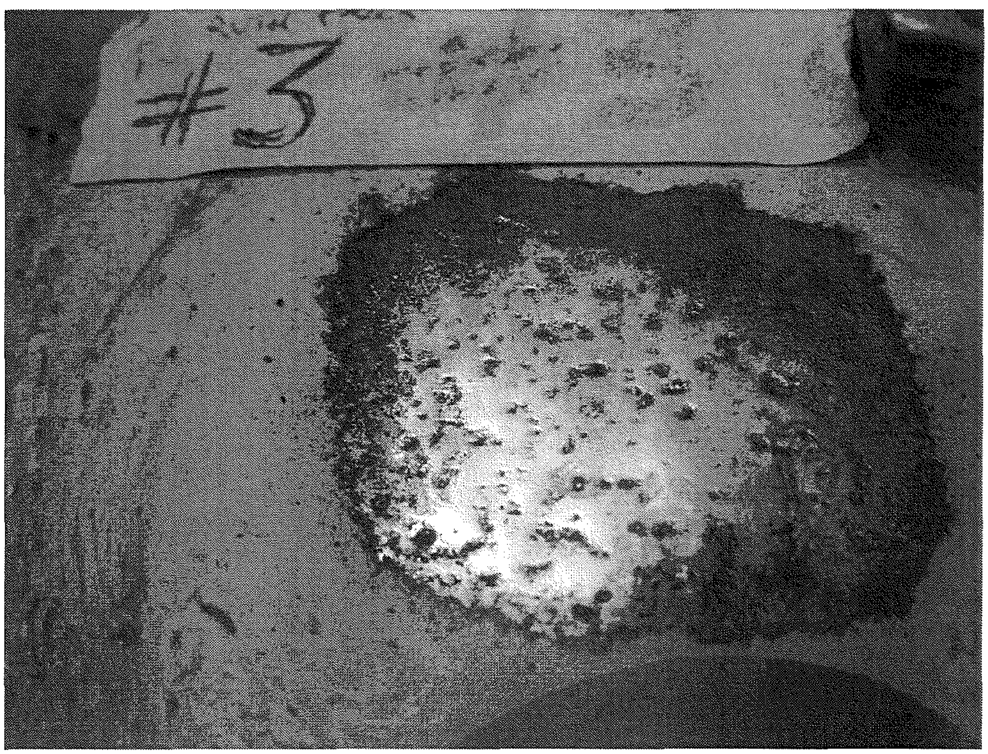


Figure 14 - Photograph of the area on Valve 3 shown in Figure 5 after polishing

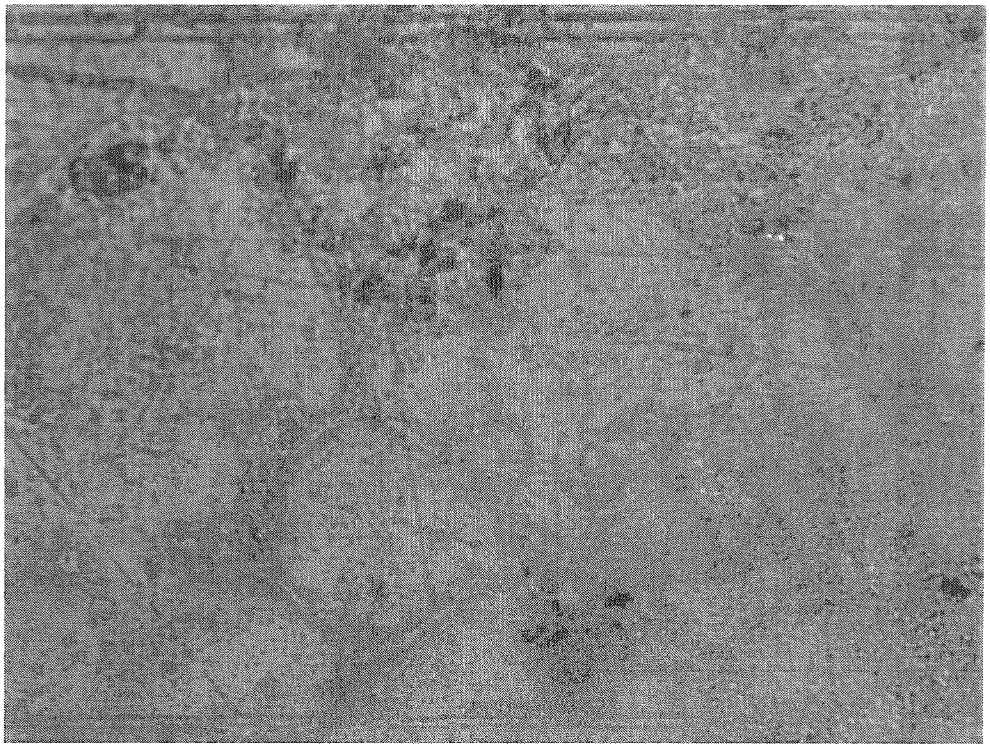


Figure 15 Micrograph From the Replica of the #3 Valve Body Showing No Distinct Microstructure. 200X

Figure 16 - Photographs showing the painted side, scale side, and profile of the core sample taken from Valve 3

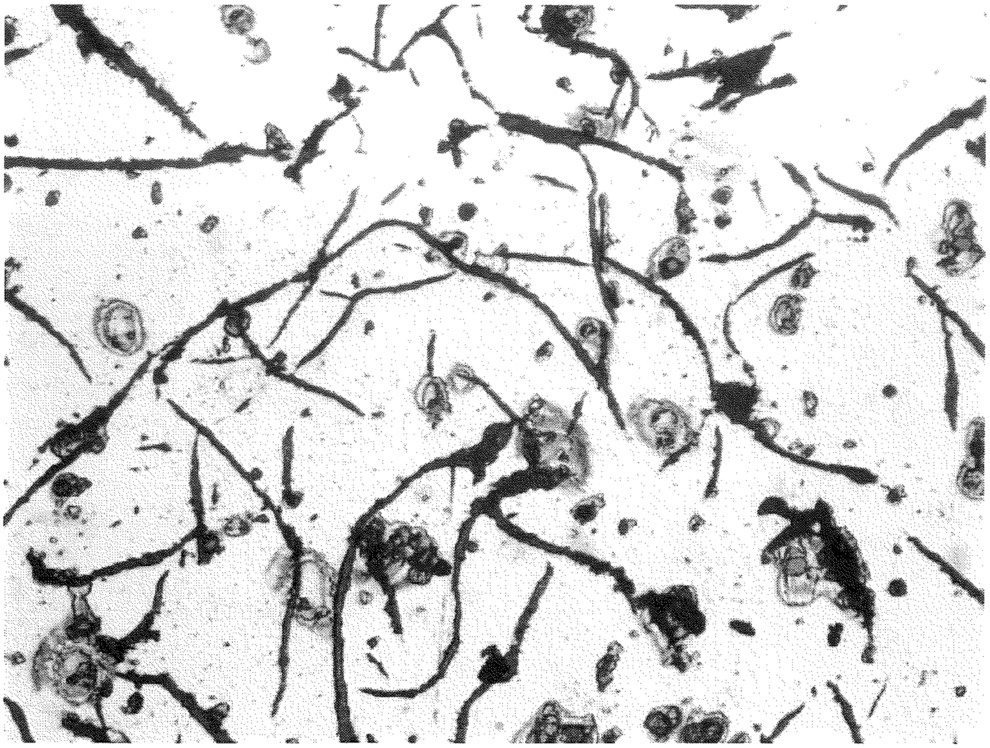


Figure 17 Micrograph of the Core Sample from Ruth Falls #3 Valve Butterfly. 100X

Attachment 4

Removed due to confidentiality

CI Number: 43127

Title: **HYD - 4th Lake Penstock Refurbishment**

Start Date: 2013/03
Final Cost Date: 2014/01
Function: Generation
Forecast Amount: $441,243

DESCRIPTION:

This item consists of refurbishing and application of a protective coating on the steel liner in the Fourth Lake penstock.

Summary of Related CIs +/- 2 years:
2013 – CI 43125 HYD 4th Lake Butterfly Valve Replacement - $127,466

JUSTIFICATION:

Justification Criteria: Health & Safety

Sub Criteria: Maintenance

Why do this project?

An inspection revealed the existing protective coating on the steel liner, its welded joints and past plating repairs is deteriorating. The steel liner is showing signs of degradation as a result of corrosion and wear, and needs to be re-coated to ensure its long term service. If left unchecked, this could compromise the structural integrity of the steel liner, which would compromise the integrity of the main embankment dam and the Fourth Lake Generating Station.

Why do this project now?

The existing protective coating on the inside of the steel penstock liner is deteriorating. As a result, the steel liner is corroding, and the rate of corrosion is expected to increase as the remnants of the original coating system are lost.

Why do this project this way?

Steel repair followed by abrasive blasting and application of a protective coating is an economic and effective method to ensure the continued safe operation of the Fourth Lake penstock.

CI Number : 43127 - HYD - 4th Lake Penstock Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 411 - 411-Sissiboo/Weymouth System **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		4,119	0	4,119
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
095		095-Hydro Regular Labour AO		1,394	0	1,394
095		095-Hydro Term Labour AO		387	0	387
095		095-Hydro Overtime Labour AO		310	0	310
001	027	001 - HYDRO Regular Labour	027 - HGP - Waterways	7,200	0	7,200
002	027	002 - HYDRO Overtime Labour	027 - HGP - Waterways	3,200	0	3,200
004	027	004 - HYDRO Term Labour	027 - HGP - Waterways	2,000	0	2,000
011	027	011 - Travel Expense	027 - HGP - Waterways	1,500	0	1,500
012	027	012 - Materials	027 - HGP - Waterways	10,000	0	10,000
013	027	013 - POWER PRODUCTION Contracts	027 - HGP - Waterways	[redacted]	0	[redacted]
028	027	028 - Consulting	027 - HGP - Waterways	[redacted]	0	[redacted]
041	027	041 - Meals & Entertainment	027 - HGP - Waterways	1,500	0	1,500
066	027	066 - Other Goods & Services	027 - HGP - Waterways	4,000	0	4,000
			Total Cost:	441,243	0	441,243
			Original Cost:	205,042		

Location: Hydro
FP#: 43127
Title: HYD - Fourth Lake Penstock Refurbishment

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	001 Regular Labour						
1.1	Site Support	hr	[redacted]		$ 7,200.00		
1.2							
				Sub-Total	$ 7,200.00		
2	012 Materials						
2.1	Miscellaneous	lot	1	$ 10,000.00	$ 10,000.00		
2.2							
				Sub-Total	$ 10,000.00		
3	013 Power Production Contracts						
3.1	Blasting & Painting Steel Penstock	lot	1	[redacted]		Cost Support 1	
3.2	Contingency	%	[redacted]				
3.3	Steel Repair	lot	1				
3.4	Concrete Resoration	lot	1				
				Sub-Total	[redacted]		
4	002 Overtime Labour						
4.1	Site Support	hr	[redacted]		$ 3,200.00		
4.2					$ -		
				Sub-Total	$ 3,200.00		
5	004 Term Labour						
5.1	Site Support	hr	[redacted]		$ 2,000.00		
5.2					$ -		
				Sub-Total	$ 2,000.00		
6	011 Travel Expenses						
6.1	Travel to site	lot	1	$ 1,500.00	$ 1,500.00		
6.2					$ -		
				Sub-Total	$ 1,500.00		
7	028 Consulting						
7.1	Design	lot	1	[redacted]			
7.2	Project Management	lot	1				
7.3	Site Inspection	lot	1				
7.4	Testing	lot	1				
				Sub-Total	[redacted]		
8	041 Meals and Entertainment						
8.1	Meals during Travel	lot	1	$ 1,500.00	$ 1,500.00		
8.2					$ -		
				Sub-Total	$ 1,500.00		
9	066- Other Goods and Services						
9.1	Miscellaneous	lot	1	$ 4,000.00	$ 4,000.00		
9.2					$ -		
				Sub-Total	$ 4,000.00		
10	094 Interest Capitalized						
10.1	Interest Capitalized	lot	1	$ 4,119.36	$ 4,119.36		
10.2					$ -		
				Sub-Total	$ 4,119.36		
11	095 Administrative Overhead						
11.1	Hydro Regular Labour AO	lot	1	$ 1,393.92	$ 1,393.92		
11.2	Hydro OT Labour AO	lot	1	$ 309.76	$ 309.76		
11.3	Hydro Term Labour AO	lot	1	$ 387.20	$ 387.20		
11.4	Thermal & Hydro Contracts AO	lot	1	$ 34,133.00	[redacted]		
				Sub-Total			
Cost Estimate				Total	$ 441,243.24		
12	Original Cost						
12.1					$ 205,042.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 & 2

Removed due to confidentiality

CI Number: 43128

Title: **HYD – Gisborne Gearbox Replacement**

Start Date: 2012/07
Final Cost Date: 2014/03
Function: Generation
Forecast Amount: $360,731

DESCRIPTION:

This item covers the replacement of the gearbox in the Gisborne Powerhouse.
Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015

JUSTIFICATION:

Justification Criteria: HYDRO

Sub Criteria: Equipment Replacement

Why do this project?

In 2012, oil samples taken from the gearbox showed a large amount of iron in the oil, indicating the gears in the gearbox have continued to wear since damage to the gears was first observed in 2000. If not corrected, this wear will cause the gearbox to fail in service.

Why do this project now?

If the gearbox fails during operation, the Gisborne Generating Station will be out of service for an extended period of time. Since the gears in the gearbox are known to have been wearing for the last 12 years, there is an increasing likelihood the gearbox will fail in the near term.

Why do this project this way?

Replacing the gearbox is more cost effective than having the gearbox refurbished. Therefore, the option to replace the gearbox is recommended.

CI Number : 43128 - HYD - Gisborne Gearbox Replacement **Project Number**

Parent CI Number : -

Cost Centre : 480 - 480-Wreck Cove Hydro System **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		8,270	0	8,270
095		095-Hydro Regular Labour AO		8,518	0	8,518
095		095 - T&CS Regular Labour AO		1,400	0	1,400
001	022	001 - HYDRO Regular Labour	022 - GTG - Elec Contr.Equip.	44,000	0	44,000
001	022	001 - T&CS Regular Labour	022 - GTG - Elec Contr.Equip.	4,480	0	4,480
011	022	011 - Travel Expense	022 - GTG - Elec Contr.Equip.	[redacted]	0	[redacted]
012	022	012 - Materials	022 - GTG - Elec Contr.Equip.	[redacted]	0	[redacted]
			Total Cost:	360,731	0	360,731
			Original Cost:	113,156		

HYD Gisborne Gearbox Replacement
Summary of Alternatives

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Hydro	**CI Number:**	43128
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Gearbox	6.48%	3,268,643	1	77.19%	2.5 years
B	Refurbish Gearbox	6.48%	3,192,119	2	60.19%	3.9 years
C	Test 3	6.48%	0	3	#NUM!	0.0 years
D	Test 4	6.48%	0	3	#NUM!	0.0 years

Recommendation :

It is recommended to replace the gearbox unit at the Gisborne Generating Plant.

Notes/Comments :

Replace Gearbox

This option considers the replacement of the gearbox.

Refurbish Gearbox

This estimate considered refurbishing the gerabox unit. The cost is based on the refurbishment cost of $329,900, plus other project costs.

Test 3

Test 4

HYD Gisborne Gearbox Replacement
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Hydro	CI Number:	43128
Originator :		Project No. :	

Replace Gearbox

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	25%	50%	25%	50%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	[redacted]					
Duration (Hours)	1	1				
Totals	$97,666	$195,840	$0	$0	$97,666	$195,840
Total Capital Cost of Alternative						$360,731

Refurbish Gearbox

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	25%	50%	25%	50%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	[redacted]					
Duration (Hours)	1	1				
Totals	$97,666	$195,840	$0	$0	$97,666	$195,840
Total Capital Cost of Alternative						$463,930

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

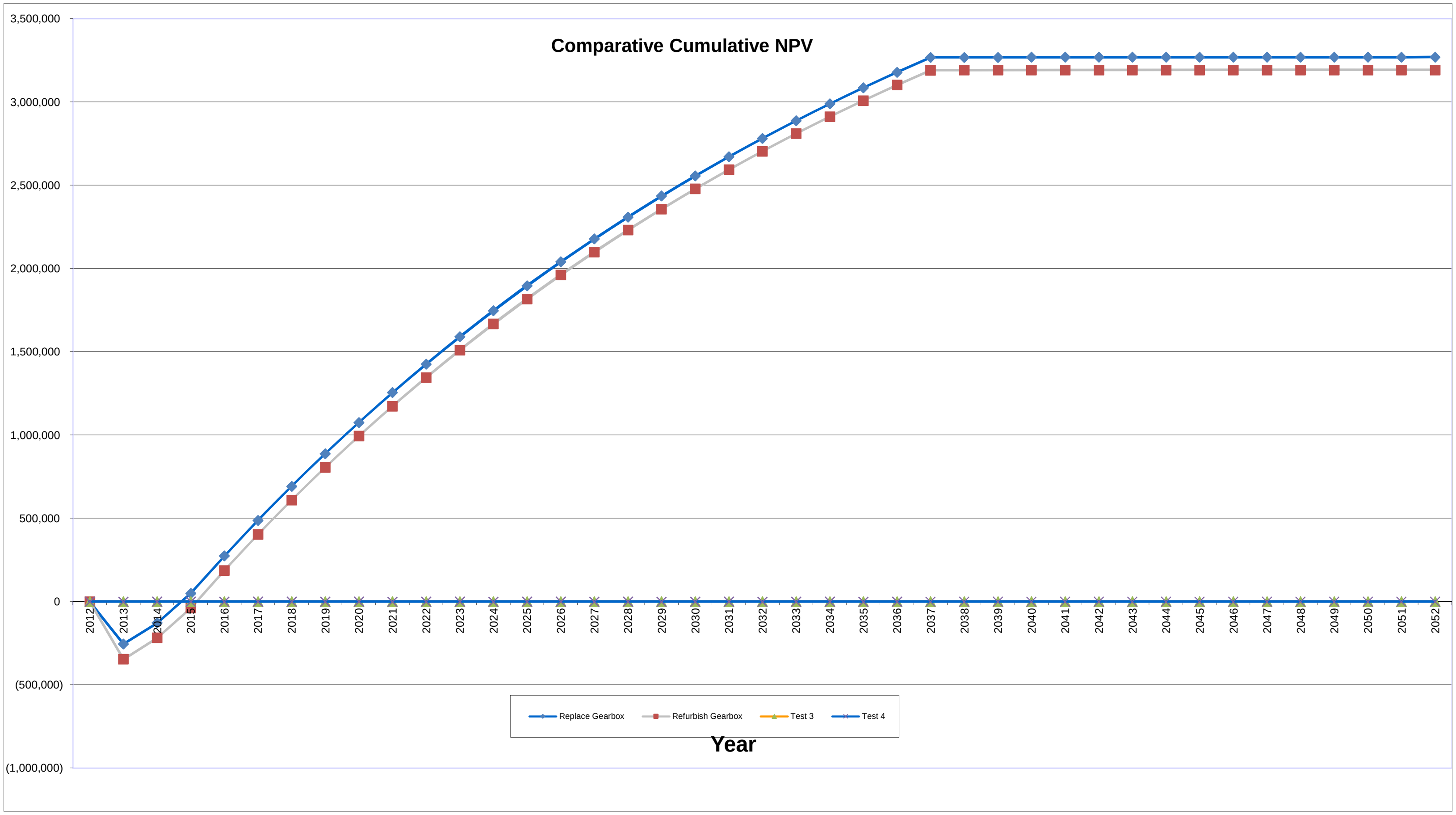
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

HYD Gisborne Gearbox Replacement
Replace Gearbox

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	97,666.4	(342,543.0)	13,820.7	331,697.7	(244,876.6)	(25,992.2)	(270,868.7)	(254,384.616)	0.9	(254,384.6)
2014	-	195,839.6	-	26,535.8	305,161.9	195,839.6	(52,484.2)	143,355.4	126,438.096	0.9	(127,946.5)
2015	-	299,634.5	-	24,412.9	280,748.9	299,634.5	(85,318.7)	214,315.8	177,521.156	0.8	49,574.6
2016	-	407,502.9	-	22,459.9	258,289.0	407,502.9	(119,363.3)	288,139.6	224,145.888	0.8	273,720.5
2017	-	415,653.0	-	20,663.1	237,625.9	415,653.0	(122,446.9)	293,206.1	214,206.595	0.7	487,927.1
2018	-	423,966.1	-	19,010.1	218,615.8	423,966.1	(125,536.4)	298,429.7	204,754.656	0.7	692,681.8
2019	-	432,445.4	-	17,489.3	201,126.5	432,445.4	(128,636.4)	303,809.0	195,760.160	0.6	888,441.9
2020	-	441,094.3	-	16,090.1	185,036.4	441,094.3	(131,751.3)	309,343.0	187,195.732	0.6	1,075,637.7
2021	-	449,916.2	-	14,802.9	170,233.5	449,916.2	(134,885.1)	315,031.1	179,036.258	0.6	1,254,673.9
2022	-	458,914.5	-	13,618.7	156,614.8	458,914.5	(138,041.7)	320,872.8	171,258.630	0.5	1,425,932.6
2023	-	468,092.8	-	12,529.2	144,085.6	468,092.8	(141,224.7)	326,868.1	163,841.542	0.5	1,589,774.1
2024	-	477,454.6	-	11,526.9	132,558.8	477,454.6	(144,437.6)	333,017.0	156,765.295	0.5	1,746,539.4
2025	-	487,003.7	-	10,604.7	121,954.1	487,003.7	(147,683.7)	339,320.0	150,011.636	0.4	1,896,551.0
2026	-	496,743.8	-	9,756.3	112,197.8	496,743.8	(150,966.1)	345,777.7	143,563.610	0.4	2,040,114.6
2027	-	506,678.7	-	8,975.8	103,221.9	506,678.7	(154,287.9)	352,390.8	137,405.437	0.4	2,177,520.1
2028	-	516,812.3	-	8,257.8	94,964.2	516,812.3	(157,651.9)	359,160.4	131,522.398	0.4	2,309,042.5
2029	-	527,148.5	-	7,597.1	87,367.0	527,148.5	(161,060.9)	366,087.6	125,900.736	0.3	2,434,943.2
2030	-	537,691.5	-	6,989.4	80,377.7	537,691.5	(164,517.7)	373,173.8	120,527.570	0.3	2,555,470.8
2031	-	548,445.3	-	6,430.2	73,947.5	548,445.3	(168,024.7)	380,420.6	115,390.816	0.3	2,670,861.6
2032	-	559,414.2	-	5,915.8	68,031.7	559,414.2	(171,584.5)	387,829.7	110,479.122	0.3	2,781,340.7
2033	-	570,602.5	-	5,442.5	62,589.1	570,602.5	(175,199.6)	395,402.9	105,781.802	0.3	2,887,122.5
2034	-	582,014.5	-	5,007.1	57,582.0	582,014.5	(178,872.3)	403,142.2	101,288.788	0.3	2,988,411.3
2035	-	593,654.8	-	4,606.6	52,975.4	593,654.8	(182,605.0)	411,049.9	96,990.575	0.2	3,085,401.9
2036	-	605,527.9	-	4,238.0	48,737.4	605,527.9	(186,399.9)	419,128.1	92,878.185	0.2	3,178,280.1
2037	-	617,638.5	-	3,899.0	44,838.4	617,638.5	(190,259.2)	427,379.2	88,943.121	0.2	3,267,223.2
2038	-	-	-	3,587.1	41,251.3	-	1,112.0	1,112.0	217.337	0.2	3,267,440.5
2039	-	-	-	3,300.1	37,951.2	-	1,023.0	1,023.0	187.781	0.2	3,267,628.3
2040	-	-	-	3,036.1	34,915.1	-	941.2	941.2	162.245	0.2	3,267,790.6
2041	-	-	-	2,793.2	32,121.9	-	865.9	865.9	140.182	0.2	3,267,930.7
2042	-	-	-	2,569.8	29,552.2	-	796.6	796.6	121.119	0.2	3,268,051.9
2043	-	-	-	2,364.2	27,188.0	-	732.9	732.9	104.648	0.1	3,268,156.5
2044	-	-	-	2,175.0	25,013.0	-	674.3	674.3	90.417	0.1	3,268,246.9
2045	-	-	-	2,001.0	23,011.9	-	620.3	620.3	78.122	0.1	3,268,325.0
2046	-	-	-	1,841.0	21,171.0	-	570.7	570.7	67.498	0.1	3,268,392.5
2047	-	-	-	1,693.7	19,477.3	-	525.0	525.0	58.319	0.1	3,268,450.9
2048	-	-	-	1,558.2	17,919.1	-	483.0	483.0	50.388	0.1	3,268,501.2
2049	-	-	-	1,433.5	16,485.6	-	444.4	444.4	43.536	0.1	3,268,544.8
2050	-	-	-	1,318.8	15,166.7	-	408.8	408.8	37.616	0.1	3,268,582.4
2051	-	-	-	1,213.3	13,953.4	-	376.1	376.1	32.501	0.1	3,268,614.9
2052	-	-	-	1,116.3	12,837.1	-	346.0	346.0	28.081	0.1	3,268,643.0
Total	-	11,717,556.4	(342,543.0)	332,681.3	3,998,593.9	11,375,013.4	(3,529,311.3)	7,845,702.1	3,268,643.0		

HYD Gisborne Gearbox Replacement
Refurbish Gearbox

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	97,666.4	(441,660.0)	17,822.4	445,560.0	(343,993.6)	(24,751.6)	(368,745.2)	(346,304.680)	0.9	(346,304.7)
2014	-	195,839.6	-	34,219.0	393,518.6	195,839.6	(50,102.4)	145,737.2	128,538.812	0.9	(217,765.9)
2015	-	299,634.5	-	31,481.5	362,037.1	299,634.5	(83,127.4)	216,507.1	179,336.200	0.8	(38,429.7)
2016	-	407,502.9	-	28,963.0	333,074.1	407,502.9	(117,347.4)	290,155.5	225,714.108	0.8	187,284.4
2017	-	415,653.0	-	26,645.9	306,428.2	415,653.0	(120,592.2)	295,060.8	215,561.556	0.7	402,846.0
2018	-	423,966.1	-	24,514.3	281,913.9	423,966.1	(123,830.1)	300,136.0	205,925.359	0.7	608,771.4
2019	-	432,445.4	-	22,553.1	259,360.8	432,445.4	(127,066.6)	305,378.8	196,771.661	0.6	805,543.0
2020	-	441,094.3	-	20,748.9	238,612.0	441,094.3	(130,307.1)	310,787.2	188,069.682	0.6	993,612.7
2021	-	449,916.2	-	19,089.0	219,523.0	449,916.2	(133,556.4)	316,359.7	179,791.360	0.6	1,173,404.1
2022	-	458,914.5	-	17,561.8	201,961.2	458,914.5	(136,819.3)	322,095.2	171,911.048	0.5	1,345,315.1
2023	-	468,092.8	-	16,156.9	185,804.3	468,092.8	(140,100.1)	327,992.7	164,405.239	0.5	1,509,720.3
2024	-	477,454.6	-	14,864.3	170,939.9	477,454.6	(143,403.0)	334,051.6	157,252.336	0.5	1,666,972.7
2025	-	487,003.7	-	13,675.2	157,264.7	487,003.7	(146,731.8)	340,271.9	150,432.445	0.4	1,817,405.1
2026	-	496,743.8	-	12,581.2	144,683.6	496,743.8	(150,090.4)	346,653.4	143,927.194	0.4	1,961,332.3
2027	-	506,678.7	-	11,574.7	133,108.9	506,678.7	(153,482.2)	353,196.4	137,719.578	0.4	2,099,051.9
2028	-	516,812.3	-	10,648.7	122,460.2	516,812.3	(156,910.7)	359,901.6	131,793.819	0.4	2,230,845.7
2029	-	527,148.5	-	9,796.8	112,663.4	527,148.5	(160,379.0)	366,769.5	126,135.248	0.3	2,356,981.0
2030	-	537,691.5	-	9,013.1	103,650.3	537,691.5	(163,890.3)	373,801.2	120,730.191	0.3	2,477,711.2
2031	-	548,445.3	-	8,292.0	95,358.3	548,445.3	(167,447.5)	380,997.8	115,565.883	0.3	2,593,277.0
2032	-	559,414.2	-	7,628.7	87,729.6	559,414.2	(171,053.5)	388,360.7	110,630.382	0.3	2,703,907.4
2033	-	570,602.5	-	7,018.4	80,711.2	570,602.5	(174,711.1)	395,891.4	105,912.492	0.3	2,809,819.9
2034	-	582,014.5	-	6,456.9	74,254.3	582,014.5	(178,422.9)	403,591.7	101,401.706	0.3	2,911,221.6
2035	-	593,654.8	-	5,940.3	68,314.0	593,654.8	(182,191.5)	411,463.3	97,088.138	0.2	3,008,309.8
2036	-	605,527.9	-	5,465.1	62,848.9	605,527.9	(186,019.5)	419,508.5	92,962.480	0.2	3,101,272.2
2037	-	617,638.5	-	5,027.9	57,821.0	617,638.5	(189,909.3)	427,729.2	89,015.953	0.2	3,190,288.2
2038	-	-	-	4,625.7	53,195.3	-	1,434.0	1,434.0	280.264	0.2	3,190,568.5
2039	-	-	-	4,255.6	48,939.7	-	1,319.2	1,319.2	242.152	0.2	3,190,810.6
2040	-	-	-	3,915.2	45,024.5	-	1,213.7	1,213.7	209.222	0.2	3,191,019.8
2041	-	-	-	3,602.0	41,422.5	-	1,116.6	1,116.6	180.770	0.2	3,191,200.6
2042	-	-	-	3,313.8	38,108.7	-	1,027.3	1,027.3	156.188	0.2	3,191,356.8
2043	-	-	-	3,048.7	35,060.0	-	945.1	945.1	134.948	0.1	3,191,491.7
2044	-	-	-	2,804.8	32,255.2	-	869.5	869.5	116.597	0.1	3,191,608.3
2045	-	-	-	2,580.4	29,674.8	-	799.9	799.9	100.741	0.1	3,191,709.1
2046	-	-	-	2,374.0	27,300.8	-	735.9	735.9	87.041	0.1	3,191,796.1
2047	-	-	-	2,184.1	25,116.8	-	677.1	677.1	75.205	0.1	3,191,871.3
2048	-	-	-	2,009.3	23,107.4	-	622.9	622.9	64.978	0.1	3,191,936.3
2049	-	-	-	1,848.6	21,258.8	-	573.1	573.1	56.142	0.1	3,191,992.4
2050	-	-	-	1,700.7	19,558.1	-	527.2	527.2	48.507	0.1	3,192,040.9
2051	-	-	-	1,564.6	17,993.5	-	485.0	485.0	41.911	0.1	3,192,082.9
2052	-	-	-	1,439.5	16,554.0	-	446.2	446.2	36.211	0.1	3,192,119.1
Total	-	11,717,556.4	(441,660.0)	429,006.0	5,174,171.5	11,275,896.4	(3,499,450.6)	7,776,445.8	3,192,119.1		


Comparative Cumulative NPV
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Replace Gearbox
Refurbish Gearbox
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: Hydro
FP#: 43128
Title: HYD - Gisborne Gearbox Replacement

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Hydro Regular Labour	hr	[redacted]		$ 44,000.00		
1.2	Project Management	hr			$ 4,480.00		
1.3		hr			$ -		
				Sub-Total	$ 48,480.00		
2	**012 Materials**						
2.1	Supply of new Gearbox	lot	1	[redacted]		Cost Support 1	
2.2	Contingency	%					
2.3					$ -		
2.4					$ -		
				Sub-Total	[redacted]		
3	**011 Travel Expenses**						
3.1	Travel & Lodging at site	lot	1	[redacted]			
3.2					$ -		
3.3					$ -		
				Sub-Total	[redacted]		
4	**094 Interest Capitalized**						
4.1	Interest Capitalized	lot	1	$ 8,270.00	$ 8,270.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 8,270.00		
5	**095 Administrative Overhead**						
5.1	Hydro Regular Labour AO	lot	1	$ 8,518.00	$ 8,518.00		
5.2	T&C Regular Labour AO	lot	1	$ 1,400.00	$ 1,400.00		
				Sub-Total	$ 9,918.00		
Cost Estimate				**Total**	$ 360,731.00		
6	**Original Cost**						
6.1					$ 113,156.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

CI Number: 42806

Title: **LIN3 – L-0 Blades Replacement**

Start Date: 2012/04
Final Cost Date: 2013/12
Function: Generation
Forecast Amount: $3,825,904

DESCRIPTION:

The Unit 3 Last Pass (L-0) Blades are considered at end of life based on assessments undertaken by NS Power in the spring of 2012. Replacement during the next planned major turbine generator outage is recommended. At this time, temporary refurbishments were also completed due to foreign object damage.

The L-0 blades are original to the turbine and are susceptible to wear due to their location in the turbine (the L-0 blades are the last blades before the steam is condensed in the condenser). The tips of the blades have started to erode, and erosion patterns caused stress risers which allowed a cyclic fatigue fracture to occur with increasing risk of blade separation.

The blades are expected to be in operation for approximately 25 years under normal operating conditions.

The depreciation class for the project is Lingan 3-4.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015.

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

Lingan Unit 3 L-0 life consumption calculations and evaluations by the NS Power turbine generator Asset Management team indicates that the L-0 blades are now at the end of their service life and replacement is needed. Operating the turbine in its current state beyond 2013 increases the risk of forced outages due to vibration excursions and blade separation. Blade separations may cause damage to both the turbine, and associated equipment such as condenser components.

Why do this project now?

Unit 3 has a major outage planned for the spring of 2013 for generator re-wind and boiler refurbishment. The outage is of sufficient duration for the L-0 blades to be replaced.

Operating the turbine in its current state beyond 2013 increases the risk of forced outages due to vibration excursions and blade separation. Blade separations may cause damage to both the turbine, and associated equipment such as condenser components.

Why do this project this way?

It is necessary for safety and continued operation of the unit to re-establish life cycle integrity of the Unit 3 L-0 blades. Repair or replacement of individual blades versus replacement of the blade set is not considered an adequate measure to restore integrity.

CI Number : 42806-SA38 - LIN3 L-0 Blades Replacement **Project Number** SA38

Parent CI Number : -

Cost Centre : 305 - 305-Lingan 3&4 Prod.Unit **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		121,155	0	121,155
095		095-Thermal & Hydro Contracts AO		166,084	0	166,084
095		095-COPS Contracts AO		4,559	0	4,559
095		095-Thermal Overtime Labour AO		371	0	371
095		095-Thermal Term Labour AO		5,327	0	5,327
095		095-Thermal Regular Labour AO		55,621	0	55,621
001	010	001 - THERMAL Regular Labour	010 - SGP - Turbo Gen.Instal.	213,070	0	213,070
001	010	001 - Regular Labour (No AO)	010 - SGP - Turbo Gen.Instal.	1,314	0	1,314
002	010	002 - THERMAL Overtime Labour	010 - SGP - Turbo Gen.Instal.	3,092	0	3,092
002	010	002 - Overtime Labour (No AO)	010 - SGP - Turbo Gen.Instal.	0	0	0
004	010	004 - Term Labour (NO AO)	010 - SGP - Turbo Gen.Instal.	17,286	0	17,286
004	010	004 - THERMAL Term Labour	010 - SGP - Turbo Gen.Instal.	22,195	0	22,195
011	010	011 - Travel Expense	010 - SGP - Turbo Gen.Instal.	10,000	0	10,000
012	010	012 - Materials	010 - SGP - Turbo Gen.Instal.	1,875,560	0	1,875,560
013	010	013 - POWER PRODUCTION Contracts	010 - SGP - Turbo Gen.Instal.	1,329,270	0	1,329,270
041	010	041 - Meals & Entertainment	010 - SGP - Turbo Gen.Instal.	1,000	0	1,000
			Total Cost:	3,825,904	0	3,825,904
			Original Cost:	1,651,300		

LIN3 L-0 Blades Replacement
Summary of Alternatives

Division :	Power Production		**Date :**	**31-Oct-12**
Department :	Lingan		**CI Number:**	42806
Originator :			**Project No. :**	SA38

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Blades	6.48%	8,071,734	1	29.86%	5.0 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

Replace L-0 Blades at next major outage (2013)

Notes/Comments :

Replace Blades

Test 2

Test 3

Test 4

LIN3 L-0 Blades Replacement
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Lingan	CI Number:	42806
Originator :		Project No. :	SA38

Replace Blades

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$3,444,488	$3,513,378		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	10%	15%	10%	15%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	154	154				
Duration (Hours)	2016	2016				
Totals	$40,655	$50,407	$344,449	$527,007	$385,104	$577,414

Total Capital Cost of Alternative $3,825,904

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative $0

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative $0

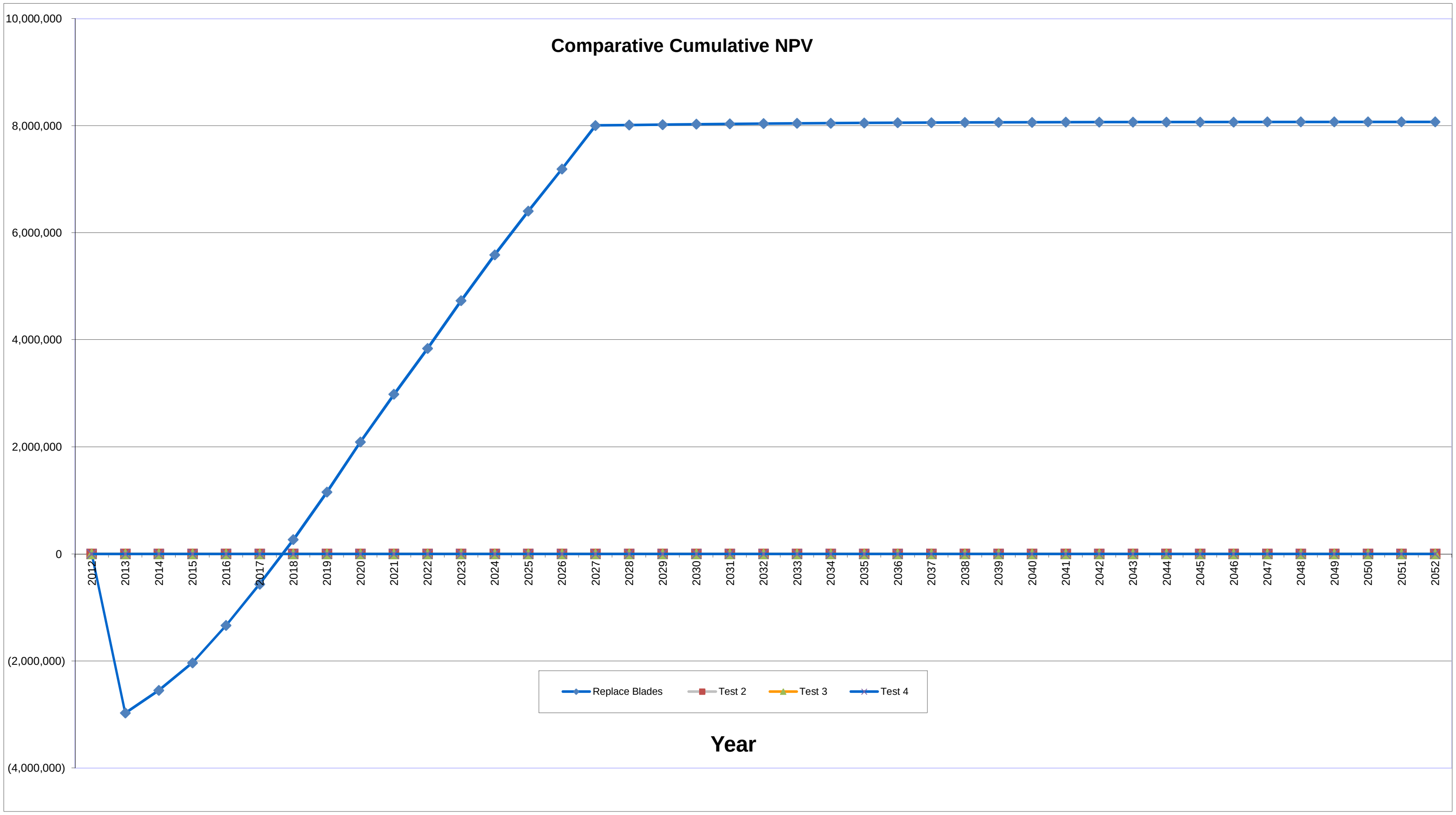
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative $0

LIN3 L-0 Blades Replacement
Replace Blades

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	385,104.1	(3,472,787.0)	141,695.0	3,400,680.6	(3,087,682.9)	(75,456.8)	(3,163,139.7)	(2,970,642.131)	0.9	(2,970,642.1)
2014	-	577,413.6	-	272,054.4	3,128,626.1	577,413.6	(94,661.3)	482,752.3	425,782.916	0.9	(2,544,859.2)
2015	-	785,282.5	-	250,290.1	2,878,336.0	785,282.5	(165,847.6)	619,434.8	513,087.586	0.8	(2,031,771.6)
2016	-	1,201,482.2	-	230,266.9	2,648,069.1	1,201,482.2	(301,076.8)	900,405.5	700,431.956	0.8	(1,331,339.7)
2017	-	1,429,763.8	-	211,845.5	2,436,223.6	1,429,763.8	(377,554.7)	1,052,209.2	768,708.825	0.7	(562,630.8)
2018	-	1,666,696.1	-	194,897.9	2,241,325.7	1,666,696.1	(456,257.5)	1,210,438.7	830,490.248	0.7	267,859.4
2019	-	1,912,533.8	-	179,306.1	2,062,019.7	1,912,533.8	(537,300.6)	1,375,233.2	886,135.332	0.6	1,153,994.7
2020	-	2,167,538.3	-	164,961.6	1,897,058.1	2,167,538.3	(620,798.8)	1,546,739.5	935,993.525	0.6	2,089,988.3
2021	-	2,210,889.1	-	151,764.6	1,745,293.4	2,210,889.1	(638,328.6)	1,572,560.5	893,706.637	0.6	2,983,694.9
2022	-	2,255,106.9	-	139,623.5	1,605,670.0	2,255,106.9	(655,799.9)	1,599,307.0	853,594.126	0.5	3,837,289.0
2023	-	2,530,229.9	-	128,453.6	1,477,216.4	2,530,229.9	(744,550.7)	1,785,679.2	895,065.844	0.5	4,732,354.9
2024	-	2,580,834.5	-	118,177.3	1,359,039.1	2,580,834.5	(763,423.7)	1,817,410.8	855,532.650	0.5	5,587,887.5
2025	-	2,632,451.2	-	108,723.1	1,250,315.9	2,632,451.2	(782,355.7)	1,850,095.5	817,917.674	0.4	6,405,805.2
2026	-	2,685,100.2	-	100,025.3	1,150,290.7	2,685,100.2	(801,373.2)	1,883,727.0	782,105.544	0.4	7,187,910.7
2027	-	2,987,784.2	-	92,023.3	1,058,267.4	2,987,784.2	(897,685.9)	2,090,098.3	814,978.370	0.4	8,002,889.1
2028	-	-	-	84,661.4	973,606.0	-	26,245.0	26,245.0	9,610.775	0.4	8,012,499.9
2029	-	-	-	77,888.5	895,717.5	-	24,145.4	24,145.4	8,303.825	0.3	8,020,803.7
2030	-	-	-	71,657.4	824,060.1	-	22,213.8	22,213.8	7,174.605	0.3	8,027,978.3
2031	-	-	-	65,924.8	758,135.3	-	20,436.7	20,436.7	6,198.945	0.3	8,034,177.3
2032	-	-	-	60,650.8	697,484.5	-	18,801.8	18,801.8	5,355.963	0.3	8,039,533.2
2033	-	-	-	55,798.8	641,685.7	-	17,297.6	17,297.6	4,627.616	0.3	8,044,160.8
2034	-	-	-	51,334.9	590,350.9	-	15,913.8	15,913.8	3,998.316	0.3	8,048,159.1
2035	-	-	-	47,228.1	543,122.8	-	14,640.7	14,640.7	3,454.593	0.2	8,051,613.7
2036	-	-	-	43,449.8	499,673.0	-	13,469.4	13,469.4	2,984.810	0.2	8,054,598.6
2037	-	-	-	39,973.8	459,699.1	-	12,391.9	12,391.9	2,578.912	0.2	8,057,177.5
2038	-	-	-	36,775.9	422,923.2	-	11,400.5	11,400.5	2,228.211	0.2	8,059,405.7
2039	-	-	-	33,833.9	389,089.4	-	10,488.5	10,488.5	1,925.201	0.2	8,061,330.9
2040	-	-	-	31,127.1	357,962.2	-	9,649.4	9,649.4	1,663.397	0.2	8,062,994.3
2041	-	-	-	28,637.0	329,325.2	-	8,877.5	8,877.5	1,437.195	0.2	8,064,431.5
2042	-	-	-	26,346.0	302,979.2	-	8,167.3	8,167.3	1,241.754	0.2	8,065,673.2
2043	-	-	-	24,238.3	278,740.9	-	7,513.9	7,513.9	1,072.890	0.1	8,066,746.1
2044	-	-	-	22,299.3	256,441.6	-	6,912.8	6,912.8	926.990	0.1	8,067,673.1
2045	-	-	-	20,515.3	235,926.3	-	6,359.8	6,359.8	800.930	0.1	8,068,474.0
2046	-	-	-	18,874.1	217,052.2	-	5,851.0	5,851.0	692.013	0.1	8,069,166.0
2047	-	-	-	17,364.2	199,688.0	-	5,382.9	5,382.9	597.908	0.1	8,069,764.0
2048	-	-	-	15,975.0	183,713.0	-	4,952.3	4,952.3	516.600	0.1	8,070,280.6
2049	-	-	-	14,697.0	169,015.9	-	4,556.1	4,556.1	446.348	0.1	8,070,726.9
2050	-	-	-	13,521.3	155,494.6	-	4,191.6	4,191.6	385.650	0.1	8,071,112.6
2051	-	-	-	12,439.6	143,055.1	-	3,856.3	3,856.3	333.207	0.1	8,071,445.8
2052	-	-	-	11,444.4	131,610.7	-	3,547.8	3,547.8	287.894	0.1	8,071,733.7
Total	-	28,008,210.5	(3,472,787.0)	3,410,764.9	40,994,984.3	24,535,423.5	(7,625,208.1)	16,910,215.4	8,071,733.7		


Comparative Cumulative NPV
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Replace Blades
Test 2
Test 3
Test 4
Year

Location: Lingan
CI# / FP#: 42806
Title: LIN3 L-0 Blades Replacement
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	hr	[redacted]	[redacted]	$ 3,280.00		
1.2	Engineering (P.Eng)	hr	[redacted]	[redacted]	$ 4,480.00		
1.3	Maintenance Trades	hr	[redacted]	[redacted]	$ 117,175.00		
1.4	Utility & Unskilled	hr	[redacted]	[redacted]	$ 47,520.00		
1.5	Regular Labour - Condition Asssessment	lot	1	$ 40,614.85	$ 40,614.85	actual	$ 213,069.85
1.6	Regular Labour - no AO	lot	1	$ 1,314.22	$ 1,314.22	actual	
1.7				$ -	$ -		
				Sub-Total	$ 214,384.07		
2	**001 Overtime Labour**						
2.1	Overtime Labour - Condition Asssessment and Temporary Refurbishment	lot	1	$ 3,091.52	$ 3,091.52	actual	
2.2							
			1	Sub-Total	$ 3,091.52		
3	**004 Term Labour**						
3.1	Term Labour - Condition Asssessment and Temporary Refurbishment	lot	1	$ 22,195.29	$ 22,195.29	actual	
3.2	Term Labour - no AO	lot	1	$ 17,286.00	$ 17,286.00	actual	
			2	Sub-Total	$ 39,481.29		
4	**012 Materials**						
4.1	L-0 Blades and hardware	lot	1	[redacted]	[redacted]	Cost Support 1. Exchange assumed to be 1.0.	
4.2	#4 & #5 Packing Rings	lot	1	[redacted]	[redacted]	Cost Support 2. Exchange assumed to be 1.0.	
4.3	4-2, 4-3 & 5-1, 5-2 Packing Ring Holders	lot	1	[redacted]	[redacted]	Cost Support 3. Exchange assumed to be 1.0.	
4.4	L-0 Spill Strips	lot	1	[redacted]	[redacted]	Cost Support 4. Exchange assumed to be 1.0.	
4.5	Glass bead and aluminum oxide	lot	1	$ 16,000.00	$ 16,000.00		
4.6	Misc materials (Fasteners Replacement , etc)	lot	1	$ 10,000.00	$ 10,000.00		
4.7	2012 Blades Indication Repair material	lot	1	$ 34,187.01	$ 34,187.01		
				Sub-Total	$ 1,875,560.01		
5	**013 Power Production Contracts**						
5.1	Blade Install	lot	1	[redacted]	[redacted]	Cost Support 5. Exchange assumed to be 1.0.	
5.2	Contingency on Blade Install	lot	1	[redacted]	[redacted]		
5.3	TA support - extract / replace 0	lot	1	[redacted]	[redacted]		
5.4	Turbine Inspection	lot	1	[redacted]	[redacted]		
5.5	Grit Blasting Rotor AR	lot	1	[redacted]	[redacted]		
5.6	Turbine insulation removal and re-installation, 25% utilization	lot	1	[redacted]	[redacted]		
5.7	On Site Machining	lot	1	$ 40,000.00	$ 40,000.00		
5.8	Condition Assessment and Temporary Refurbishment	lot	1	$ 44,270.01	$ 44,270.01	actual	
5.9	NDT Inspection	lot	1	$ 20,000.00	$ 20,000.00		
5.10	Freight Blades	lot	1	$ 20,000.00	$ 20,000.00		
				Sub-Total	$ 1,329,270.01		
6	**011 Travel Expenses**						
6.1	Travel to Blades Inspection	$	1	10000	$ 10,000.00		
				Sub-Total	$ 10,000.00		
7	**041 Meals and Entertainment**						
7.1	GS Travel to Site - 2 trips	$	1	1000	$ 1,000.00		
				Sub-Total	$ 1,000.00		
8	**094 Interest Capitalized**						
8.1	Interest Capitalized	lot	1	121155.05	$ 121,155.05		
				Sub-Total	$ 121,155.05		
9	**095 Administrative Overhead**						
9.1	Thermal Hydro Contracts AO	lot	1	166084.16	$ 166,084.16		
9.2	Thermal Reg Lab AO	lot	1	55620.59	$ 55,620.59		
9.3	Thermal Term Lab	lot	1	5326.87	$ 5,326.87		
9.4	Thermal OT	lot	1	370.98	$ 370.98		
9.5	COPS Contracts	lot	1	4559.36	$ 4,559.36		
				Sub-Total	$ 231,961.96		
ect Cost Estimate				**Total**	$ 3,825,903.91		
10	**Original Cost**				$ 1,651,300.00		
10.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 - 5

Removed due to confidentiality

CI Number: 43088

Title: **LIN3 Rotor Rewind**

Start Date: 2013/03
Final Cost Date: 2013/12
Function: Generation
Forecast Amount: $2,740,665

DESCRIPTION:

During the Lingan Unit 1 scheduled shutdown in October 2008, a ground fault was experienced in the generator rotor. The generator rotor was removed from the machine and disassembled to determine the location and extent of the ground fault and to implement corrective measures. The fault was identified and necessitated a temporary partial rewind to return the unit to service. Based on inspection results and recommendations from a number of Original Equipment Manufacturers (OEMs), a complete rewind was determined to be required. This direction is based on reduced cooling due to migration of Mylar liner insulation into the cooling openings, and the presence of copper dusting levels at higher than expected concentrations around the winding turns.

It is expected this condition is present on the other generators at Lingan. Assessments by NS Power turbine generator specialists and third party asset management consultants indicate that the Unit 3 generator rotor should be rewound in 2013. A major planned maintenance outage is scheduled to accommodate the work.
Project life is expected to be at least 30 years.

The depreciation class for the project is Lingan 3-4.
Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 and 2015.

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

Rewinding the rotor will reduce the risk of a ground fault due to insulation and copper dusting migration. A generator outage due to a ground fault can create an unplanned outage of 6-10 weeks. The rotor rewind will alleviate future copper dust formation and migration of Mylar insulation.

Why do this project now?

A rotor rewind requires extraction of the rotor for factory rewind and test. An outage window of 7-8 weeks is required. A major Unit 3 outage is planned for spring 2013 to allow the rewind work to occur as a planned activity.

Why do this project this way?

Rewinding is common practice and was completed successfully on Unit 1 in 2010. Rewinding will restore the rotor to full capability and mitigate Mylar insulation migration and copper dusting issues. The refurbished rotor is expected to operate without further rewinds for greater than 15 years. A new rotor is approximately twice the cost of refurbishment and has extensive lead time.

CI Number : 43088 - LIN3 Rotor Rewind **Project Number**

Parent CI Number : -

Cost Centre : 305 - 305-Lingan 3&4 Prod.Unit **Budget Version** 2012 08/04 Forecast

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		49,243	0	49,243
095		095-Thermal Regular Labour AO		40,022	0	40,022
095		095-Thermal & Hydro Contracts AO		139,785	0	139,785
001	010	001 - THERMAL Regular Labour	010 - SGP - Turbo Gen.Instal.	150,460	0	150,460
002	010	002 - THERMAL Overtime Labour	010 - SGP - Turbo Gen.Instal.	0	0	0
004	010	004 - Term Labour (NO AO)	010 - SGP - Turbo Gen.Instal.	0	0	0
011	010	011 - Travel Expense	010 - SGP - Turbo Gen.Instal.	15,000	0	15,000
012	010	012 - Materials	010 - SGP - Turbo Gen.Instal.	1,250,659	0	1,250,659
013	010	013 - POWER PRODUCTION Contracts	010 - SGP - Turbo Gen.Instal.	1,095,495	0	1,095,495
041	010	041 - Meals & Entertainment	010 - SGP - Turbo Gen.Instal.	0	0	0
			Total Cost:	2,740,665	0	2,740,665
			Original Cost:	200,000		

LIN3 Rotor Rewind
Summary of Alternatives

Division :	Power Production		**Date :**	**31-Oct-12**
Department :	Lingan		**CI Number:**	43088
Originator :			**Project No. :**	

	Alternative	**After Tax WACC**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Rewind Rotor	6.48%	5,267,520	1	24.90%	6.5 years
B	Replace Rotor	6.48%	2,822,376	2	12.23%	10.6 years
C	Test 3	6.48%	0	3	#NUM!	0.0 years
D	Test 4	6.48%	0	3	#NUM!	0.0 years

Recommendation :

Rewind LIN3 Generator Rotor to reduce risk of forced outages and ensure LIN3 availability .

Notes/Comments :

Rewind Rotor

Estimate for repair cost is based on plant experience with similar work. Failure assumed to result in an 8 week outage.

Replace Rotor

Purchase of a replacement rotor would cost approximately $4.9 million per OEM quotation (Cost Support 4). Note that capital investment for this option includes installation costs as well. Assumptions for cost of failure are the same as those in the Rewind Rotor option.

Test 3

Test 4

LIN3 Rotor Rewind
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Lingan	CI Number:	43088
Originator :		Project No. :	

Rewind Rotor

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$1,333,854	$1,360,531		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	10%	15%	10%	15%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	154	154				
Duration (Hours)	1344	1344				
Totals	$27,104	$33,605	$133,385	$204,080	$160,489	$237,684
Total Capital Cost of Alternative						$2,740,665

Replace Rotor

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$1,333,854	$1,360,531		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	10%	15%	10%	15%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	154	154				
Duration (Hours)	1344	1344				
Totals	$27,104	$33,605	$133,385	$204,080	$160,489	$237,684
Total Capital Cost of Alternative						$5,833,248

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

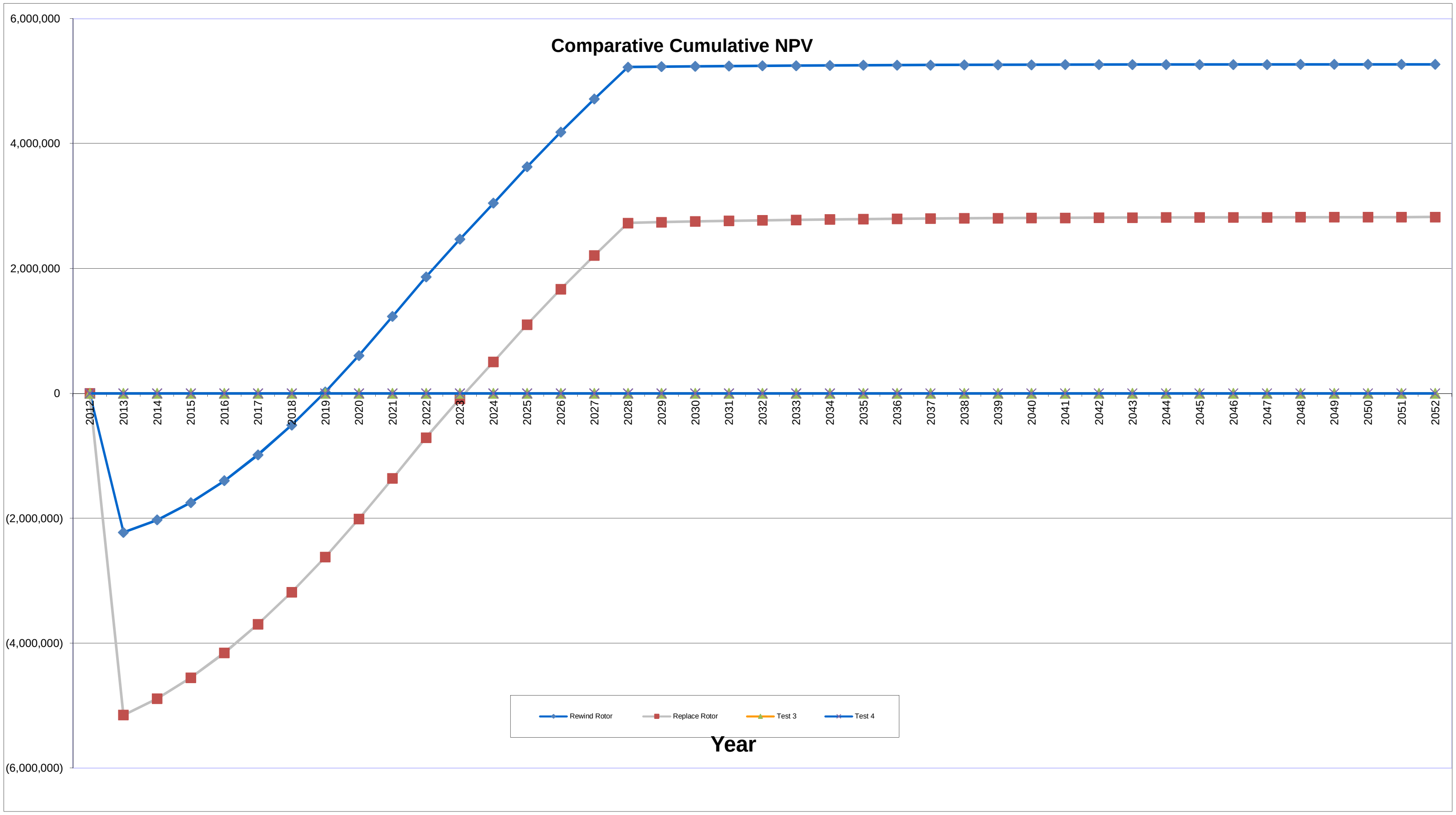
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

LIN3 Rotor Rewind
Rewind Rotor

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	160,488.9	(2,511,614.0)	102,622.3	2,462,934.0	(2,351,125.1)	(17,938.7)	(2,369,063.8)	(2,224,890.831)	0.9	(2,224,890.8)
2014	-	237,684.3	-	197,034.7	2,265,899.3	237,684.3	(12,601.4)	225,082.9	198,521.001	0.9	(2,026,369.8)
2015	-	404,063.3	-	181,271.9	2,084,627.3	404,063.3	(69,065.3)	334,998.0	277,484.064	0.8	(1,748,885.8)
2016	-	577,002.4	-	166,770.2	1,917,857.2	577,002.4	(127,172.0)	449,830.4	349,926.334	0.8	(1,398,959.4)
2017	-	756,697.4	-	153,428.6	1,764,428.6	756,697.4	(187,013.3)	569,684.1	416,192.122	0.7	(982,767.3)
2018	-	943,349.4	-	141,154.3	1,623,274.3	943,349.4	(248,680.5)	694,668.9	476,617.099	0.7	(506,150.2)
2019	-	1,137,164.8	-	129,861.9	1,493,412.4	1,137,164.8	(312,263.9)	824,900.9	531,527.213	0.6	25,377.0
2020	-	1,338,355.5	-	119,473.0	1,373,939.4	1,338,355.5	(377,853.6)	960,502.0	581,237.885	0.6	606,614.9
2021	-	1,547,139.0	-	109,915.1	1,264,024.2	1,547,139.0	(445,539.4)	1,101,599.6	626,053.422	0.6	1,232,668.3
2022	-	1,670,910.1	-	101,121.9	1,162,902.3	1,670,910.1	(486,634.3)	1,184,275.8	632,080.552	0.5	1,864,748.9
2023	-	1,704,328.3	-	93,032.2	1,069,870.1	1,704,328.3	(499,501.8)	1,204,826.5	603,915.331	0.5	2,468,664.2
2024	-	1,738,414.9	-	85,589.6	984,280.5	1,738,414.9	(512,375.8)	1,226,039.1	577,148.801	0.5	3,045,813.0
2025	-	1,871,693.4	-	78,742.4	905,538.0	1,871,693.4	(555,814.8)	1,315,878.6	581,743.137	0.4	3,627,556.1
2026	-	1,909,127.2	-	72,443.0	833,095.0	1,909,127.2	(569,372.1)	1,339,755.1	556,253.606	0.4	4,183,809.7
2027	-	1,947,309.8	-	66,647.6	766,447.4	1,947,309.8	(583,005.3)	1,364,304.5	531,974.333	0.4	4,715,784.1
2028	-	1,986,256.0	-	61,315.8	705,131.6	1,986,256.0	(596,731.5)	1,389,524.5	508,835.658	0.4	5,224,619.7
2029	-	-	-	56,410.5	648,721.1	-	17,487.3	17,487.3	6,014.024	0.3	5,230,633.8
2030	-	-	-	51,897.7	596,823.4	-	16,088.3	16,088.3	5,196.189	0.3	5,235,829.9
2031	-	-	-	47,745.9	549,077.5	-	14,801.2	14,801.2	4,489.570	0.3	5,240,319.5
2032	-	-	-	43,926.2	505,151.3	-	13,617.1	13,617.1	3,879.042	0.3	5,244,198.6
2033	-	-	-	40,412.1	464,739.2	-	12,527.8	12,527.8	3,351.539	0.3	5,247,550.1
2034	-	-	-	37,179.1	427,560.1	-	11,525.5	11,525.5	2,895.770	0.3	5,250,445.9
2035	-	-	-	34,204.8	393,355.3	-	10,603.5	10,603.5	2,501.980	0.2	5,252,947.8
2036	-	-	-	31,468.4	361,886.9	-	9,755.2	9,755.2	2,161.741	0.2	5,255,109.6
2037	-	-	-	28,950.9	332,935.9	-	8,974.8	8,974.8	1,867.770	0.2	5,256,977.4
2038	-	-	-	26,634.9	306,301.0	-	8,256.8	8,256.8	1,613.776	0.2	5,258,591.1
2039	-	-	-	24,504.1	281,796.9	-	7,596.3	7,596.3	1,394.322	0.2	5,259,985.5
2040	-	-	-	22,543.8	259,253.2	-	6,988.6	6,988.6	1,204.711	0.2	5,261,190.2
2041	-	-	-	20,740.3	238,512.9	-	6,429.5	6,429.5	1,040.885	0.2	5,262,231.0
2042	-	-	-	19,081.0	219,431.9	-	5,915.1	5,915.1	899.337	0.2	5,263,130.4
2043	-	-	-	17,554.6	201,877.4	-	5,441.9	5,441.9	777.038	0.1	5,263,907.4
2044	-	-	-	16,150.2	185,727.2	-	5,006.6	5,006.6	671.370	0.1	5,264,578.8
2045	-	-	-	14,858.2	170,869.0	-	4,606.0	4,606.0	580.072	0.1	5,265,158.9
2046	-	-	-	13,669.5	157,199.5	-	4,237.6	4,237.6	501.189	0.1	5,265,660.1
2047	-	-	-	12,576.0	144,623.5	-	3,898.5	3,898.5	433.033	0.1	5,266,093.1
2048	-	-	-	11,569.9	133,053.6	-	3,586.7	3,586.7	374.146	0.1	5,266,467.2
2049	-	-	-	10,644.3	122,409.3	-	3,299.7	3,299.7	323.267	0.1	5,266,790.5
2050	-	-	-	9,792.7	112,616.6	-	3,035.8	3,035.8	279.306	0.1	5,267,069.8
2051	-	-	-	9,009.3	103,607.3	-	2,792.9	2,792.9	241.324	0.1	5,267,311.1
2052	-	-	-	8,288.6	95,318.7	-	2,569.5	2,569.5	208.507	0.1	5,267,519.6
Total	-	19,929,984.9	(2,511,614.0)	2,470,237.6	29,690,510.2	17,418,370.9	(5,412,521.7)	12,005,849.2	5,267,519.6		

LIN3 Rotor Rewind
Replace Rotor

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	160,488.9	(5,664,839.3)	227,348.2	5,683,705.7	(5,504,350.4)	20,726.4	(5,483,624.0)	(5,149,909.827)	0.9	(5,149,909.8)
2014	-	237,684.3	-	436,508.6	5,019,848.9	237,684.3	61,635.5	299,319.8	263,997.244	0.9	(4,885,912.6)
2015	-	404,063.3	-	401,587.9	4,618,260.9	404,063.3	(767.4)	403,295.9	334,056.325	0.8	(4,551,856.3)
2016	-	577,002.4	-	369,460.9	4,248,800.1	577,002.4	(64,337.9)	512,664.5	398,805.447	0.8	(4,153,050.8)
2017	-	756,697.4	-	339,904.0	3,908,896.1	756,697.4	(129,206.0)	627,491.4	458,424.264	0.7	(3,694,626.5)
2018	-	943,349.4	-	312,711.7	3,596,184.4	943,349.4	(195,497.7)	747,851.7	513,106.177	0.7	(3,181,520.4)
2019	-	1,137,164.8	-	287,694.8	3,308,489.6	1,137,164.8	(263,335.7)	873,829.1	563,054.215	0.6	(2,618,466.2)
2020	-	1,338,355.5	-	264,679.2	3,043,810.5	1,338,355.5	(332,839.7)	1,005,515.9	608,477.593	0.6	(2,009,988.6)
2021	-	1,547,139.0	-	243,504.8	2,800,305.6	1,547,139.0	(404,126.6)	1,143,012.4	649,588.858	0.6	(1,360,399.7)
2022	-	1,670,910.1	-	224,024.4	2,576,281.2	1,670,910.1	(448,534.6)	1,222,375.6	652,415.452	0.5	(707,984.3)
2023	-	1,704,328.3	-	206,102.5	2,370,178.7	1,704,328.3	(464,450.0)	1,239,878.3	621,484.929	0.5	(86,499.3)
2024	-	1,738,414.9	-	189,614.3	2,180,564.4	1,738,414.9	(480,128.2)	1,258,286.7	592,329.145	0.5	505,829.8
2025	-	1,871,693.4	-	174,445.2	2,006,119.2	1,871,693.4	(526,147.0)	1,345,546.4	594,859.136	0.4	1,100,689.0
2026	-	1,909,127.2	-	160,489.5	1,845,629.7	1,909,127.2	(542,077.7)	1,367,049.6	567,585.987	0.4	1,668,274.9
2027	-	1,947,309.8	-	147,650.4	1,697,979.3	1,947,309.8	(557,894.4)	1,389,415.4	541,765.647	0.4	2,210,040.6
2028	-	1,986,256.0	-	135,838.3	1,562,141.0	1,986,256.0	(573,629.5)	1,412,626.5	517,295.471	0.4	2,727,336.1
2029	-	-	-	124,971.3	1,437,169.7	-	38,741.1	38,741.1	13,323.404	0.3	2,740,659.5
2030	-	-	-	114,973.6	1,322,196.1	-	35,641.8	35,641.8	11,511.581	0.3	2,752,171.0
2031	-	-	-	105,775.7	1,216,420.4	-	32,790.5	32,790.5	9,946.144	0.3	2,762,117.2
2032	-	-	-	97,313.6	1,119,106.8	-	30,167.2	30,167.2	8,593.588	0.3	2,770,710.8
2033	-	-	-	89,528.5	1,029,578.3	-	27,753.8	27,753.8	7,424.963	0.3	2,778,135.7
2034	-	-	-	82,366.3	947,212.0	-	25,533.5	25,533.5	6,415.258	0.3	2,784,551.0
2035	-	-	-	75,777.0	871,435.0	-	23,490.9	23,490.9	5,542.860	0.2	2,790,093.9
2036	-	-	-	69,714.8	801,720.2	-	21,611.6	21,611.6	4,789.097	0.2	2,794,883.0
2037	-	-	-	64,137.6	737,582.6	-	19,882.7	19,882.7	4,137.838	0.2	2,799,020.8
2038	-	-	-	59,006.6	678,576.0	-	18,292.0	18,292.0	3,575.142	0.2	2,802,595.9
2039	-	-	-	54,286.1	624,289.9	-	16,828.7	16,828.7	3,088.965	0.2	2,805,684.9
2040	-	-	-	49,943.2	574,346.7	-	15,482.4	15,482.4	2,668.903	0.2	2,808,353.8
2041	-	-	-	45,947.7	528,399.0	-	14,243.8	14,243.8	2,305.964	0.2	2,810,659.8
2042	-	-	-	42,271.9	486,127.1	-	13,104.3	13,104.3	1,992.381	0.2	2,812,652.2
2043	-	-	-	38,890.2	447,236.9	-	12,056.0	12,056.0	1,721.441	0.1	2,814,373.6
2044	-	-	-	35,779.0	411,458.0	-	11,091.5	11,091.5	1,487.346	0.1	2,815,860.9
2045	-	-	-	32,916.6	378,541.3	-	10,204.2	10,204.2	1,285.085	0.1	2,817,146.0
2046	-	-	-	30,283.3	348,258.0	-	9,387.8	9,387.8	1,110.329	0.1	2,818,256.4
2047	-	-	-	27,860.6	320,397.4	-	8,636.8	8,636.8	959.337	0.1	2,819,215.7
2048	-	-	-	25,631.8	294,765.6	-	7,945.9	7,945.9	828.879	0.1	2,820,044.6
2049	-	-	-	23,581.2	271,184.3	-	7,310.2	7,310.2	716.161	0.1	2,820,760.7
2050	-	-	-	21,694.7	249,489.6	-	6,725.4	6,725.4	618.772	0.1	2,821,379.5
2051	-	-	-	19,959.2	229,530.4	-	6,187.3	6,187.3	534.626	0.1	2,821,914.1
2052	-	-	-	18,362.4	211,168.0	-	5,692.4	5,692.4	461.924	0.1	2,822,376.1
Total	-	19,929,984.9	(5,664,839.3)	5,472,537.7	66,003,384.5	14,265,145.6	(4,481,808.6)	9,783,337.0	2,822,376.1		


Comparative Cumulative NPV
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2,000,000
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2052
Rewind Rotor
Replace Rotor
Test 3
Test 4
Year

Location: Lingan
CI# / FP#: 43088
Title: LIN3 Rotor Rewind
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	hr	[redacted]		$ 45,100.00		37609
1.2	Engineering (P.Eng)	hr			$ 17,920.00		
1.3	Maintenance Trades	hr			$ 55,040.00		37609
1.4	Utility & Unskilled	hr			$ 32,400.00		37609
1.5		hr		$ -	$ -		
				Sub-Total	$ 150,460.00		
2	**012 Materials**						
2.1	Retain rings	lot	1	[redacted]		Cost Support 1. Exchange and other risk is included in line 2.4.	
2.2	Misc materials (hardware)	lot	1	$ 10,000.00	$ 10,000.00		
2.3	Factory Rewind Kit	lot	1	[redacted]		Cost Support 2. Exchange and other risk is included in line 2.4.	CI37609
2.4	Contingency on Materials	%	[redacted]				
2.5							
				Sub-Total	$ 1,250,659.00		
3	**013 Power Production Contracts**						
3.1	Technical Specialist to monitor remove / install - 14 days on site and 2 return trips	lot	1	$ 25,000.00	$ 25,000.00	OEM Rates	
3.2	Factory Rewind	lot	1	[redacted]		Cost Support 3. Exchange and other risk is included in line 3.3.	CI37609
3.3	Contingency on Factory Rewind	%	[redacted]				
3.4	Expedited Shipping to / from Toshiba US factory	lot	1	$ 18,000.00	$ 18,000.00		CI37609
3.5	Contingency for factory assessment discoveries (Stator, Wedge)	lot	1	[redacted]			
3.6	Speciality Machine Subs (Fasteners)	lot	1	$ 20,000.00	$ 20,000.00		
3.7							
				Sub-Total	$ 1,095,495.00		
4	**011 Travel Expenses**						
4.1	Insection, progress, test factory visits 2 visits 2 people	each	2	$ 7,500.00	$ 15,000.00		CI37609
4.2					$ -		
				Sub-Total	$ 15,000.00		
5	**094 Interest Capitalized**						
5.1	Interest Capitalized	lot	1	$ 49,243.38	$ 49,243.38		
				Sub-Total	$ 49,243.38		
6	**095 Administrative Overhead**						
6.1	Thermal Hydro Contracts	lot	1	$ 139,785.16	$ 139,785.16		
6.2	Thermal Regular Labour Hydro Contracts	lot	1	$ 40,022.36	$ 40,022.36		
6.3					$ -		
				Sub-Total	$ 179,807.52		
Cost Estimate				**Total**	$ 2,740,664.90		
7	**Original Cost**				$ 200,000.00		
7.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 - 5

Removed due to confidentiality

CI Number: 41227

Title: **LIN3 Cond Large Bore Pipe and Valve Refurbishment**

Start Date: 2013/03
Final Cost Date: 2013/12
Function: Generation
Forecast Amount: $1,137,289

DESCRIPTION:

Steam discharge from the low pressure section of the turbine is condensed by seawater delivered through a large tubular condenser located under the turbine. The seawater is delivered from the circulating water (CW) Pumphouse via 72 inch diameter underground concrete pipelines. The concrete pipe connects to steel pipe inside the plant close to the condenser. This project focuses on work to the steel pipe and valves directly under the condenser.

The scope of this project is to replace Unit 3 large-bore CW Piping located at the condenser and refurbish eight 48 inch CW Inlet and Outlet Valves and actuators. The piping has experienced multiple leaks. Based on non-destructive testing and past experience with the other three units at Lingan, plant engineering personnel predict pipe leaks will become more pronounced without corrective action. Valve work will restore flow control and isolations needed to allow on-line leak checks and condenser cleaning to be completed, as well as support condenser efficiency improvements by reducing cooling water by-pass.

Units 1, 2 and 4 have been completed prior to 2011.

Project life is expected to be 20 years under normal operating conditions.

Project depreciation class is Lingan 3-4.

Summary of Related CIs +/- 2 years:
CI37743 2010 LIN1 CW Large Bore Pipe Replacement $1,151,000

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

The steel piping at the condenser has been prone to leakage after over 30 years of service. The pipe is exposed to corrosive sea water conditions that have reduced the wall thickness to unacceptable levels in some areas. Similarly the valves need to be renewed to allow proper isolation and operation of the condenser system.

Why do this project now?

This project needs to be executed during a major unit outage. A major maintenance outage is planned on Unit 3 in 2013. Based on degree of degradation measured and observed, waiting another cycle of 7 to10 years for another major outage is not recommended.

Why do this project this way?

Conducting the work during a planned outage and completing all work in one mobilization is the most efficient approach. Replacement of isolated sections or running to failure and repairing is not feasible. Much of the 48 inch steel piping is located below floor level and below the condenser. Significant mobilization, including removal of the floor around the condenser is necessary. The pipe sections are pre-fabricated, then fitted in place and joined to the concrete piping as a field-fit.

CI Number : 41227 - LIN3 Cond Large Bore Pipe and Valve Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 305 - 305-Lingan 3&4 Prod.Unit **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		14,482	0	14,482
095		095-Thermal Regular Labour AO		5,735	0	5,735
095		095-Thermal & Hydro Contracts AO		91,606	0	91,606
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	21,560	0	21,560
002	014	002 - THERMAL Overtime Labour	014 - SGP - Circ.Water Sys.	0	0	0
004	014	004 - THERMAL Term Labour	014 - SGP - Circ.Water Sys.	0	0	0
011	014	011 - Travel Expense	014 - SGP - Circ.Water Sys.	0	0	0
012	014	012 - Materials	014 - SGP - Circ.Water Sys.	285,993	0	285,993
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	717,913	0	717,913
028	014	028 - Consulting	014 - SGP - Circ.Water Sys.	0	0	0
			Total Cost:	1,137,289	0	1,137,289
			Original Cost:	82,500		

LIN3 Cond Large Bore Pipe and Valve Refurbishment
Summary of Alternatives

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Lingan	**CI Number:**	41227
Originator :		**Project No. :**	

	Alternative	**After Tax WACC**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Replace Pipe and Valving	6.48%	1,224,819	1	20.74%	6.7 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

Replace LIN3 Condenser piping and rebuild valves to avoid risk of extended forced outage due to failed 48" pipe and valving

Notes/Comments :

Replace Pipe and Valving

Failure scenario is a forced outage due to failure of a section of CW pipe or valve. Large sections of CW can fail due to reduced wall thickness from corrosion / erosion. Valves can fail by loosing seal or failing to open due to valve component material wastage and corrosion. Due to the size of the pipe and valves (48"), under floor location (condenser pit), and connections to 72" concrete CW piping, significant mobilzation is required to access and repair / replace pipes and valves.

Test 2

Test 3

Test 4

LIN3 Cond Large Bore Pipe and Valve Refurbishment
Avoided Cost Calculations

Nova Scotia POWER An Emera Company

Division :	Power Production	Date :	31-Oct-12
Department :	Lingan	CI Number:	41227
Originator :		Project No. :	

Replace Pipe and Valving

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$287,560	$299,095		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	30%	35%	30%	35%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	154	154				
Duration (Hours)	336	336				
Totals	$20,328	$19,603	$86,268	$104,683	$106,596	$124,286
Total Capital Cost of Alternative						$1,137,289

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

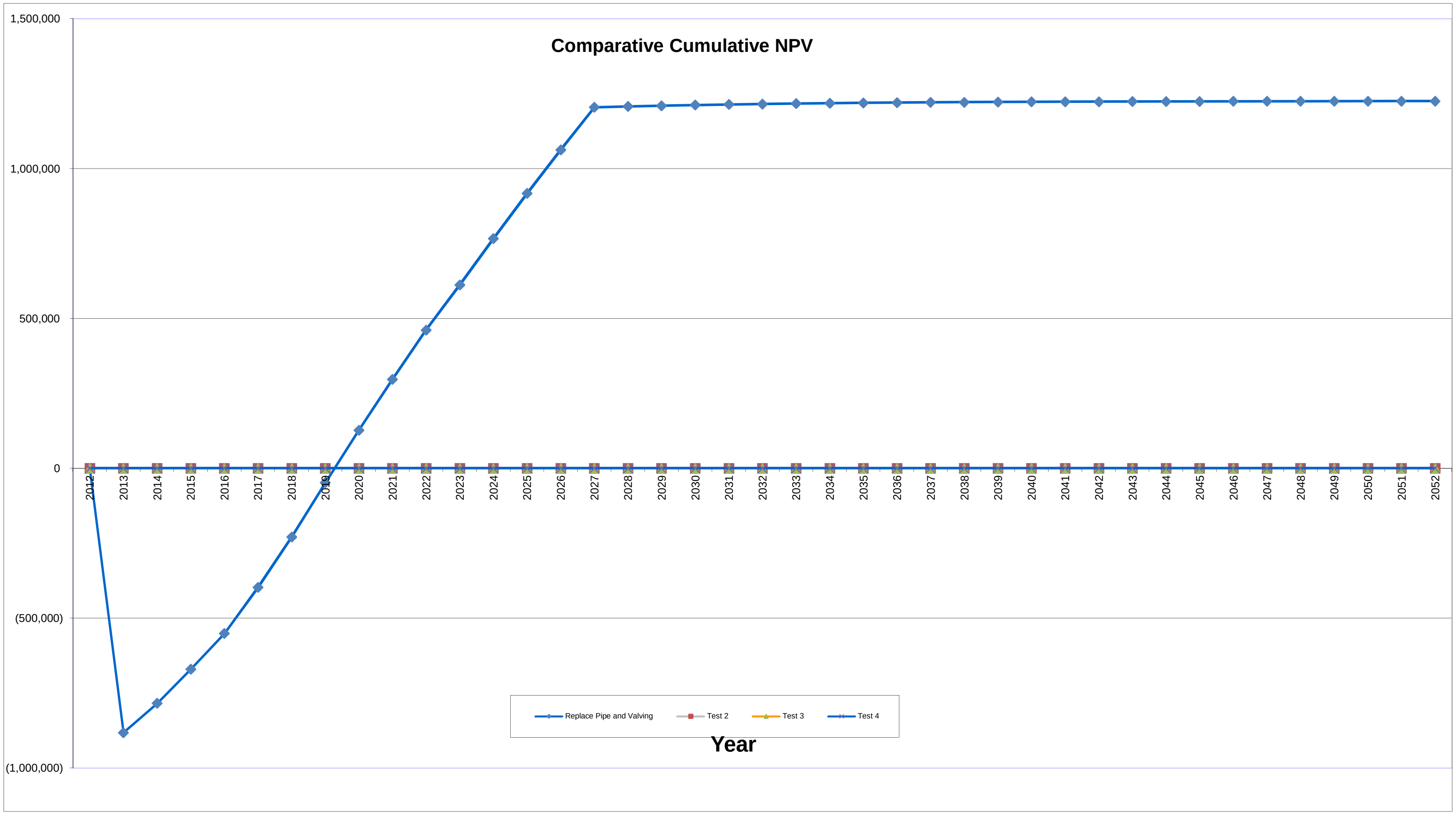
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

LIN3 Cond Large Bore Pipe and Valve Refurbishment
Replace Pipe and Valving

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	106,595.6	(1,025,466.3)	42,186.7	1,012,481.8	(918,870.7)	(19,966.8)	(938,837.4)	(881,703.067)	0.9	(881,703.1)
2014	-	124,286.1	-	80,998.5	931,483.2	124,286.1	(13,419.1)	110,867.0	97,783.601	0.9	(783,919.5)
2015	-	165,699.7	-	74,518.7	856,964.6	165,699.7	(28,266.1)	137,433.5	113,838.359	0.8	(670,081.1)
2016	-	190,921.8	-	68,557.2	788,407.4	190,921.8	(37,933.0)	152,988.7	119,011.046	0.8	(551,070.1)
2017	-	277,192.3	-	63,072.6	725,334.8	277,192.3	(66,377.1)	210,815.2	154,014.538	0.7	(397,055.5)
2018	-	328,542.9	-	58,026.8	667,308.0	328,542.9	(83,860.0)	244,682.9	167,878.590	0.7	(229,176.9)
2019	-	383,340.1	-	53,384.6	613,923.4	383,340.1	(102,286.2)	281,053.9	181,097.877	0.6	(48,079.1)
2020	-	397,598.4	-	49,113.9	564,809.5	397,598.4	(108,030.2)	289,568.2	175,229.200	0.6	127,150.1
2021	-	412,406.2	-	45,184.8	519,624.7	412,406.2	(113,838.6)	298,567.5	169,679.826	0.6	296,830.0
2022	-	427,785.2	-	41,570.0	478,054.8	427,785.2	(119,726.7)	308,058.5	164,419.280	0.5	461,249.3
2023	-	419,104.6	-	38,244.4	439,810.4	419,104.6	(118,066.7)	301,038.0	150,894.288	0.5	612,143.5
2024	-	460,347.5	-	35,184.8	404,625.6	460,347.5	(131,800.4)	328,547.1	154,661.105	0.5	766,804.6
2025	-	477,578.5	-	32,370.0	372,255.5	477,578.5	(138,014.6)	339,563.8	150,119.425	0.4	916,924.1
2026	-	495,475.9	-	29,780.4	342,475.1	495,475.9	(144,365.6)	351,110.3	145,777.664	0.4	1,062,701.7
2027	-	514,066.1	-	27,398.0	315,077.1	514,066.1	(150,867.1)	363,199.0	141,619.810	0.4	1,204,321.5
2028	-	-	-	25,206.2	289,870.9	-	7,813.9	7,813.9	2,861.408	0.4	1,207,183.0
2029	-	-	-	23,189.7	266,681.2	-	7,188.8	7,188.8	2,472.291	0.3	1,209,655.2
2030	-	-	-	21,334.5	245,346.7	-	6,613.7	6,613.7	2,136.089	0.3	1,211,791.3
2031	-	-	-	19,627.7	225,719.0	-	6,084.6	6,084.6	1,845.607	0.3	1,213,636.9
2032	-	-	-	18,057.5	207,661.5	-	5,597.8	5,597.8	1,594.626	0.3	1,215,231.6
2033	-	-	-	16,612.9	191,048.6	-	5,150.0	5,150.0	1,377.776	0.3	1,216,609.3
2034	-	-	-	15,283.9	175,764.7	-	4,738.0	4,738.0	1,190.415	0.3	1,217,799.8
2035	-	-	-	14,061.2	161,703.5	-	4,359.0	4,359.0	1,028.533	0.2	1,218,828.3
2036	-	-	-	12,936.3	148,767.2	-	4,010.2	4,010.2	888.665	0.2	1,219,717.0
2037	-	-	-	11,901.4	136,865.8	-	3,689.4	3,689.4	767.817	0.2	1,220,484.8
2038	-	-	-	10,949.3	125,916.6	-	3,394.3	3,394.3	663.403	0.2	1,221,148.2
2039	-	-	-	10,073.3	115,843.2	-	3,122.7	3,122.7	573.188	0.2	1,221,721.4
2040	-	-	-	9,267.5	106,575.8	-	2,872.9	2,872.9	495.242	0.2	1,222,216.6
2041	-	-	-	8,526.1	98,049.7	-	2,643.1	2,643.1	427.895	0.2	1,222,644.5
2042	-	-	-	7,844.0	90,205.7	-	2,431.6	2,431.6	369.706	0.2	1,223,014.2
2043	-	-	-	7,216.5	82,989.3	-	2,237.1	2,237.1	319.431	0.1	1,223,333.6
2044	-	-	-	6,639.1	76,350.1	-	2,058.1	2,058.1	275.992	0.1	1,223,609.6
2045	-	-	-	6,108.0	70,242.1	-	1,893.5	1,893.5	238.460	0.1	1,223,848.1
2046	-	-	-	5,619.4	64,622.8	-	1,742.0	1,742.0	206.033	0.1	1,224,054.1
2047	-	-	-	5,169.8	59,452.9	-	1,602.6	1,602.6	178.015	0.1	1,224,232.1
2048	-	-	-	4,756.2	54,696.7	-	1,474.4	1,474.4	153.807	0.1	1,224,385.9
2049	-	-	-	4,375.7	50,321.0	-	1,356.5	1,356.5	132.891	0.1	1,224,518.8
2050	-	-	-	4,025.7	46,295.3	-	1,248.0	1,248.0	114.819	0.1	1,224,633.7
2051	-	-	-	3,703.6	42,591.7	-	1,148.1	1,148.1	99.205	0.1	1,224,732.9
2052	-	-	-	3,407.3	39,184.3	-	1,056.3	1,056.3	85.715	0.1	1,224,818.6
Total	-	5,180,940.8	(1,025,466.3)	1,015,484.2	12,205,402.1	4,155,474.5	(1,291,291.6)	2,864,182.9	1,224,818.6		


Comparative Cumulative NPV
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(1,000,000)
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2052
Replace Pipe and Valving
Test 2
Test 3
Test 4
Year

Location: Lingan
CI# / FP#: 41227
Title: LIN3 CW Valves and Piping Replacement
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.2	Engineering (P.Eng)	hr	[redacted]		$ 1,120.00		
1.3	Maintenance Trades	hr	[redacted]		$ 17,200.00		
1.4	Utility & Unskilled	hr	[redacted]		$ 3,240.00		
1.5							
				Sub-Total	$ 21,560.00		37743
2	**012 Materials**						
2.1	48" dia. X .375" Steel Pipe	each	230	[redacted]		Cost Support 1	37743
2.2	Rolled steel plate for 72" Diameter Steel Pipe repair	lot	1	$ 4,000.00	$ 4,000.00		37743
2.3	24 - 48" Diameter Flanges 125lb Class ASTM A181 Slip	each	22	[redacted]		Cost Support 1	37743
2.4	Replacement Fasteners	lot	1	$ 5,000.00	$ 5,000.00		37743
2.5	Expansion joints	lot	1	[redacted]			37743
2.6	Valve Actuators for 48" valves	each	4				37743
2.7	Delivery Cost Pipe/Flanges	lot	1	$ 2,500.00	$ 2,500.00		37743
2.8	Misc. Supplies and consumables	lot	1	$ 4,000.00	$ 4,000.00		37743
2.9	Valve refurbish parts kits - Phipps	lot	1	[redacted]		Cost Support 2	37743
2.10					$ -		
				Sub-Total	$ 285,993.30		
3	**013 Power Production Contracts**						
3.1	Installation Contract	lot	1	[redacted]		Cost Support 3	37743
3.2	Construction Contigency - Field Fit	lot	1				37743
3.3	Fabrication of pipe and coating	lot	1			Cost Support 4	37743
3.4	Refurbish 8 inlet valves and repair of shafts.	lot	1			Cost Support 5	37743
3.5	Post Installation sealing	lot	1	$ 8,000.00	$ 8,000.00		37743
3.6	Project Management	hr	320	[redacted]			
3.7	Valve Setting service	lot	1	$ 15,000.00	$ 15,000.00		37743
3.8	Valve machining for new actuator	lot	1	[redacted]			37743
3.9	High presure clean / vac.	lot	1	$ 12,000.00	$ 12,000.00		37743
3.10	Drawing management and as builts	lot	1	[redacted]			37743
				Sub-Total	$ 717,913.00		
4	**094 Interest Capitalized**						
4.1	Interest Capitalized		1	14481.89	$ 14,481.89		
4.2					$ -		
				Sub-Total	$ 14,481.89		
5	**095 Administrative Overhead**						
5.1	Thermal & Hydro Contracts		1	91605.7	$ 91,605.70		
5.2	Thermal Regular Labour		1	5734.96	$ 5,734.96		
5.3					$ -		
				Sub-Total	$ 97,340.66		
Cost Estimate				**Total**	$ 1,137,288.85		
6	**Original Cost**						
6.1					$ 82,500.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 - 5

Removed due to confidentiality

CI Number: 41265

Title: **TUC – Oil Dock Piling Refurbishment**

Start Date: 2011/08
Final Cost Date: 2014/03
Function: Generation
Forecast Amount: $945,025

DESCRIPTION:

The Tufts Cove Oil Dock is constructed of Steel Sheet Piling (SSP) and was constructed in 1978. The dock consists of three steel sheet pile cells (north, manifold and south), two walkways which link the steel sheet pile cells, an access trestle which connects the central manifold cell to shore, and two mooring buoys.

An Ultrasonic Thickness (UT) Survey completed in 2010 has revealed that there are numerous holes in the steel sheet piling at or about the low tide level. The interlocks that connect each of the steel sheet pilings are also severely deteriorated. This project will address these deficiencies, and refurbish the steel sheet piling cells that make up the dock.

Summary of Related CIs +/- 2 years:
No projects 2011, 2012, 2013, 2014 or 2015.

JUSTIFICATION:

Justification Criteria: Health & Safety

Sub Criteria: Equipment Replacement

Why do this project?

An Ultrasonic Thickness (UT) Survey completed in 2010 has revealed that there are numerous holes in the steel sheet piling at or about the low tide level. The interlocks that connect each of the steel sheet pilings are also severely deteriorated. Approximately 80 percent of the interlocks have heavy corrosion with splits and holes throughout. If the holes in the piling continue to grow, fill material will be released into the harbour. Should the interlocks of the piling fail, the stability of the structure would be compromised which is a safety concern, and may result in damage to NS Power assets. In addition, it is not clear in the structure's current condition that it would be able to resist heavy loading, such as berthing forces from a vessel.

Why do this project now?

Refurbishment of the steel sheet piling is required to prevent the steel sheet pile and the interlocks from failure. It is anticipated that the material will continue to degrade at an accelerated rate, and should be refurbished in the near term.

Why do this project this way?

Given the existing condition of the SSP, refurbishment is the most cost-effective approach. A third-party consultant was engaged to assist plant personnel in identifying options for refurbishment and repair. NS Power plans to move forward with the most cost-effective and technically acceptable option.

CI Number : 41265-S852 - TUC - Oil Dock Piling Refurbishment **Project Number** S852

Parent CI Number : -

Cost Centre : 311 - 311-Tufts Cove Admin./Common Capita **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		25,007	0	25,007
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
095		095-Thermal Regular Labour AO		[redacted]	0	[redacted]
095		095 - T&CS Regular Labour AO		62	0	62
001	003	001 - THERMAL Regular Labour	003 - SGP - Bldg.,Struct.Grnd.	28,701	0	28,701
001	003	001 - T&CS Regular Labour	003 - SGP - Bldg.,Struct.Grnd.	259	0	259
013	003	013 - POWER PRODUCTION Contracts	003 - SGP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
028	003	028 - Consulting	003 - SGP - Bldg.,Struct.Grnd.	43,800	0	43,800
			Total Cost:	945,025	0	945,025
			Original Cost:	288,565		

Location: Tufts Cove Generating Station
CI# / FP#: 41265
Title: TUC - Oil Dock Piling Refurbishment
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	hr	[redacted]		$ 6,560.00		
1.2	Engineering (P.Eng)	hr			$ 11,200.00		
1.3	Maintenance Trades	hr			$ 6,880.00		
1.4	Utility & Unskilled	hr			$ 4,320.00		
1.5		hr					
				Sub-Total	$ 28,960.00		
2	**013 Power Production Contracts**						
2.1	Steel Sheet Piling Refurbishment (New concrete copewall)	lot	1	[redacted]			
2.2	Contingency on Refurbishment Contract	%	[redacted]				
2.3	Project management	lot	1	[redacted]			
2.4							
				Sub-Total	[redacted]		
3	**028 Consulting**						
3.1	Preliminary engineering	lot	1	[redacted]			
3.2	Detailed engineering and Engineering support during construction	lot	1				
3.3	Contingency on Consulting	%	[redacted]				
				Sub-Total	$ 43,800.00		
4	**094 Interest Capitalized**						
4.1	Interest Capitalized	lot	1	$ 25,007.12	$ 25,007.12		
4.2							
				Sub-Total	$ 25,007.12		
5	**095 Administrative Overhead**						
5.1	T&CS Labour AO	lot	1	$ 62.13	$ 62.13		
5.2	Contracts AO	lot	1	[redacted]			
5.3	Thermal Labour AO	lot	1				
				Sub-Total	$ 102,258.10		
Project Cost Estimate				**Total**	$ 945,025.22		
6	**Original Cost**						
6.1					$ 288,564.53		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

CONNORS DIVING SERVICES

TUFTS COVE MARINE TERMINAL
ULTRA SONIC METAL THICKNESS SURVEY

PREPARED FOR:

NOVA SCOTIA POWER

CONNORS DIVING SERVICES LTD
11-2 LAKESIDE PARK DRIVE
HALIFAX NS CANADA B3T 1L7
TEL: (902) 876-7078
FAX: (902) 876-7079

CDS # 3250

AUGUST, 2010

TABLE OF CONTENTS

GENERAL INFORMATION

TASK:	Metal thickness survey – Tufts Cove	
REFERENCE:	Blaise McNeil - NSPC	
DIVERS:	Diving Supervisor	Mike Finley
	Diver	Bojan Cingi
	Stand By Diver	Cole Scarfe
	Tender	Stephan Unruh
DATE/TIME COMMENCED:	0800- August 16, 2010	
LOCATION:	Tufts Cove Generating Plant – Marine Terminal	
WEATHER	Varied	
SEA CONDITIONS	Calm	
VISIBILITY - SURFACE	Varied	
VISIBILITY – U/W	5’ to 20’	

OBJECTIVE

As directed by Nova Scotia Power, Connors Diving Services carried out an in-water survey of the Marine unloading facility. Divers will be collecting metal thickness data from the sheet pile cells, fender systems and approach way support piles.

PROCEDURE

As per the Nova Scotia Occupational Diving Regulations a four man diving team was dispatched to the work site.

Upon arriving, a hazard assessment of the area was conducted. This, in conjunction with a safe job plan, is reviewed by the diving team prior to starting any work. In addition, the scope of the work and procedures are discussed.

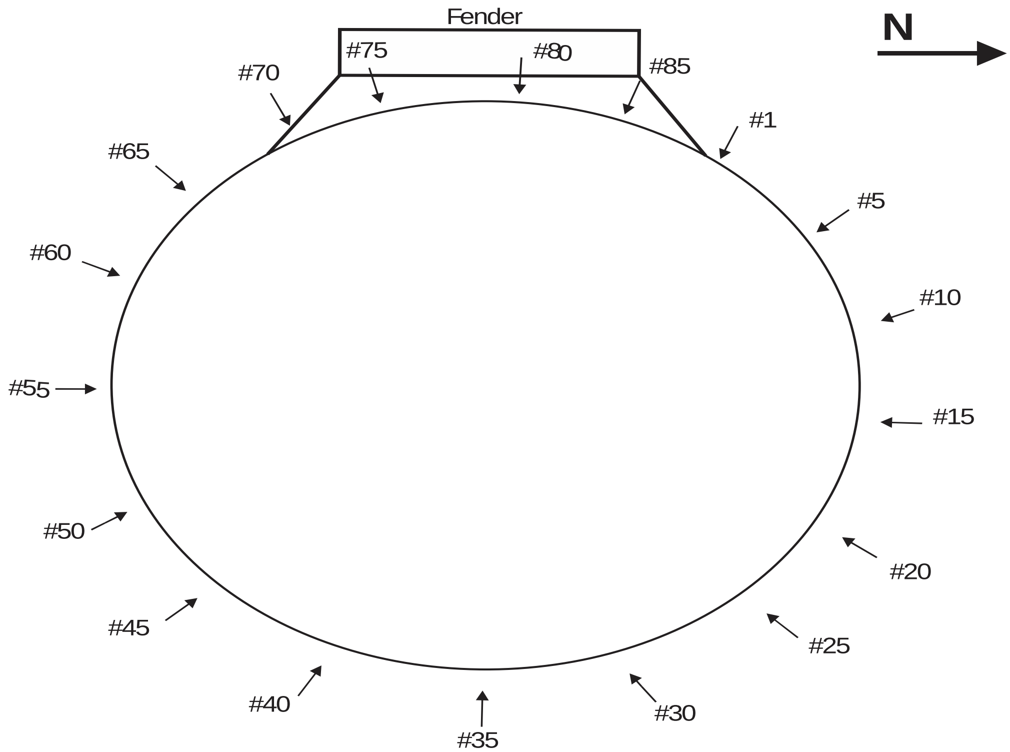
Divers used surfaced supplied diving equipment (SSDE) and closed circuit T.V. (CCTV). This gives the supervisor and client representative a real-time look at what the diver is experiencing. This ability also allows questions to be asked during the dive, eliminating the chance of missing valuable data.

The purpose of this inspection was to determine the condition of the steel sheet pile cells, fender assemblies and approach way support piles. In addition the crew will complete a cleaning and survey of the permanent oil boom, including all boom sliders.

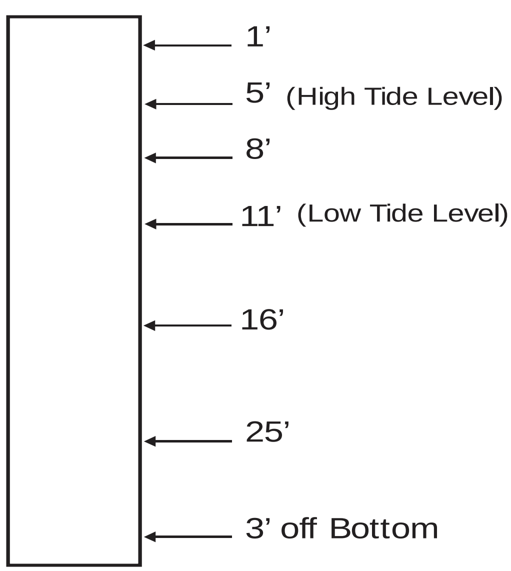
The findings of this inspection are detailed in the following report.

The following is a general outline of the number sequence used to obtain the metal thickness locations. The same sequence was utilized on each cell

SSP Numbering on Cells



Typical Elevation of Measurements



*** Drawing not to scale – as general reference only**

RESULTS

STEEL SHEET PILE (SSP)

On each of the three SSP cells the divers completed a full cleaning from the tidal zone to the harbor bottom. Similar amounts of marine growth were found on each of the cells. The divers reported heavy growth near the low tide level which dissipated quickly.

On all of the cells a similar numbering system was used to identify each section of SSP. Metal thickness measurements were taken at the same elevation and sequence on each cell.

The divers reported the SSP on all cells in the tidal zone to be in poor condition. Heavy pitting and corrosion was reported on each. Typically the divers reported holes through the SSP at the high tide level, with heavy pitting throughout this elevation.

The SSP knuckles on all cells are in poor condition. Approximately 80% on the knuckles have heavy corrosion with splits and holes throughout.

Below the tidal zone the condition of the SSP improves and is generally in good condition near the harbor bottom. No holes were found below the low tide level on any of the cells.

Metal thickness readings for the SSP are located in Appendix A. Due to the poor condition of the SSP at the high water level, readings were taken above and below the level containing the holes.

DOCK FENDERS

The divers first completed a full cleaning of the fender assemblies from the tidal zone to the harbor bottom.

Each of the three SSP cells has a fender system attached to the west face. The fender system consists of two vertical H piles from the harbor bottom which are connected with horizontal H piles near the top of the SSP. Only one of the horizontal beams is located underwater.

The divers reported the vertical beams to be in poor condition near the top with holes visible through the flange and webs of the beams.

Metal thickness measurements for the vertical H piles are located in Appendix B.

The Horizontal beams are attached to the vertical beams with steel bolt assemblies. The divers reported the attachment bolts to be in poor condition and missing is some locations.

The following is a list of the bolt assemblies per cell,

- North Cell – 4 of 6 bolt assemblies are missing
- Centre Cell – 3 of 6 bolts assemblies are missing
- South Cell – 1 of 6 bolt assemblies is missing

All bolt assemblies which are in place were found to be in poor condition.

The fender has a series of wooden timbers attached to the outer face of the steel beams which are attached to the horizontal beam with steel bolt assemblies. All wooden timbers are in place with bolt assemblies in varying states of corrosion.

GANGWAY CYLINDER PILES

The divers completed a full inspection and cleaning of the exposed steel sections of the approach way support piles. These piles are contained in concrete from the top down to a level below the tidal zone.

Two of the piles inspected have approximately 20’ of exposed steel and the two piles have 6’ of exposed steel under the concrete jackets. At each pile the divers cleaned the steel sections down to clean steel.

The steel sections of the support piles are generally in fair condition with some areas of corrosion. No visible holes were found, although the metal thickness reading found the steel to be heavily corroded and thin in some locations.

Metal thickness readings for theses piles can be found in Appendix C.

PERMANENT OIL BOOM ASSEMBLIES

The divers conducted a complete cleaning and inspection of the two sections of permanent oil boom attached to the SSP and all associated oil boom slider assemblies.

Both sections of oil boom were found to have heavy marine growth throughout. Upon the completion of the cleaning both sections were inspected and found to be in good condition with no damage or deficiencies found.

ON the north and south SSP cells the divers cleaned and inspected three separate sliders on each, while the centre has two separate sliders which were inspected.

The following a list of the sliders inspected and conditions found,

North Cell

- North slider
    - 50% of fasteners are missing or damaged (24 total)
    - Bottom 24" is off the SSP ½" due to missing attachment bolts

- Permanent boom slider
    - Good Condition
    - All attachments are good except bottom two (Missing)

- East Slider
    - Good condition
    - All attachments are good except bottom two (Missing)

Centre Cell

- Permanent boom slider (North face)
    - Slider in good condition
    - Slider welded in place
    - welds are in good condition

- Permanent boom slider (South face)
    - Slider in good condition
    - Slider bolted in place
    - One missing bolts

South Cell

- South slider
    - Good Condition

- Permanent boom slider
    - Good Condition

- East Slider
    - Good condition

Shore Based Sliders

- North of Approach way
    - Slider in good condition
    - 16 of 26 attachments are in place – remainder are missing or damaged

- South of Approach way
    - Slider in good condition
    - 13 of 26 attachment bolts are missing

Overall the slider assemblies are in good condition with only a few deficiencies found. All sliders are clean and usable incase of an emergency.

If you have any further questions, please feel free to contact me anytime,

Tim Connors
Chief Diving Supervisor
Connors Diving Services Limited
Tel: 902-876-7078 Fax: 902-876-7079
E-mail: tim@connorsdiving.com
ISO 9001:2000 registered

Appendix A

SSP CELL READINGS

- ALL MEASUREMENTS ARE BASED OFF THE TOP OF THE SHEET PILE
- MEASURMENTS ARE EXPRESSED IN INCHES

North Cell							
Pile #	**1’**	**5’**	**8’**	**11’**	**16’**	**25’**	**Sea Bed**
1	0.500	0.360	0.450	0.220	0.285	0.325	0.365
5	0.470	Hole	0.380	0.165	0.370	0.400	0.420
10	0.455	Hole	0.350	0.215	0.315	0.375	0.385
15	0.465	0.340	0.370	0.245	0.355	0.415	0.410
20	0.500	0.360	0.385	0.245	0.370	0.375	0.405
25	0.500	0.315	0.435	0.230	0.335	0.385	0.425
30	0.470	0.300	0.360	0.250	0.365	0.385	0.355
35	0.490	0.325	0.400	0.235	0.365	0.380	0.415
40	0.475	0.270	0.420	0.230	0.295	0.305	0.405
45	0.450	0.245	0.410	0.325	0.305	0.365	0.370
50	0.465	0.325	0.390	0.265	0.265	0.395	0.355
55	**Gangway**	0.365	0.385	0.195	0.390	0.375	0.390
60	0.465	0.225	0.400	0.240	0.380	0.345	0.410
65	0.455	0.315	0.385	0.190	0.240	0.350	0.390
70	**Covered By Concrete Cope Wall (Fender)**			0.340	0.335	0.395	0.400
75				0.270	0.265	0.350	0.405
80				0.130	0.300	0.355	0.405
85				0.395	0.385	0.340	0.435

Centre Cell							
Pile #	**1'**	**5'**	**8'**	**11'**	**16'**	**25'**	**Sea Bed**
1	0.486	0.320	0.405	0.300	0.370	0.380	0.430
5	0.376	0.290	0.335	0.285	0.395	0.325	0.415
10	0.405	0.325	0.410	0.285	0.375	0.390	0.370
15	0.440	0.390	0.425	0.290	0.350	0.370	0.430
20	0.420	0.265	0.405	0.335	0.405	0.390	0.415
25	0.460	0.350	0.445	0.305	0.440	0.385	0.425
30	0.485	0.290	0.445	0.280	0.375	0.390	0.430
35	**Gangway**	0.335	0.465	0.315	0.280	0.345	0.430
40	0.470	0.330	0.450	0.290	0.415	0.395	0.415
45	0.470	0.325	0.420	0.285	0.360	0.405	0.425
50	0.460	0.340	0.460	0.310	0.410	0.400	0.440
55	0.490	0.450	0.440	0.340	0.395	0.290	0.425
60	0.470	0.365	0.405	0.305	0.395	0.415	0.430
65	**Gangway**	0.260	0.425	0.300	0.345	0.355	0.425
70	**Covered By Concrete Cope Wall (Fender)**			0.330	0.370	0.385	0.405
75				0.360	0.380	0.350	0.400
80				0.350	0.300	0.290	0.410
85				0.290	0.315	0.340	0.415

South Cell							
Pile #	**1'**	**5'**	**8'**	**11'**	**16'**	**25'**	**Sea Bed**
1	0.486	0.320	0.405	0.300	0.370	0.380	0.430
5	0.376	0.290	.0335	0.285	0.395	0.325	0.415
10	0.405	0.325	0.410	0.285	0.375	0.390	0.370
15	0.440	0.390	0.425	0.290	0.350	0.370	0.430
20	0.420	0.265	0.405	0.335	0.405	0.385	0.415
25	0.460	0.350	0.445	0.305	0.440	0.390	0.425
30	0.485	0.290	0.445	0.280	0.375	0.345	0.430
35	0.460	0.335	0.465	0.315	0.280	0.395	0.430
40	0.470	0.330	0.450	0.290	0.415	0.405	0.415
45	0.470	0.325	0.420	0.285	0.360	0.400	0.425
50	0.460	0.340	0.460	0.310	0.410	0.290	0.440
55	0.490	0.450	0.440	0.340	0.395	0.415	0.425
60	0.470	0.365	0.405	0.305	0.395	0.355	0.430
65	**Gangway**	0.260	0.425	0.300	0.345	0.385	0.425
70	**Covered By Concrete Cope Wall (Fender)**			0.330	0.370	0.385	0.405
75				0.360	0.380	0.350	0.400
80				0.350	0.300	0.290	0.410
85				0.290	0.315	0.340	0.415

Appendix B

FENDER READINGS

* MEASURMENTS ARE EXPRESSED IN INCHES

North Cell Fender							
North Pile				South Pile			
	West Flange	East Flange	Web		West Flange	East Flange	Web
11' (Top)	0.220	0.250	Hole	**11' (Top)**	0.215	0.115	Hole
16'	0.310	0.400	0.265	**16'**	0.375	0.310	0.340
25'	0.350	0.350	0.340	**25'**	0.315	0.380	0.400
30'	0.300	0.250	0.390	**30'**	0.360	0.325	0.405
Bottom	0.310	0.380	0.350	**Bottom**	0.340	0.300	0.400

Centre Cell Fender							
North Pile				South Pile			
	West Flange	East Flange	Web		West Flange	East Flange	Web
11' (Top)	0.385	Hole	0.285	**11' (Top)**	0.245	Hole	Hole
16'	Hole	Hole	0.340	**16'**	Hole	0.295	0.275
25'	0.285	0.395	0.325	**25'**	0.340	0.360	0.345
30'	0.285	0.430	0.415	**30'**	0.325	0.315	0.355
Bottom	0.395	0.375	0.400	**Bottom**	0.390	0.355	0.390

South Cell Fender							
North Pile				South Pile			
	West Flange	East Flange	Web		West Flange	East Flange	Web
11' (Top)	0.385	0.315	0.415	**11' (Top)**	0.335	0.310	0.340
16'	0.320	0.340	0.400	**16'**	0.315	0.330	0.445
25'	0.430	0.315	0.420	**25'**	0.385	0.415	0.420
30'	0.395	0.350	0.420	**30'**	0.360	0.395	0.425
Bottom	0.435	0.405	0.465	**Bottom**	0.360	0.435	0.365

Appendix C

GANGWAY CYLINDER PILE READINGS

* MEASURMENTS ARE EXPRESSED IN INCHES

North West Pile (20’ Exposed Steel)				
	North	South	West	East
5’ Off Bottom	0.440	0.450	0.425	0.435
10’Off Bottom	0.205	0.420	0.365	0.285
15’ Off Bottom	0.325	0.415	0.195	0.280

South West Pile (20’ Exposed Steel)				
	North	South	West	East
5’ Off Bottom	0.155	0.195	0.270	0.350
10’Off Bottom	0.270	0.285	0.370	0.275
15’ Off Bottom	0.245	0.220	0.245	0.195

North East Pile (6’ Exposed Steel)				
	North	South	West	East
Sea Bed	0.165	0.390	0.265	0.395
3’Off Bottom	0.320	0.430	0.370	0.420
6’ Off Bottom	0.390	0.375	0.165	0.310

North East Pile (6’ Exposed Steel)				
	North	South	West	East
Sea Bed	0.245	0.440	0.315	0.410
3’Off Bottom	0.480	0.425	0.430	0.450
6’ Off Bottom	0.500	0.500	0.425	0.440

Appendix D

Typical SSP Condition in Tidal Zone
Picture Taken at Low Tide

Typical SSP Condition in Tidal Zone
Picture Taken at Low Tide (North Cell)

Typical SSP Condition in Tidal Zone
Picture Taken at Low Tide

Typical SSP Condition in Tidal Zone
Picture Taken at Low Tide

Typical SSP Condition in Tidal Zone
Picture Taken at Low Tide

SSP Knuckles in Poor Condition (Open)
Picture Taken at Low Tide

Safety Rail in Poor Condition

Appendix E

Safe Job Plan

This safe job plan is intended for use as a risk recognition tool to assist you in evaluating all the aspects of a job before starting work and to prepare properly in order that the job will be preformed in compliance with our safety and environmental standards. This safe job plan must always be used for, but not limited to, any of the following job tasking.

- SSDE diving around new construction and/or renovations to wharves
- Any diving on dam structures
- Water inlets/outlets, sluice gates and piping
- When entrapment hazards exist
- Diving in enclosed tanks where entrance and egress are difficult
- When suction hazards exist from water leakage

In addition, a safe job plan is required when one of the following conditions exists:

- When the risks and/or hazards of the job to be performed cannot be adequately controlled under the limitations, precautions and hazard assessment overview
- When there is a high risk of entanglement on the bottom from debris, due to demolition
- When the job is an unusual, different and/or non-routine nature

Before Starting Work

- Review the work plan and the procedures with the workers
- Consider failure modes, effects and events
- Establish work stoppage criteria
- Establish a contingency plan
- Review hazards/ Protection/ Precautions
- Ensure lock out/tag out precautions are in place

During Work

- Monitor conditions around the area
- Correct poor practices and conditions
- Assist in problem solving
- Stop and review work plan changes with affected personnel

After Job Completion

- Clean up area
- Return and/or load equipment
- Verbal report to on scene representative
- Have time sheet signed by representative

Job Specific Procedures

Action	Reference (Safety Manual)
Dive team arrives on-site and prepares the dive site	
Perform a hazard assessment of the area	2.1 Hazard Assessment 2.11 Safe Job Plan
Job briefing with the client	**Perform safety checklist (see attached form)**
Lock-out the machinery (if applicable)	Via lock-out checklist form
Tool-box meeting with divers to discuss safety and procedure	Section 5 – PPE 11.5 – emergency preparedness for diving
Ensure contact numbers are available	11.1 Emergency Contact Numbers
Systems check	
Enter water	
Perform work	3b.8 – surfaced supplied diving procedures ***As per NS Occupational Diving Regulations***
Record all diving information via dive log	12.4 – diving logs
Exit water	
Job de-brief	
Recover lock-out tags (if applicable)	
De-mobilize dive site	
Record any minor problems	ISO 9001:2000 program

In the event of an accident, the person discovering the injured worker shall:

- Assess the initial hazards and identify any secondary hazards,
- Make the area safe for all personnel

- Give first aid
- Send someone to call for help
- Remain with the injured worker until medical attention arrives

In the event of a **diving** emergency, the following steps should be taken. Variations of this plan may be introduced as circumstances change.

1. In the event of a diving emergency, the diving supervisor will assess the situation and begin diver extraction.
    a. Deploy safety diver to assist the diver.
2. Based on the situation, the diving supervisor will either call an ambulance or transport the diver to a hyperbaric facility via company vehicle.

Emergency Contact Numbers

Hyperbaric Emergency	
Hyperbaric Chamber – VG	1-902-473-7998
Divers Alert Network – Emergency	1-919-684-8111
Divers Alert Network – Information	1-919-684-2948
Other Emergency Numbers	
All Emergencies – Nova Scotia	9-1-1
Poison Control	1-800-565-8161
Company Contact Numbers	
Connors Diving Services	1-902-876-7078 (24Hr)
Toll Free	1-877-388-7078
Neil Connors – President (Home)	1-902-479-1630
Company Pager	1-902-459-4042

An Incident Report shall be completed for all accidents or incidents. This information shall be recorded on the available forms

Job Site Hazard Assessment Form

Client NSPC Date August / September, 2010
Location Tufts Cove Job N° 3250
Description of Task Ultra Sonic Survey - Cleaning

	Name (Please Print)	Signature
Client Representative		
Connors Diving Services Representatives	Mike Finley	
	Bojan Cingi	
	Stephan Unruh	
	Cole Scarfe	

WATER HAZARD GROUP	
Analyzed	**Risk**
☒	ENTRAPMENT
☒	DECOMPRESSION PROBLEM
☒	ENTRANCE / EGRESS DIFFICULTY
☒	BOAT TRAFFIC
☒	BLACK WATER
☒	ANCHOR
☒	DIVER EXHAUSTION
☒	CURRENT/ WATER FLOW
☒	CONTAMINATION DIVE
☒	EQUIPMENT IN GOOD CONDITION
LIST ADDITIONAL HAZARDS	

SURFACE HAZARD GROUP	
Analyzed	**Risk**
☒	PINCH POINTS IDENTIFIED
☒	TOOLS/MACHINERY PRESENT
☒	SLIPPING/FALLING
☒	NOISE
☒	FALLING OBJECTS
☒	LIGHTING PROBLEMS
☒	DUST, FUMES, ETC. PRESENT
☒	ELECTROCUTION POSSIBLE
☒	LIFTING/PULLING STRAINS
☒	ASBESTOS PRESENT
LIST ADDITIONAL HAZARDS	

HOW WILL HAZARDS BE CONTROLLED AND/OR ELIMINATED	
Controlled	**Method**
☒	REMOVE HAZARD
☒	DRESSED STANDBY DIVER
☒	NS OCCUPATIONAL DIVING REGULATIONS OCCUPATIONAL HEALTH AND SAFETY ACT
☒	ISOLATE AND/OR DE-ENERGIZE
☒	SAFETY BOAT
☒	ANCHOR SECURE
☒	PPE
☒	NOTIFY ALL CONTRACTORS IN AREA

Comments

Appendix F

789 North Dixboro Road, Ann Arbor, Michigan 48105
(888) NSF-9000

Certificate of Registration

This certifies that the Quality Management System of

Connors Diving Services Ltd.

2 Lakeside Park Drive, Unit 11
Halifax, Nova Scotia, B3T 1L7, Canada

has been assessed by NSF-ISR and found to be in conformance to the following standard(s):

ISO 9001:2008

Scope of Registration:
The provision of diving services in the areas of marine construction, repair & inspections

Exclusions: 7.3

Industrial Classification:

IAF - QMS:	35
NACE:	K 74.8
SIC:	73

Certificate Number:	6B941-IS3
Certificate Issue Date:	24-FEB-2010
Registration Date:	24-FEB-2010
Expiration Date *:	23-FEB-2013

Christian B. Lupo

Christian B. Lupo, General Manager
NSF-ISR, Ltd.

Page 1 of 2

WORKERS' COMPENSATION BOARD OF NOVA SCOTIA

5668 South Street
Post Office Box 1150
Halifax, Nova Scotia
B3J 2Y2

Toll Free 1-800-870-3331

Client Services Department
Telephone (902) 491-8999
Fax (902) 491-8001

Assessment Department
Telephone (902) 491-8324
Fax (902) 491-8326

Corporate Services
Telephone (902) 491-8999
Fax (902) 491-8002

September 09, 2010

CONNORS DIVING SERVICES LIMITED
2 LAKESIDE PARK DRIVE
UNIT 11
LAKESIDE NS B3T 1L7

BN # 101096485
FIRM # 756673

This employer is assessed and in good standing.

This clearance/good standing letter is valid up to December 31, 2010.

This letter does not cover the directors of the company who do not receive T4 earnings and/or family members of the directors who live in their households.

If there is any change in the status of your account before the expiry date, this letter becomes null and void, and you must advise the WCB and principal contractors accordingly.

Candace Hollett
Clearance Officer
Telephone: 491-8370
Toll Free: 1-877-211-9267
Direct Fax: 902-491-8325
Clearance@wcb.gov.ns.ca

Note: Although this letter does not hold the author's handwritten signature, it is considered a valid document and any concerns with respect to its authenticity should be directed to the above-noted Clearance Officers.

/rb
11273070

TOWARDS A HEALTHY, WORKING NOVA SCOTIA

INDUSTRY FUNDED
NSCSA

Tel: 902-468-6696
Toll Free NS: 800-971-3888
Fax: 902-468-8843
Web: www.nscsa.org

35 MacDonald Ave.
Dartmouth, Nova Scotia
B3B 1C6

Member Code	CONNOR01
Member Type	M
Certificate Number	185398

Letter of Good Standing
Certificate of Recognition Program

Issued to:

CONNORS DIV.SER.LTD/BREATH.AIR SYS/DIVERS WORLD
2 LAKESIDE PARK DR., UNIT 11
LAKESIDE, NS B3T 1L7

Based upon the fact that CONNORS DIV.SER.LTD/BREATH.AIR SYS/DIVERS WORLD is an active participant in the Certificate of Recognition Program, the Nova Scotia Construction Safety Association hereby issues a letter of good standing:

April 19, 2010
Date of Issue

April 25, 2011
Expiry Date

This letter of good standing is issued to a firm actively participating in NSCSA programs and whose current standing falls into the category noted below:

Certificate of Recognition ☒
See reverse for category definitions.

Audit Pending ☐

Conditions:

Rhea White
Audit Technical Advisor
Extension 21

NSCSA Representative

Original Issue Oct. 08, 2000 Revision #6 Revision Date: November 20, 2009 Document # FM 9.00

CI Number: 41233

Title: **LIN 3 Boiler Refurbishment**

Start Date: 2013/03
Final Cost Date: 2013/12
Function: Generation
Forecast Amount: $809,680

DESCRIPTION:

The scope of work for this project is to inspect, repair and replace tubes, tube bends and shields on the Unit 3 boiler and replace approximately 11 sections of the Division Wall. Division wall sections that are heavily padded will be replaced.

In March 2012, outage planning for Lingan Unit 3 (LIN3) was revised. An asset reliability review by the NS Power Asset Management team and a third party consultant recommended that LIN3 undergo a major maintenance outage for generator rewind in 2013. Where feasible, work on LIN3 originally planned for 2012 has been deferred to 2013 to align with the major outage. The timeline and scope of this boiler refurbishment project has been modified since its inclusion as a Subsequent Approval item in the 2012 ACE Plan. The division wall replacement has been deferred to 2013, and general refurbishment (tube / bends and shields) was performed in a short outage in April 2012 under CI 42886 to ensure boiler readiness for winter 2012 / 2013.

Summary of Related CIs +/- 2 years
2011 CI 40422 LIN3 Boiler Refurbishment $757,232
2012 CI 42886 LIN3 U&U Boiler Refurbishment $152,824

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

This project is required to maintain the long term reliability of the boiler and mitigate the risk of unplanned outages due to division wall tube leaks. The division wall is heavily padded in certain sections and non-destructive testing (NDT) assessment of wall thickness is not effective.

Why do this project now?

Some of the tubes to be replaced are difficult to access and sufficient time during a planned outage is required to complete the required work. The planned outage for Unit 3 in 2013 will be of sufficient duration to complete replacement of the division wall panels.

Why do this project this way?

The work will be completed in the most cost effective manner to extend the life of the boiler. By replacing the division wall sections, the risk of tube leaks and unplanned outages to the Unit 3 boiler will be reduced. Further overlay repairs are not feasible or appropriate boiler maintenance practice.

CI Number : 41233 - LIN 3 Boiler Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 305 - 305-Lingan 3&4 Prod.Unit **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		13,345	0	13,345
095		095-Thermal Regular Labour AO		5,695	0	5,695
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	21,410	0	21,410
004	013	004 - THERMAL Term Labour	013 - SGP - Boiler	0	0	0
011	013	011 - Travel Expense	013 - SGP - Boiler	0	0	0
012	013	012 - Materials	013 - SGP - Boiler	92,670	0	92,670
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	[redacted]	0	[redacted]
028	013	028 - Consulting	013 - SGP - Boiler	0	0	0
041	013	041 - Meals & Entertainment	013 - SGP - Boiler	0	0	0
			Total Cost:	809,680	0	809,680
			Original Cost:	334,125		

LIN3 Boiler Refurbishment
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Lingan	**CI Number:**	41233
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refubish Boiler	6.48%	724,013	1	23.91%	5.4 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

Refurbish Boiler incluing replace Division Wall sections in 2013

Notes/Comments :

Refubish Boiler

Test 2

Test 3

Test 4

LIN3 Boiler Refurbishment
Avoided Cost Calculations

Division :	Production	Date :	31-Oct-12
Department :	Lingan	CI Number:	41233
Originator :		Project No. :	

Refubish Boiler

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$69,413	$70,801		
Events/Outages (#)	1	2	1	2		
Probability of Occurance (%)	80%	80%	80%	80%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	154	154				
Duration (Hours)	80	80				
Totals	$12,906	$21,336	$55,530	$113,282	$68,437	$134,618
Total Capital Cost of Alternative						$809,680

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

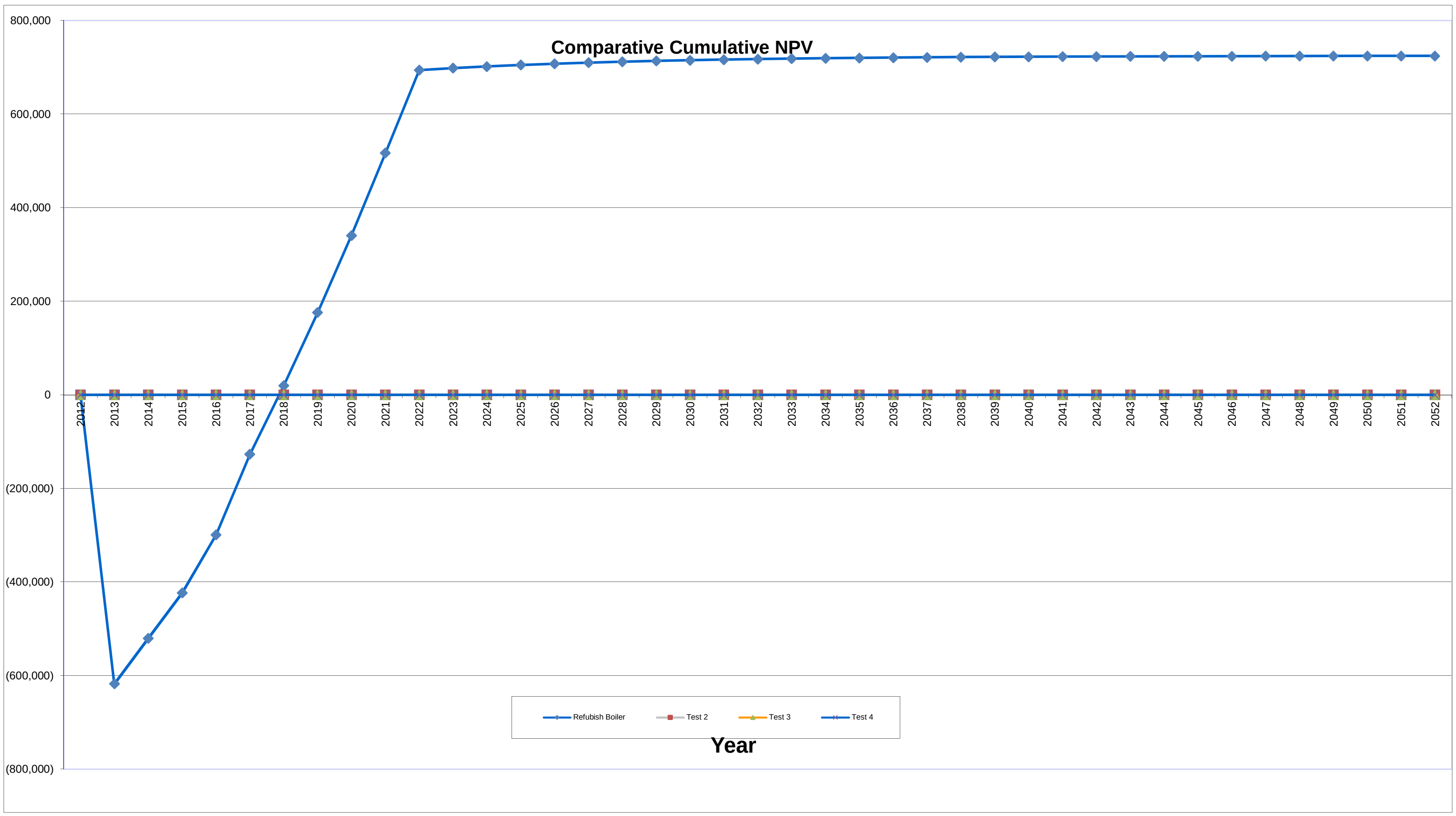
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

LIN3 Boiler Refurbishment
Refubish Boiler

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	68,436.9	(714,080.0)	29,550.3	709,206.3	(645,643.1)	(12,054.8)	(657,698.0)	(617,672.786)	0.9	(617,672.8)
2014	-	134,618.4	-	56,736.5	652,469.8	134,618.4	(24,143.4)	110,475.0	97,437.882	0.9	(520,234.9)
2015	-	145,892.6	-	52,197.6	600,272.2	145,892.6	(29,045.5)	116,847.2	96,786.340	0.8	(423,448.6)
2016	-	210,085.4	-	48,021.8	552,250.4	210,085.4	(50,239.7)	159,845.7	124,345.112	0.8	(299,103.5)
2017	-	321,430.7	-	44,180.0	508,070.4	321,430.7	(85,947.7)	235,483.0	172,035.978	0.7	(127,067.5)
2018	-	291,430.5	-	40,645.6	467,424.7	291,430.5	(77,743.3)	213,687.2	146,612.224	0.7	19,544.7
2019	-	334,416.5	-	37,394.0	430,030.8	334,416.5	(92,077.0)	242,339.5	156,152.122	0.6	175,696.9
2020	-	379,005.3	-	34,402.5	395,628.3	379,005.3	(106,826.9)	272,178.4	164,705.980	0.6	340,402.9
2021	-	434,908.6	-	31,650.3	363,978.0	434,908.6	(125,010.1)	309,898.5	176,119.367	0.6	516,522.2
2022	-	468,251.6	-	29,118.2	334,859.8	468,251.6	(136,131.3)	332,120.3	177,261.712	0.5	693,783.9
2023	-	-	-	26,788.8	308,071.0	-	8,304.5	8,304.5	4,162.615	0.5	697,946.5
2024	-	-	-	24,645.7	283,425.3	-	7,640.2	7,640.2	3,596.549	0.5	701,543.1
2025	-	-	-	22,674.0	260,751.3	-	7,028.9	7,028.9	3,107.462	0.4	704,650.6
2026	-	-	-	20,860.1	239,891.2	-	6,466.6	6,466.6	2,684.884	0.4	707,335.4
2027	-	-	-	19,191.3	220,699.9	-	5,949.3	5,949.3	2,319.772	0.4	709,655.2
2028	-	-	-	17,656.0	203,043.9	-	5,473.4	5,473.4	2,004.311	0.4	711,659.5
2029	-	-	-	16,243.5	186,800.4	-	5,035.5	5,035.5	1,731.749	0.3	713,391.3
2030	-	-	-	14,944.0	171,856.4	-	4,632.6	4,632.6	1,496.252	0.3	714,887.5
2031	-	-	-	13,748.5	158,107.9	-	4,262.0	4,262.0	1,292.780	0.3	716,180.3
2032	-	-	-	12,648.6	145,459.2	-	3,921.1	3,921.1	1,116.977	0.3	717,297.3
2033	-	-	-	11,636.7	133,822.5	-	3,607.4	3,607.4	965.082	0.3	718,262.4
2034	-	-	-	10,705.8	123,116.7	-	3,318.8	3,318.8	833.842	0.3	719,096.2
2035	-	-	-	9,849.3	113,267.4	-	3,053.3	3,053.3	720.450	0.2	719,816.7
2036	-	-	-	9,061.4	104,206.0	-	2,809.0	2,809.0	622.477	0.2	720,439.1
2037	-	-	-	8,336.5	95,869.5	-	2,584.3	2,584.3	537.828	0.2	720,977.0
2038	-	-	-	7,669.6	88,199.9	-	2,377.6	2,377.6	464.690	0.2	721,441.6
2039	-	-	-	7,056.0	81,143.9	-	2,187.4	2,187.4	401.497	0.2	721,843.1
2040	-	-	-	6,491.5	74,652.4	-	2,012.4	2,012.4	346.899	0.2	722,190.0
2041	-	-	-	5,972.2	68,680.2	-	1,851.4	1,851.4	299.725	0.2	722,489.8
2042	-	-	-	5,494.4	63,185.8	-	1,703.3	1,703.3	258.966	0.2	722,748.7
2043	-	-	-	5,054.9	58,130.9	-	1,567.0	1,567.0	223.749	0.1	722,972.5
2044	-	-	-	4,650.5	53,480.5	-	1,441.6	1,441.6	193.322	0.1	723,165.8
2045	-	-	-	4,278.4	49,202.0	-	1,326.3	1,326.3	167.033	0.1	723,332.8
2046	-	-	-	3,936.2	45,265.9	-	1,220.2	1,220.2	144.318	0.1	723,477.2
2047	-	-	-	3,621.3	41,644.6	-	1,122.6	1,122.6	124.693	0.1	723,601.8
2048	-	-	-	3,331.6	38,313.0	-	1,032.8	1,032.8	107.736	0.1	723,709.6
2049	-	-	-	3,065.0	35,248.0	-	950.2	950.2	93.085	0.1	723,802.7
2050	-	-	-	2,819.8	32,428.1	-	874.2	874.2	80.427	0.1	723,883.1
2051	-	-	-	2,594.3	29,833.9	-	804.2	804.2	69.490	0.1	723,952.6
2052	-	-	-	2,386.7	27,447.2	-	739.9	739.9	60.040	0.1	724,012.6
Total	-	2,788,476.3	(714,080.0)	711,309.3	8,549,435.6	2,074,396.3	(643,921.8)	1,430,474.6	724,012.6		



Comparative Cumulative NPV
800,000
600,000
400,000
200,000
0
(200,000)
(400,000)
(600,000)
(800,000)
2012
2013
2014
2015
2016
2017
2018
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2052
Refubish Boiler
Test 2
Test 3
Test 4
Year

Location: Lingan
FP#:41233
Title: LIN3 Boiler Refurbishment

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Engineering Support TCS	hr	[redacted]		$ 2,240.00		
1.2	Utiltity	hr	[redacted]		$ 19,170.00		
1.3							
				Sub-Total	$ 21,410.00		38943
2	**012 Materials**						
2.1	Division Wall panels	lot	1	$ 67,670.00	$ 67,670.00	NS Power Stores	
2.2	Tubes, bends, Shields	lot	1	$ 25,000.00	$ 25,000.00		
2.3					$ -		
				Sub-Total	$ 92,670.00		
3	**013 Power Production Contracts**						
3.1	Boiler service - Division Wall + Refurb 5 wk Mobilisation	lot	1	[redacted]			38943
					$ -		
				Sub-Total	[redacted]		
4	**094 Interest Capitalized**						
4.1	Interest Capitalized	lot	1	$ 13,344.61	$ 13,344.61		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 13,344.61		
5	**095 Administrative Overhead**						
5.1	Therm & Hydro Contracts AO	lot	1	[redacted]			
5.2	Thermal Regular labour AO	lot	1	$ 5,695.06	$ 5,695.06		
5.3					$ -		
				Sub-Total	[redacted]		
ect Cost Estimate				**Total**	$ 809,679.67		
6	**Original Cost**						
6.1					$ 334,125.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

ALSTOM
Canada Inc

EXECUTIVE SUMMARY REPORT

Nova Scotia Power Incorporated
Lingan Generating Station
Unit # 3
November, 2011 – Shutdown

Summary

The utility boiler for Unit # 3 at Lingan Generating Station was shut down as part of the Planned Annual Maintenance in November 2011.

The major scope of work during this outage was the replacement of twenty-five {25} tube replacements though out the boiler. The Main Feed Water valve and 3-B BFP Check Valve were replaced during this shutdown.

There were 683 areas for a total of 3,771" {314'} of pad welding carried out in the Upper Furnace and 33 areas for a total of 269"{22'} in the Lower Furnace.

Introduction

During the November, 2011 shutdown, the boiler was inspected internally to determine the condition and assessment. Sections of the boiler were repaired to ensure the Unit's integrity could be maintained.

Alstom under the Supervision of Mr. Gerard LeBlanc carried out the Non-Destructive Testing. Alstom under the Supervision of Mr. Gary MacDonnell carried out the repairs. Safety Officer was Ernie Aker and Quality Assurance representative was Matthew Muise during this shutdown.

Lower Furnace

Access to the lower furnace was via swing staging to carry out water wall inspection and repair.

The North Waterwall was surveyed with eight {8} areas for a total of eighty-two {82} inches that required pad weld overlay. These areas were repaired, inspected with color contrast magnetic particles and found acceptable. Due to a previous emergency outage, there were two repaired tubes {T-20, T21 @ IR14} that were replaced. The butt welds on these tubes were radiographed and found acceptable.

The South Waterwall was surveyed with six {6} areas for a total of sixty-two {62} inches that required pad weld overlayed. These areas were repaired, inspected with color contrast magnetic particles and found acceptable.

The East Water wall was surveyed with no repairs required.

The West Waterwall was surveyed with eleven {11} areas for a total of sixty-five {65} inches that required pad weld overlay. These areas were repaired, inspected with color contrast magnetic particles and found acceptable.

The four corners were surveyed with following areas pad welded:

Corner # 1 – No pad welds were required in this corner.
Corner # 2 – There was one (1) area that required sixteen {16} inches of pad weld overlay.
Corner # 3 – There was six {6} areas that required thirty-eight {38} inches of pad weld overlay.
Corner # 4 – There was one (1) area that required six {6} inches of pad weld overlay.

These areas were repaired, inspected with color contrast magnetic particles and found acceptable.

HTSH Plt – A Section

A survey was carried out in A Section with the following work carried out:

A-1 – 159 pad welds for a total of four hundred sixteen inches {416"}. There were five {5} tube replacements carried out. Three {3} replacements were from previous leaks and two {2} replacements were due to wall thinning.
A-2 – 17 pad welds for a total of one hundred seventy-seven inches {177"}. There was one {1} tube replaced due to wall thinning.
A-3 – 157 pad welds for a total of eight hundred seventy-four inches {874"}. There were two {2} tubes replaced. One tube was replaced from a previous leak and one replacement due to wall thinning.

The front wall was surveyed with twenty {20} areas for a total of one hundred seventy-two {172"} inches pad welded.

The division wall was surveyed with eighty-eight {88} areas for a total of eight hundred seventy-four {874"} inches pad welded.

All new pad welding on the Front and Division Walls were visually and magnetic particle inspected.

RH-Intermediate – B & B – C Sections

The RH Intermediate section was surveyed with two {2} areas for a total of eleven {11"} inches identified and pad welded. There were also twenty-six {26} deteriorated shields identified for replacement. No shields were replaced.

RH-Finish – C Section

The RH Finish section was surveyed with one {1} area for a total of one {1"} inch identified and pad welded. There were forty-four {44} deteriorated shields identified for replacement. No shields were replaced.

HTSH-Finish – D Section

The HTSH Finish section was surveyed with sixty-seven {67} areas for a total of three hundred ninety-three {393"} inches identified and pad welded. There were nine {9} tube replacements carried out. Four

c/o Nova Scotia Power Inc
Lingan Generating Station
New Waterford, N.S. Canada
Tel.: (902) 862-6422 Ext 3331
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ALSTOM Canada Inc.

{4} replacements were from previous leaks and five5} replacements were due to wall thinning. There were eighty-seven {87} deteriorated shields identified for replacement. Two {2} shields were replaced during this shutdown.

LTSH-4 – E Section

E Section was surveyed with forty-one {41} areas totaling one hundred three {103"} inches pad welded. In addition, ninety-five {95} deteriorated shields were identified for replacement. No shields were replaced.

LTSH-3 – F Section

The visual and UT survey identified with nine {9} areas for a total of twenty-two {22"} inches pad welded. Thirty-eight {38} deteriorated shields were identified, but not replaced during this shutdown.

LTSH-2 – G Section

The visual and UT survey revealed four {4} areas for a total of six {6} inches pad welded. Seven {7} deteriorated shields were identified, but not replaced.

LTSH-1-2 – H-I Sections

A survey was carried out in the LTSH Section. Six {6} areas for a total of twenty-three {23"} inches were pad welded in H Section. Seven {7} deteriorated shields were identified, but not replaced.

There were seven {7} areas for a total of fifty-six {56"} inches identified and repaired in I Section. In addition, there were forty-five {45} areas for a total of three hundred twenty {320"} inches in I Center Assessment identified and repaired due to wall thinning. There were six {6} tube replacements and two {2} bifurcates replaced during this shutdown due to wall thinning.

Economizer – J Section

J Section was surveyed with fifty-five {55} areas for a total of three hundred eleven {311"} inches pad welded. One {1}-tube replacement was carried out due to wall thinning.

Economizer – K Section

K Section was surveyed with five {5} areas for a total of ten {10"} inches identified and repaired.

Deaerator

The Deaerator Heater vessel was inspected with no pad weld overlay required. The North West Bled Steam elbow was replaced inside the shell.

The Deaerator Storage vessel was inspected visually and with MPI on the circumferential, longitudinal and attachment welds. No defects were noted during this inspection.

Steam Drum

An internal visual inspection was carried out in the steam drum. Holes were identified in the 6" distribution line. There were two {2} elbows replaced in the South end and one elbow repaired. There was one {1} elbow replaced in the North end.

Blow-down Tank

An internal visual inspection was carried out in the blow-down tank. Cracking in the attachment weld of the shell to liner was identified. There was a bulge in the liner. This section was cut out and new liner pieces were installed and the liner was re-affixed to the shell.

Headers

The RH-1, RH-2 and SH-5 Headers were visually and Magnetic Particle inspected on the circumferential welds and Tees. The pipe to header welds, hanger bracket welds and 20 tube ligament sockolet welds on the West End and 20 tube ligament sockolet welds on the East End were inspected with no defects noted. The Economizer Inlet cap was removed to perform internal inspection. The existing cap was re-installed following internal inspection.

The three {3} hand-hole caps were removed for internal inspection and new caps were re-installed.

Feed Water Control Valve

The feed water control valve on the mezzanine floor was replaced with a new valve. The butt welds were radiographed prior to and after post weld heat treatment and found acceptable.

3-BFP Check Valve

The check valve at 3-BFP was replaced during this shutdown. The butt welds were radiographed prior to and after post weld heat treatment and found acceptable.

Inspection Ports {Weldolets}

There were five {5} inspection ports {weldolets} replaced on the feed water line. These welds were inspected prior to and after post weld heat treatment with no defects noted.

Low Load Valve

The low load valve on the 2nd floor was replaced during this shutdown. Butt welds radiograhed with no defects noted.

Conclusions and Recommendations

During the next Planned Shutdown scheduled for 2012, the following recommendations should be considered:

NSPI Engineering investigate the feasibility of replacing the Division Wall in "A-3" Section.

NSPI Engineering investigate the feasibility of installing envelope shields from Plt 7-78 to protect bends from fly ash erosion.
Replace deteriorated tube shields not replaced during the 2011 shutdown.
Re-inspect the liner in the blow-down tank.
Replace the repaired elbow in the south end of the steam drum.

CI Number: 43094

Title: **LIN3 HT Fastener Replacement**

Start Date: 2013/03
Final Cost Date: 2013/11
Function: Generation
Forecast Amount: $779,269

DESCRIPTION:

This project is to replace LIN3 steam turbine high temperature fasteners (bolts and studs) to ensure the integrity of the steam turbine for continued safe and efficient operation. High Temperature Fasteners are monitored for life cycle maintenance as described in NS Power's Thermal Maintenance Practice (TMP) - Steam Turbine - High Temperature Bolting Maintenance Practice. This practice applies to the high-pressure outer casing, high-pressure inner casing, intermediate-pressure outer casing, intermediate-pressure inner casing, main stop valve cover, control valves, reheat stop valve covers, intercept valve covers, combined reheat valve covers, main and reheat steam leads.

The basic criteria for evaluating the consumed life for steam turbine high-temperature bolts are the material, number of times the bolts have been tightened, number of unit start/stop cycles, running hours, bolt operating temperature and critical maintenance data.

Evaluation of Unit 3 high temperature fasteners using Original Equipment Manufacturer (OEM) criteria indicates that these fasteners are now at the end of their service life and must be replaced.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015.

JUSTIFICATION:

Justification Criteria: Health & Safety

Sub Criteria: Equipment Replacement

Why do this project?

The function of the steam turbine high temperature bolting is to maintain a tight joint with no steam leakage into other sections of the turbine or into the plant. High pressure steam leaking from high-pressure joints is a safety concern, and may also require maintenance outages and costly repairs. Leaking joints within the steam turbine can result in steam bypassing portions of the intended steam path and a resultant loss of efficiency.

Why do this project now?

These bolts will exceed the consumed fastener life criteria recommended by the Original Equipment Manufacturer (OEM) before the next planned major outage (approx. 2020), if they are not replaced during the planned maintenance shutdown in 2013.

Why do this project this way?

In addition to ensuring that safe and reliable operation of the turbine is maintained, completing the bolting replacement during the 2013 planned outage represents the most cost effective solution.

CI Number : 43094 - LIN3 HT Fastener Replacement **Project Number**

Parent CI Number : -

Cost Centre : 305 - 305-Lingan 3&4 Prod.Unit **Budget Version** 2012 08/04 Forecast

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		7,607	0	7,607
095		095-Thermal Regular Labour AO		35,564	0	35,564
095		095-Thermal & Hydro Contracts AO		36,366	0	36,366
001	010	001 - THERMAL Regular Labour	010 - SGP - Turbo Gen.Instal.	133,700	0	133,700
002	010	002 - THERMAL Overtime Labour	010 - SGP - Turbo Gen.Instal.	0	0	0
004	010	004 - THERMAL Term Labour	010 - SGP - Turbo Gen.Instal.	0	0	0
011	010	011 - Travel Expense	010 - SGP - Turbo Gen.Instal.	2,000	0	2,000
012	010	012 - Materials	010 - SGP - Turbo Gen.Instal.	278,032	0	278,032
013	010	013 - POWER PRODUCTION Contracts	010 - SGP - Turbo Gen.Instal.	285,000	0	285,000
041	010	041 - Meals & Entertainment	010 - SGP - Turbo Gen.Instal.	1,000	0	1,000
			Total Cost:	779,269	0	779,269
			Original Cost:	274,500		

Location: Lingan
CI# / FP#: 43094
Title: LIN3 Turbine Fastener Replacement
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	hr	[redacted]		$ 3,280.00		
1.2	Engineering (P.Eng)	hr	[redacted]		$ 6,720.00		
1.3	Maintenance Trades	hr	[redacted]		$ 107,500.00		39443
1.4	Utility & Unskilled	hr	[redacted]		$ 16,200.00		
1.5		hr		$ -	$ -		
				Sub-Total	$ 133,700.00		
2	**012 Materials**						
2.1	Fasteners Quote Package	lot	1	[redacted]		Cost Support 1	
2.2	Contingency on Fasteners	%	[redacted]				
2.3	Misc Materials - LIN supply	lot	1	$ 25,000.00	$ 25,000.00		
2.4	UH Taps and fabricaton of chasers. (Special tool build (thread recovery AR)	lot	1	$ 10,000.00	$ 10,000.00		
2.5	Cylinders and Powerpacks	lot	1	$ 8,000.00	$ 8,000.00		
				Sub-Total	$ 278,032.00		39443
3	**013 Power Production Contracts**						
3.1	TA to support install AR	lot	1	$ 50,000.00	$ 50,000.00		39443
3.2	Fastener Removal Contract - on site machining 5 wks, lab (crew of 4 plus supervision & Speciality Equip)	lot	1	[redacted]			39443
3.3	Contingency on Fastener Removal Contract	%	[redacted]				
3.4	Bolt Heating Services	lot	1	$ 50,000.00	$ 50,000.00		39443
3.5	Shipping	lot	1	$ 15,000.00	$ 15,000.00		39443
3.6	Materials Lab test	lot	1	$ 5,000.00	$ 5,000.00		
3.7							
				Sub-Total	$ 285,000.00		
4	**011 Travel Expenses**						
4.1	GS Travel to Site - 2 trips	lot	1	$ 2,000.00	$ 2,000.00		
				Sub-Total	$ 2,000.00		
5	**041 Meals and Entertainment**						
5.1	GS Travel to Site - 2 trips	lot	1	$ 1,000.00	$ 1,000.00		
				Sub-Total	$ 1,000.00		
6	**094 Interest Capitalized**						
6.1	Interest Capitalized	lot	1	$ 7,606.99	$ 7,606.99		
				Sub-Total	$ 7,606.99		
7	**095 Administrative Overhead**						
7.1	Thermal Hydro Contracts AO	lot	1	$ 36,366.00	$ 36,366.00		
7.2	Thermal Reg Lab AO	lot	1	$ 35,564.20	$ 35,564.20		
7.3					$ -		
				Sub-Total	$ 71,930.20		
ect Cost Estimate				**Total**	$ 779,269.19		
8	**Original Cost**				$ 274,500.00		
8.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

CI Number: 43006

Title: **TRE6 Programmable Logic Controller (PLC) Upgrades**

Start Date: 2013/04
Final Cost Date: 2014/01
Function: Generation
Forecast Amount: $728,309

DESCRIPTION:

The Programmable Logic Controller (PLC) network is one of the two major systems responsible for the control and monitoring of the generating station. Whereas the Distributed Control and Management System (DCMS) works by analogue signals and performs modulating control (flow, level, control of dampers, modulating valves, etc.), the PLC network uses digital signals, and performs discrete control (switches, on/off control, motor start/stop control, etc.)

The PLCs at Trenton Unit 6 were installed when the unit was constructed in 1990. The PLC network consists of five communication highways that connect over twenty PLC and their associated I/O sub-systems that all the plant signals are wired to. The highways communicate with the central control room to provide plant operations personnel with a control mechanism and to give them plant information.

Most original PLC models became obsolete over the last ten years. The latest replacement models of the line are listed to enter the obsolescence phase in 2012 or 2013. The OEM offers a new series of PLCs that will work with the older I/O cards, thus only the controllers will have to be replaced. The costs associated with this project are to purchase PLCs, engineering, programming and troubleshooting software, as well as the engineering involved in converting the PLC logic programs. 17 existing PLC controllers will be replaced with 3 new controllers. The upgraded equipment is expected to last 20 to 25 years.

Summary of Related CIs +/- 2 years:
No projects 2011, 2012, 2013, 2014 or 2015

JUSTIFICATION:

Justification Criteria: Thermal
Sub Criteria: Equipment Replacement

Why do this project?

The existing PLCs are no longer being supported or developed. The original components can no longer be purchased, and the upgraded compatible versions will not be supported in the future. As the PLCs are essential to plant control, in time, the increasing number of failures will lead to plant outages.

Why do this project now?

The technology used in the Trenton 6 PLC network is over twenty years old and considered antiquated by current controls systems standards. The manufacturer has announced that the product line has entered into the "Silver Series" stage of support (start of obsolescence). The Trenton Unit 6 PLC models entered "Silver Series" between 2001 and 2009. The latest models in the particular line used at Trenton Unit 6 are slated for this category at the end of 2012.

Why do this project this way?

The OEM supplies a new line of PLCs that will communicate with the existing I/O sub-systems. This will allow NS Power to retain the I/O modules & chassis and avoid having to rewire and re-commission field systems involving hundreds of cables.

In addition, the new PLC line retains much of the same programming format as the older system. This will provide a familiarity to Trenton technicians when troubleshooting problems and /or modifying logic, thus reducing training and start-up costs.

The 17 existing controllers use the same data communication channel to communicate with the DCMS. This communication channel cannot host a mix of old and new processors. To leave the processors that are now just entering silver stage or scheduled to enter silver stage in 2013 in operation while replacing the obsolete processors, a separate communication channel would have to be installed and commissioned which would include new cable, new DCMS interface cards and additional DCMS programming. The installation of another data channel to support a separate network of PLCs is not the most economical option given the short period of time left before these processors also reach silver stage.

CI Number : 43006 - TRE6 PLC Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 345 - 345-Trenton unit 6 Capital **Budget Version** 2012 08/04 Forecast

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		13,850	0	13,850
095		095-Thermal Regular Labour AO		26,674	0	26,674
095		095-Thermal & Hydro Contracts AO		31,567	0	31,567
095		095-Thermal Overtime Labour AO		5,802	0	5,802
001	022	001 - THERMAL Regular Labour	022 - SGP - Elec Contr.Equip.	46,520	0	46,520
002	022	002 - THERMAL Overtime Labour	022 - SGP - Elec Contr.Equip.	43,624	0	43,624
011	022	011 - Travel Expense	022 - SGP - Elec Contr.Equip.	9,000	0	9,000
012	022	012 - Materials	022 - SGP - Elec Contr.Equip.	246,621	0	246,621
013	022	013 - POWER PRODUCTION Contracts	022 - SGP - Elec Contr.Equip.	247,390	0	247,390
021	022	021 - Telephones	022 - SGP - Elec Contr.Equip.	500	0	500
041	022	041 - Meals & Entertainment	022 - SGP - Elec Contr.Equip.	3,000	0	3,000
001	085	001 - THERMAL Regular Labour	085 Design	20,160	0	20,160
001	087	001 - THERMAL Regular Labour	087 Field Super.& Ops.	33,600	0	33,600
			Total Cost:	728,309	0	728,309
			Original Cost:	478,000		

TRE6 PLC Upgrades
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Trenton Generating Station	**CI Number:**	43006
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	PLC Upgrades	6.48%	8,648,201	1	48.90%	4.0 years
B	Full PLC Replacement	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

Recommended to upgrade PLC for TRE6.

Notes/Comments :

PLC Upgrades

Upgrade of current PLC, utilizing existing I/O cards.

Full PLC Replacement

Replacement of the PLC and I/O cards with a complete new system is more expensive than upgrading to the new series of PLCs offered by the OEM, and is not evaluated further.

Test 3

Test 4

TRE6 PLC Upgrades
Avoided Cost Calculations

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Trenton Generating Station	**CI Number:**	43006
Originator :		**Project No. :**	

PLC Upgrades

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$79,000**	**$80,580**		
Events/Outages (#)	**1**	**1**	**1**	**1**		
Probability of Occurance (%)	**5%**	**8%**	**5%**	**8%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**160**	**160**				
Duration (Hours)	**1152**	**1152**				
Totals	**$120,730**	**$173,076**	**$3,950**	**$6,044**	**$124,680**	**$179,120**
Total Capital Cost of Alternative						**$728,309**

Full PLC Replacement

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

Test 3

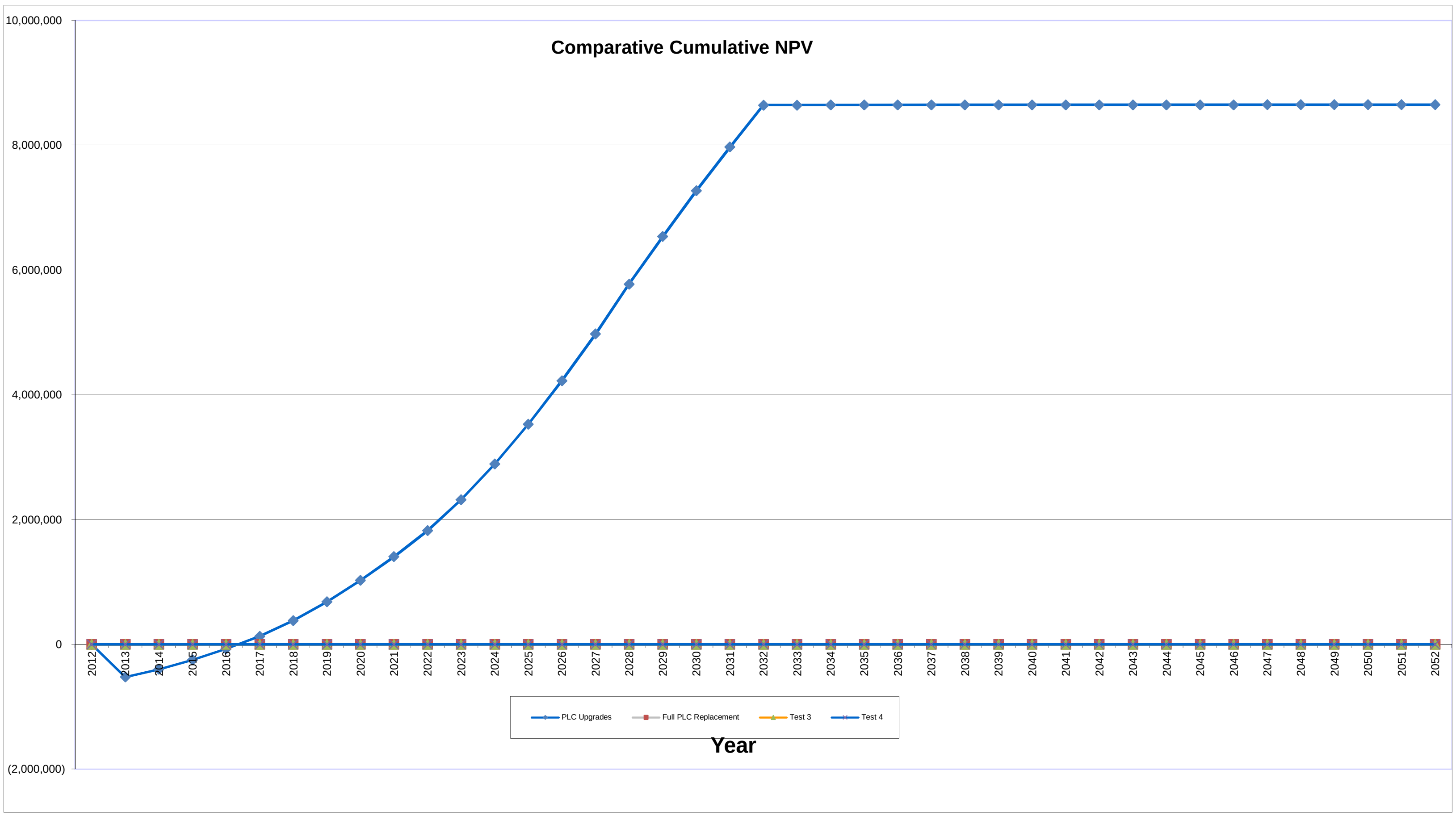
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

TRE6 PLC Upgrades
PLC Upgrades

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	124,679.6	(650,415.0)	26,785.1	642,842.9	(525,735.4)	(30,347.3)	(556,082.7)	(522,241.443)	0.9	(522,241.4)
2014	-	179,120.0	-	51,427.4	591,415.5	179,120.0	(39,584.7)	139,535.3	123,068.803	0.9	(399,172.6)
2015	-	243,603.2	-	47,313.2	544,102.2	243,603.2	(60,849.9)	182,753.3	151,377.415	0.8	(247,795.2)
2016	-	310,594.0	-	43,528.2	500,574.1	310,594.0	(82,790.4)	227,803.6	177,210.097	0.8	(70,585.1)
2017	-	380,167.1	-	40,045.9	460,528.1	380,167.1	(105,437.6)	274,729.5	200,708.217	0.7	130,123.1
2018	-	517,027.3	-	36,842.3	423,685.9	517,027.3	(148,857.4)	368,169.9	252,603.895	0.7	382,727.0
2019	-	659,209.8	-	33,894.9	389,791.0	659,209.8	(193,847.6)	465,362.2	299,857.394	0.6	682,584.4
2020	-	806,872.8	-	31,183.3	358,607.7	806,872.8	(240,463.7)	566,409.0	342,756.597	0.6	1,025,341.0
2021	-	960,178.6	-	28,688.6	329,919.1	960,178.6	(288,761.9)	671,416.7	381,574.860	0.6	1,406,915.8
2022	-	1,119,293.9	-	26,393.5	303,525.6	1,119,293.9	(338,799.1)	780,494.8	416,571.523	0.5	1,823,487.4
2023	-	1,427,099.7	-	24,282.0	279,243.5	1,427,099.7	(434,873.5)	992,226.2	497,350.134	0.5	2,320,837.5
2024	-	1,746,770.0	-	22,339.5	256,904.1	1,746,770.0	(534,573.5)	1,212,196.6	570,632.552	0.5	2,891,470.0
2025	-	2,078,656.4	-	20,552.3	236,351.7	2,078,656.4	(638,012.3)	1,440,644.1	636,901.329	0.4	3,528,371.4
2026	-	2,423,119.4	-	18,908.1	217,443.6	2,423,119.4	(745,305.5)	1,677,813.9	696,612.395	0.4	4,224,983.8
2027	-	2,780,529.5	-	17,395.5	200,048.1	2,780,529.5	(856,571.6)	1,923,958.0	750,196.345	0.4	4,975,180.1
2028	-	3,151,266.8	-	16,003.8	184,044.3	3,151,266.8	(971,931.5)	2,179,335.3	798,059.681	0.4	5,773,239.8
2029	-	3,214,292.1	-	14,723.5	169,320.7	3,214,292.1	(991,866.3)	2,222,425.9	764,311.795	0.3	6,537,551.6
2030	-	3,278,578.0	-	13,545.7	155,775.1	3,278,578.0	(1,012,160.0)	2,266,418.0	732,007.006	0.3	7,269,558.6
2031	-	3,344,149.5	-	12,462.0	143,313.1	3,344,149.5	(1,032,823.1)	2,311,326.4	701,081.445	0.3	7,970,640.0
2032	-	3,411,032.5	-	11,465.0	131,848.0	3,411,032.5	(1,053,865.9)	2,357,166.6	671,474.354	0.3	8,642,114.4
2033	-	-	-	10,547.8	121,300.2	-	3,269.8	3,269.8	874.775	0.3	8,642,989.2
2034	-	-	-	9,704.0	111,596.2	-	3,008.2	3,008.2	755.816	0.3	8,643,745.0
2035	-	-	-	8,927.7	102,668.5	-	2,767.6	2,767.6	653.034	0.2	8,644,398.0
2036	-	-	-	8,213.5	94,455.0	-	2,546.2	2,546.2	564.229	0.2	8,644,962.2
2037	-	-	-	7,556.4	86,898.6	-	2,342.5	2,342.5	487.501	0.2	8,645,449.8
2038	-	-	-	6,951.9	79,946.7	-	2,155.1	2,155.1	421.207	0.2	8,645,871.0
2039	-	-	-	6,395.7	73,551.0	-	1,982.7	1,982.7	363.928	0.2	8,646,234.9
2040	-	-	-	5,884.1	67,666.9	-	1,824.1	1,824.1	314.438	0.2	8,646,549.3
2041	-	-	-	5,413.4	62,253.5	-	1,678.1	1,678.1	271.678	0.2	8,646,821.0
2042	-	-	-	4,980.3	57,273.3	-	1,543.9	1,543.9	234.733	0.2	8,647,055.7
2043	-	-	-	4,581.9	52,691.4	-	1,420.4	1,420.4	202.812	0.1	8,647,258.5
2044	-	-	-	4,215.3	48,476.1	-	1,306.7	1,306.7	175.232	0.1	8,647,433.8
2045	-	-	-	3,878.1	44,598.0	-	1,202.2	1,202.2	151.403	0.1	8,647,585.2
2046	-	-	-	3,567.8	41,030.2	-	1,106.0	1,106.0	130.814	0.1	8,647,716.0
2047	-	-	-	3,282.4	37,747.7	-	1,017.5	1,017.5	113.025	0.1	8,647,829.0
2048	-	-	-	3,019.8	34,727.9	-	936.1	936.1	97.655	0.1	8,647,926.7
2049	-	-	-	2,778.2	31,949.7	-	861.3	861.3	84.375	0.1	8,648,011.0
2050	-	-	-	2,556.0	29,393.7	-	792.4	792.4	72.901	0.1	8,648,083.9
2051	-	-	-	2,351.5	27,042.2	-	729.0	729.0	62.987	0.1	8,648,146.9
2052	-	-	-	2,163.4	24,878.8	-	670.6	670.6	54.422	0.1	8,648,201.4
Total	-	32,156,240.2	(650,415.0)	644,749.2	7,749,429.7	31,505,825.2	(9,768,562.2)	21,737,263.0	8,648,201.4		


Comparative Cumulative NPV
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PLC Upgrades
Full PLC Replacement
Test 3
Test 4
Year

Location: Trenton Generating Station
CI# / FP#: 43006
Title: TRE6 PLC Upgrades
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrical	lot	[redacted]	[redacted]	$ 36,080.00		27416-S114
1.2	Operations	lot	[redacted]	[redacted]	$ 5,520.00		
1.3	Instrumentation	lot	[redacted]	[redacted]	$ 4,920.00		
1.4	Internal Engineering	lot	[redacted]	[redacted]	$ 20,160.00		
1.5	Internal Supervision	lot	[redacted]	[redacted]	$ 33,600.00		
1.6					$ -		
				Sub-Total	$ 100,280.00		
2	**002 Overtime Labour**						
2.1	Electrical	lot	[redacted]	[redacted]	$ 39,360.00		
2.2	Operations	lot	[redacted]	[redacted]	$ 984.00		
2.3	Instrumentation	lot	[redacted]	[redacted]	$ 3,280.00		
2.4							
				Sub-Total	$ 43,624.00		
3	**004 Term Labour**						
3.1					$ -		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ -		
4	**012 Materials**						
4.1	PLC supply	lot	1	[redacted]	[redacted]	Cost Support 1	
4.2	Misc. materials	lot	1	[redacted]	[redacted]		
4.3	Materials Contingency	%	[redacted]	[redacted]	[redacted]		
4.4					$ -		
4.5					$ -		
				Sub-Total	$ 246,621.10		
5	**013 Power Production Contracts**						
5.1	Project Engineering	lot	1	[redacted]	[redacted]		
5.2	Commissioning Assistance	lot	1	[redacted]	[redacted]		
5.3	Contract Contigency (10%)	lot	[redacted]	[redacted]	[redacted]		
5.4					$ -		
5.5					$ -		
				Sub-Total	$ 247,390.00		
6	**028 Consulting**						
6.1					$ -		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ -		
7	**011 Travel**						
7.1	Travel	lot	1	$ 9,000.00	$ 9,000.00		
				Sub-Total	$ 9,000.00		
8	**021 Telephones**						
8.1	Telephones	lot	1	$ 500.00	$ 500.00		
				Sub-Total	$ 500.00		
9	**041 Meals and Entertainment**						
9.1	Meals	lot	1	$ 3,000.00	$ 3,000.00		
				Sub-Total	$ 3,000.00		
10	**094 Interest Capitalized**						
10.1	Interest Capitalized	lot	1	$ 13,850.32	$ 13,850.32		
				Sub-Total	$ 13,850.32		
11	**095 Administrative Overhead**						
11.1	Thermal Regular Labour AO	lot	1	$ 26,674.48	$ 26,674.48		
11.2	Thermal Overtime Labour AO	lot	1	$ 5,801.99	$ 5,801.99		
11.3	Thermal & Hydro Contracts AO	lot	1	$ 31,566.96	$ 31,566.96		
11.4					$ -		
				Sub-Total	$ 64,043.43		
Cost Estimate				Total	$ 728,308.85		
12	**Original Cost**						
12.1	Retirement				$ 478,000.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project.

Attachment 1

Removed due to confidentiality

Atlantic Canada
10 – 109 Williams Ave
Dartmouth, NS
Tel 902.407.9210
bthibault@ra.rockwell.com

Rockwell Automation

August 22, 2012

Nova Scotia Power

Dear Sirs,

Rockwell Automation appreciates your investment in our control products. As a valued customer, part of our commitment to you is to inform you of changes to the status of mature products.

Catalog Number	Passport or BOM Description	Silver (Last Time Buy)Date
1771-IAN	120VAC, 32 Point Input Module	12/31/2013
1771-IBN	24VDC, 32 Point Input Module	12/31/2013
1771-OAN	120/240VAC, 32 Point Output Module	12/31/2013
1771-ODZ	120VAC 8 Point Output Module	12/31/2013
1771-OWNA	Digital Contact 32 Point Output Module	12/31/2013
1771-OYL	24VAC/VDC 8 Point Module	12/31/2013

These products are now part of the **Silver Series** program (reference www.ab.com/silver for more details). As of the Silver Dates listed in the table above, these products will no longer be offered for general sale; however, we plan to provide repair services and technical support for an additional seven years if necessary components remain available. Based on your needs, Rockwell Automation will work with your company to develop a complete support and/or migration plan for your existing installations.

We understand the commitment you have made to Rockwell Automation products. I hope that this letter communicates Rockwell Automation's commitment to supporting our customers. We welcome the opportunity to work with you in your future planning. Please do not hesitate to call me at (902) 407-9210 with any questions or comments.

Yours Truly

Robert L. Thibault
Account Manager Automation and Solutions

LISTEN. THINK. SOLVE.

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August 22, 2012

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Catalog Number	Product Description	Silver Series Date
1771-A1B	4 Slot 1771 IO Chassis	3/31/2013
1771-A1BK	4 Slot 1771 IO Chassis, Conformally Coated	3/31/2013
1771-A2B	8 Slot 1771 IO Chassis	3/31/2013
1771-A2BK	8 Slot 1771 IO Chassis, Conformally Coated	3/31/2013
1771-A3B	12 Slot 1771 IO Chassis	3/31/2013
1771-A3BK	12 Slot 1771 IO Chassis, Conformally Coated	3/31/2013
1771-A3B1	12 Slot 1771 IO Chassis	3/31/2013
1771-A3B1K	12 Slot 1771 IO Chassis, Conformally Coated	3/31/2013
1771-A4B	16 Slot 1771 IO Chassis	3/31/2013
1771-A4BK	16 Slot 1771 IO Chassis, Conformally Coated	3/31/2013

These products are now designated in **Silver Series** (reference www.ab.com/silver for more details). As of the Silver Date listed in the table above, these products will no longer be offered for general sale; however, we plan to provide repair services and technical support for as long as practical. When these products reach their Silver Series date, this product line will have been selling in the market for over 30 years. This is further evidence of our commitment to protect your automation investment.

Based on your needs, Rockwell Automation will work with your company to develop a complete support and/or migration plan for your existing installations. Rockwell Automation has developed several migration tools to aid and help make your migration to ControlLogix a success. These tools include software conversion utility, network interface modules, wiring swing arm adaptors, hardware selection tools, service offerings and commercial programs.

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Rockwell Automation

August 22, 2012

Nova Scotia Power

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Catalog Number	PLC-5 Processor Description	Silver Series Date	Recommended Replacement	PLC-5 Processor Description
1785-L11B	Standard PLC-5 Processor (8K memory)	12/31/2012	1785-L20B	Standard PLC-5 Processor (16K memory)
1785-L30B	Standard PLC-5 Processor (32K memory)	12/31/2012	1785-L40B	Standard PLC-5 Processor (48K memory)
1785-L20C15	ControlNet PLC-5 Processor (16K memory)	12/31/2012	1785-L40C15	ControlNet PLC-5 Processor (48K memory)
1785-L40L	Extended Local PLC-5 Processor (48K memory)	12/31/2012	1785-L60L	Extended Local PLC-5 Processor (64K memory)
1785-L46B	Protected Memory PLC-5 Processor (48K memory)	12/31/2012	1785-L86B	Protected Memory PLC-5 Processor (100K memory)

These products are now designated in **Silver Series** (reference www.ab.com/silver for more details). As of the Silver Date listed in the table above, these products will no longer be offered for general sale; however, we plan to provide repair services and technical support for as long as practical. When these products reach their Silver Series date, these products will have been selling in the market for over 25 years. This is further evidence of our commitment to protect your automation investment.

Based on your needs, Rockwell Automation will work with your company to develop a complete support and/or migration plan for your existing installations. Rockwell Automation has developed several migration tools to aid and help make your migration to ControlLogix a success. These tools include software conversion utility, network interface modules, wiring swing arm adaptors, hardware selection tools, service offerings and commercial programs.

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Rockwell Automation

August 22, 2012

Nova Scotia Power

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Catalog Number	PLC-5 Processor Description	Silver Series Date	Recommended Replacement	PLC-5 Processor Description
1785-L16B	Protected Memory Processor (8K memory)	12/31/2013	1785-L86B	Protected Memory Processor (100K memory)
1785-L26B	Protected Memory Processor (16K memory)	12/31/2013	1785-L86B	Protected Memory Processor (100K memory)
1785-L36B	Protected Memory Processor (32K memory)	12/31/2013	1785-L86B	Protected Memory Processor (100K memory)
1785-L40C15	ControlNet PLC-5 Processor (48K memory)	12/31/2013	1785-L80C15	ControlNet PLC-5 Processor (100K memory)
1785-L46C15	ControlNet PLC-5 Processor (48K memory)	12/31/2013	1785-L86C15	ControlNet PLC-5 Processor (100K memory)
1785-L46L	Protected Memory PLC-5 Processor (48K memory)	12/31/2013	1785-L66L	Protected Memory PLC-5 Processor (64K memory)
1785-L60B	Standard PLC-5 Processor (64K memory)	12/31/2013	1785-L80B	Standard PLC-5 Processor (100K memory)
1785-L60C15	ControlNet PLC-5 Processor (48K memory)	12/31/2013	1785-L80C15	ControlNet PLC-5 Processor (100K memory)
1785-L66B	Protected Memory l PLC-5 Processor (48K memory)	12/31/2013	1785-L86B	Protected Memory PLC-5 Processor (100K memory)

These products are now designated in **Silver Series** (reference www.ab.com/silver for more details). As of the Silver Date listed in the table above, these products will no longer be offered for general sale; however, we plan to provide repair services and technical support for as long as practical. When these products reach their Silver Series date, these products will have been selling in the market for over 25 years. This is further evidence of our commitment to protect your automation investment.

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Yours Truly

Robert L. Thibault
Account Manager Automation and Solutions

CI Number: 42729

Title: **POT - Replace Economizer Inlet Header**

Start Date: 2013/03
Final Cost Date: 2014/03
Function: Generation
Forecast Amount: $626,028

DESCRIPTION:

The economizer inlet header is part of the boiler feedwater supply piping. In 2005, one of the stubs failed during operation, resulting in a forced outage and the release of a large amount of steam into the boilerhouse. Following this failure, ultrasonic thickness (UT) testing revealed several more stubs required replacement. Over subsequent outages, the economizer header has been accessed and checked resulting in ongoing replacement of stubs.

Similar issues had been experienced at the Lingan generating station, and replacing the header with a modified design has eliminated ongoing stub wastage. Learning from this experience, a similar design modification is proposed for Point Tupper.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 and 2015.

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

This project is required to eliminate ongoing premature erosion of tubes at the Point Tupper Generating Station's Unit 2 economizer header.

Why do this project now?

The phenomenon observed at the Point Tupper Station has been reviewed over a sufficient period of time to propose a design modification to eliminate excessive erosion, and avoid unplanned outages due to leakage. As time passes without replacement, the rate of degradation will increase, resulting in more failures and unplanned downtime.

Why do this project this way?

Erosion issues at the header have been identified. Modifying the header design with regard to flow considerations will eliminate premature failure.

CI Number : 42729 - POT - Replace economizer inlet header **Project Number**

Parent CI Number : -

Cost Centre : 351 - 351-Pt.Tupper Admin./Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		4,022	0	4,022
095		095-Thermal & Hydro Contracts AO		52,754	0	52,754
095		095-Thermal Regular Labour AO		718	0	718
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	2,700	0	2,700
011	013	011 - Travel Expense	013 - SGP - Boiler	500	0	500
012	013	012 - Materials	013 - SGP - Boiler	150,899	0	150,899
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	413,435	0	413,435
028	013	028 - Consulting	013 - SGP - Boiler	500	0	500
041	013	041 - Meals & Entertainment	013 - SGP - Boiler	500	0	500
			Total Cost:	626,028	0	626,028
			Original Cost:	89,769		

POT - Replace economizer inlet header
Summary of Alternatives

Division :	Power Production		**Date :**	**31-Oct-12**
Department :	Point Tupper Generating Station		**CI Number:**	42729
Originator :			**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace economizer inlet header	6.48%	3,206,291	1	25.30%	8.5 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

This project is recommended to proceed based on favorable economic analysis.

Notes/Comments :

Replace economizer inlet header

Replacing the inlet header and nozzles with upgraded material will reduce or eliminate the flow assisted corrosion currently being experienced where the nozzles from the header attach to the economizer. Currently, the highest rate of wear occurs near the tubes in the center, and spreads out towards the ends. As time passes without replacement, more nozzles will be thin, resulting in more leaks, and more repairs once offline, which is why likelihood of failure and cost of materials increase.

Test 2

Test 3

Test 4

POT - Replace economizer inlet header
Avoided Cost Calculations

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Point Tupper Generating Station	**CI Number:**	42729
Originator :		**Project No. :**	

Replace economizer inlet header

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$36,000**	**$38,526**		
Events/Outages (#)	**1**	**1**	**1**	**1**		
Probability of Occurance (%)	**20%**	**25%**	**20%**	**25%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**150**	**150**				
Duration (Hours)	**96**	**96**				
Totals	**$4,368**	**$8,494**	**$7,200**	**$9,632**	**$11,568**	**$18,125**
Total Capital Cost of Alternative						**$626,028**

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

Test 3

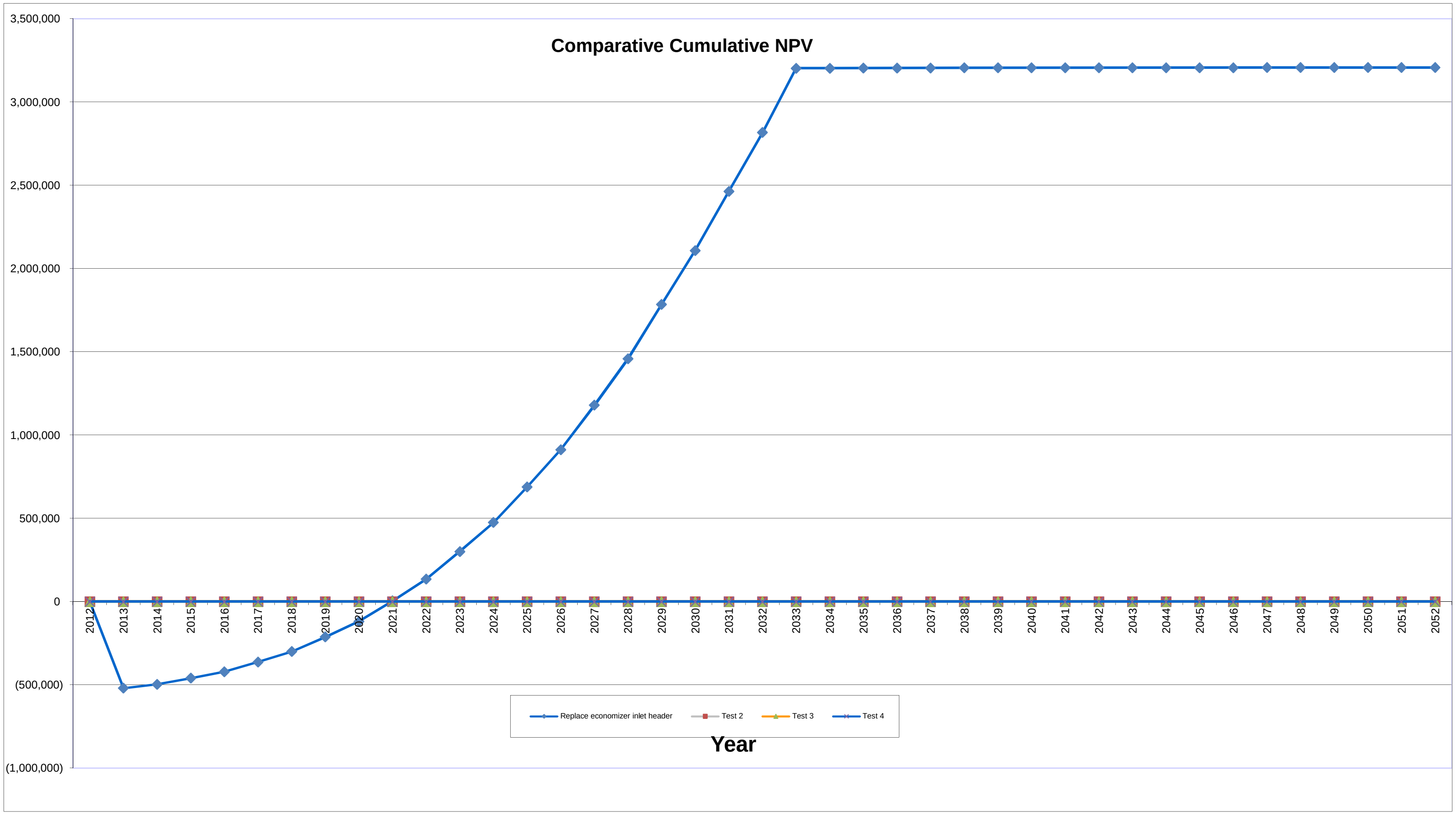
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

POT - Replace economizer inlet header
Replace economizer inlet header

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	11,568.4	(568,533.5)	23,383.0	561,192.2	(556,965.1)	3,662.5	(553,302.6)	(519,630.515)	0.9	(519,630.5)
2014	-	18,125.3	-	44,895.4	516,296.9	18,125.3	8,298.7	26,424.1	23,305.763	0.9	(496,324.8)
2015	-	45,530.5	-	41,303.7	474,993.1	45,530.5	(1,310.3)	44,220.2	36,628.272	0.8	(459,696.5)
2016	-	55,629.1	-	37,999.4	436,993.7	55,629.1	(5,465.2)	50,163.9	39,022.868	0.8	(420,673.6)
2017	-	99,927.6	-	34,959.5	402,034.2	99,927.6	(20,140.1)	79,787.5	58,290.083	0.7	(362,383.5)
2018	-	117,864.8	-	32,162.7	369,871.4	117,864.8	(26,567.7)	91,297.2	62,639.620	0.7	(299,743.9)
2019	-	183,176.9	-	29,589.7	340,281.7	183,176.9	(47,612.0)	135,564.9	87,351.598	0.6	(212,392.3)
2020	-	211,492.9	-	27,222.5	313,059.2	211,492.9	(57,123.8)	154,369.1	93,414.846	0.6	(118,977.5)
2021	-	302,877.1	-	25,044.7	288,014.4	302,877.1	(86,128.0)	216,749.1	123,181.330	0.6	4,203.9
2022	-	344,776.9	-	23,041.2	264,973.3	344,776.9	(99,738.1)	245,038.8	130,783.968	0.5	134,987.8
2023	-	468,434.1	-	21,197.9	243,775.4	468,434.1	(138,643.2)	329,790.8	165,306.576	0.5	300,294.4
2024	-	527,944.0	-	19,502.0	224,273.4	527,944.0	(157,617.0)	370,327.0	174,328.680	0.5	474,623.1
2025	-	691,461.8	-	17,941.9	206,331.5	691,461.8	(208,791.2)	482,670.6	213,386.186	0.4	688,009.3
2026	-	773,619.3	-	16,506.5	189,825.0	773,619.3	(234,705.0)	538,914.3	223,752.113	0.4	911,761.4
2027	-	986,267.8	-	15,186.0	174,639.0	986,267.8	(301,035.4)	685,232.5	267,188.208	0.4	1,178,949.6
2028	-	1,097,352.6	-	13,971.1	160,667.9	1,097,352.6	(335,848.2)	761,504.3	278,858.371	0.4	1,457,808.0
2029	-	1,370,438.9	-	12,853.4	147,814.4	1,370,438.9	(420,851.5)	949,587.4	326,571.455	0.3	1,784,379.4
2030	-	1,445,954.6	-	11,825.2	135,989.3	1,445,954.6	(444,580.1)	1,001,374.5	323,423.626	0.3	2,107,803.0
2031	-	1,695,951.4	-	10,879.1	125,110.1	1,695,951.4	(522,372.4)	1,173,579.0	355,975.028	0.3	2,463,778.1
2032	-	1,791,087.4	-	10,008.8	115,101.3	1,791,087.4	(552,134.4)	1,238,953.1	352,934.408	0.3	2,816,712.5
2033	-	2,081,664.0	-	9,208.1	105,893.2	2,081,664.0	(642,461.3)	1,439,202.7	385,028.669	0.3	3,201,741.2
2034	-	-	-	8,471.5	97,421.8	-	2,626.2	2,626.2	659.816	0.3	3,202,401.0
2035	-	-	-	7,793.7	89,628.0	-	2,416.1	2,416.1	570.089	0.2	3,202,971.1
2036	-	-	-	7,170.2	82,457.8	-	2,222.8	2,222.8	492.564	0.2	3,203,463.6
2037	-	-	-	6,596.6	75,861.2	-	2,045.0	2,045.0	425.581	0.2	3,203,889.2
2038	-	-	-	6,068.9	69,792.3	-	1,881.4	1,881.4	367.707	0.2	3,204,256.9
2039	-	-	-	5,583.4	64,208.9	-	1,730.8	1,730.8	317.703	0.2	3,204,574.6
2040	-	-	-	5,136.7	59,072.2	-	1,592.4	1,592.4	274.500	0.2	3,204,849.1
2041	-	-	-	4,725.8	54,346.4	-	1,465.0	1,465.0	237.171	0.2	3,205,086.3
2042	-	-	-	4,347.7	49,998.7	-	1,347.8	1,347.8	204.919	0.2	3,205,291.2
2043	-	-	-	3,999.9	45,998.8	-	1,240.0	1,240.0	177.052	0.1	3,205,468.3
2044	-	-	-	3,679.9	42,318.9	-	1,140.8	1,140.8	152.975	0.1	3,205,621.2
2045	-	-	-	3,385.5	38,933.4	-	1,049.5	1,049.5	132.172	0.1	3,205,753.4
2046	-	-	-	3,114.7	35,818.7	-	965.5	965.5	114.198	0.1	3,205,867.6
2047	-	-	-	2,865.5	32,953.2	-	888.3	888.3	98.669	0.1	3,205,966.3
2048	-	-	-	2,636.3	30,317.0	-	817.2	817.2	85.251	0.1	3,206,051.5
2049	-	-	-	2,425.4	27,891.6	-	751.9	751.9	73.658	0.1	3,206,125.2
2050	-	-	-	2,231.3	25,660.3	-	691.7	691.7	63.641	0.1	3,206,188.8
2051	-	-	-	2,052.8	23,607.5	-	636.4	636.4	54.987	0.1	3,206,243.8
2052	-	-	-	1,888.6	21,718.9	-	585.5	585.5	47.509	0.1	3,206,291.3
Total	-	14,321,145.4	(568,533.5)	562,856.4	6,765,136.1	13,752,611.9	(4,265,069.6)	9,487,542.3	3,206,291.3		


Comparative Cumulative NPV
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Replace economizer inlet header
Test 2
Test 3
Test 4
Year

Location: POT
CI# / FP#: 42729
Title: POT - Replace Economizer Inlet Header
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	001 Regular Labour						
1.1	Utility & Unskilled	hr	[redacted]		$ 2,700.00		
				Sub-Total	$ 2,700.00		
2	012 Materials						
2.1	Header	Lot	1	[redacted]		Cost Support 1	
2.2	Contingency on Header	%					
2.3	Misc. and consumables	Lot	1				
2.4					$ -		
				Sub-Total	$ 150,898.50		
3	013 Power Production Contracts						
3.1	Installation and NDE	Lot	1	[redacted]		Cost Support 2	
3.2	Contingency on Installation	%					
3.3					$ -		
				Sub-Total	$ 413,435.00		
4	011 Travel Expenses						
4.1	Travel	Lot	1	$ 500.00	$ 500.00		
4.2					$ -		
				Sub-Total	$ 500.00		
5	028 Consulting						
5.1	Consulting	Lot	1	$ 500.00	$ 500.00		
5.2					$ -		
				Sub-Total	$ 500.00		
6	041 Meals and Entertainment						
6.1	Meals and expenses	Lot	1	$ 500.00	$ 500.00		
6.2					$ -		
				Sub-Total	$ 500.00		
7	094 Interest Capitalized						
7.1	Interest	Lot	1	$ 4,022.30	$ 4,022.30		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 4,022.30		
8	095 Administrative Overhead						
8.1	AO	Lot	1	$ 53,472.51	$ 53,472.51		
8.2					$ -		
9.3					$ -		
				Sub-Total	$ 53,472.51		
Cost Estimate				Total	$ 626,028.31		
9	Original Cost				$ 89,768.82		
9.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 & 2

Removed due to confidentiality

CI Number: 43053

Title: **POT - Waterwall Refurbishment 2013**

Start Date: 2013/05
Final Cost Date: 2014/03
Function: Generation
Forecast Amount: $623,050.27

DESCRIPTION:

This project is intended to increase reliability of the Unit 2 boiler at the Point Tupper Generating Station by replacing existing wall tubes that have been experiencing flue gas erosion/corrosion, as well as erosion from nearby sootblowers. Timely replacement of waterwall panels avoids unplanned repair and replacement energy costs. The replacement of waterwall panels is an integral component of the boiler tube failure reduction program. It serves to maintain target heat rates and support reliable boiler operation.

Summary of Related CIs +/- 2 years:
2011 - CI 40344 POT - Waterwall replacement 2011 $300K

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

The outage in 2008 provided an opportunity to access many areas by extending the scaffolding already being erected for the Low NOx project. A wall inspection was repeated in 2010. The results of the inspection were that the panels were approaching minimum wall thickness and must be replaced. The extent of the thinning precludes padding as an effective method of repair. Replacing tubes that have experienced normal wear from erosion/corrosion will ensure reliable operation of the unit is maintained.

Why do this project now?

The panels are approaching minimum wall thickness, increasing the risk of boiler tube failures. Boiler tube failures have historically been a major contributor to the unavailability of thermal units. Replacement of selected waterwall panels now will maintain target heat rates and mitigate the risk of unplanned Unit outages due to waterwall tube leaks.

Why do this project this way?

The waterwall panel replacement program is required to support reliable Unit performance. Replacement is the only viable option. Entire panels will be replaced to ensure efficient installation and avoiding the additional costs of piecing smaller panels and tubes together.

CI Number : 43053 - POT - Waterwall Refurbishment 2013 **Project Number**

Parent CI Number : -

Cost Centre : 351 - 351-Pt.Tupper Admin./Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		5,423	0	5,423
095		095-Thermal Regular Labour AO		2,370	0	2,370
095		095-Thermal & Hydro Contracts AO		62,051	0	62,051
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	8,910	0	8,910
012	013	012 - Materials	013 - SGP - Boiler	55,000	0	55,000
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	486,296	0	486,296
011	085	011 - Travel Expense	085 Design	500	0	500
028	085	028 - Consulting	085 Design	2,000	0	2,000
041	085	041 - Meals & Entertainment	085 Design	500	0	500
			Total Cost:	623,050	0	623,050
			Original Cost:	337,934		

Waterwall refurbishment 2013
Summary of Alternatives

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Point Tupper Generating Station	**CI Number:**	43053
Originator :		**Project No. :**	

	Alternative	**After Tax WACC**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Replace sections of waterwall	6.48%	607,534	1	18.98%	7.4 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

This project is recommended to proceed based on favorable economic analysis.

Notes/Comments :

Replace sections of waterwall

This option assumes that a waterwall failure will occur annually until waterwall is restored to original condition. The replacement of waterwall panels will result in an outage of approximately 216 hours. Assume a likelihood of 75%, increasing by 1% per year. Also assume the repair cost to replace the panels would increase by 30% on an emergency turnaround. Assume 2% increase on materials annually, and incremental replacement energy cost annually after 2013.

Test 2

Test 3

Test 4

Waterwall refurbishment 2013
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Point Tupper Generating Station	CI Number:	43053
Originator :		Project No. :	

Replace sections of waterwall

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$61,800	$63,036		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	75%	76%	75%	76%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	150	150				
Duration (Hours)	216	216				
Totals	$36,858	$58,098	$46,350	$47,907	$83,208	$106,005
Total Capital Cost of Alternative						$623,050

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

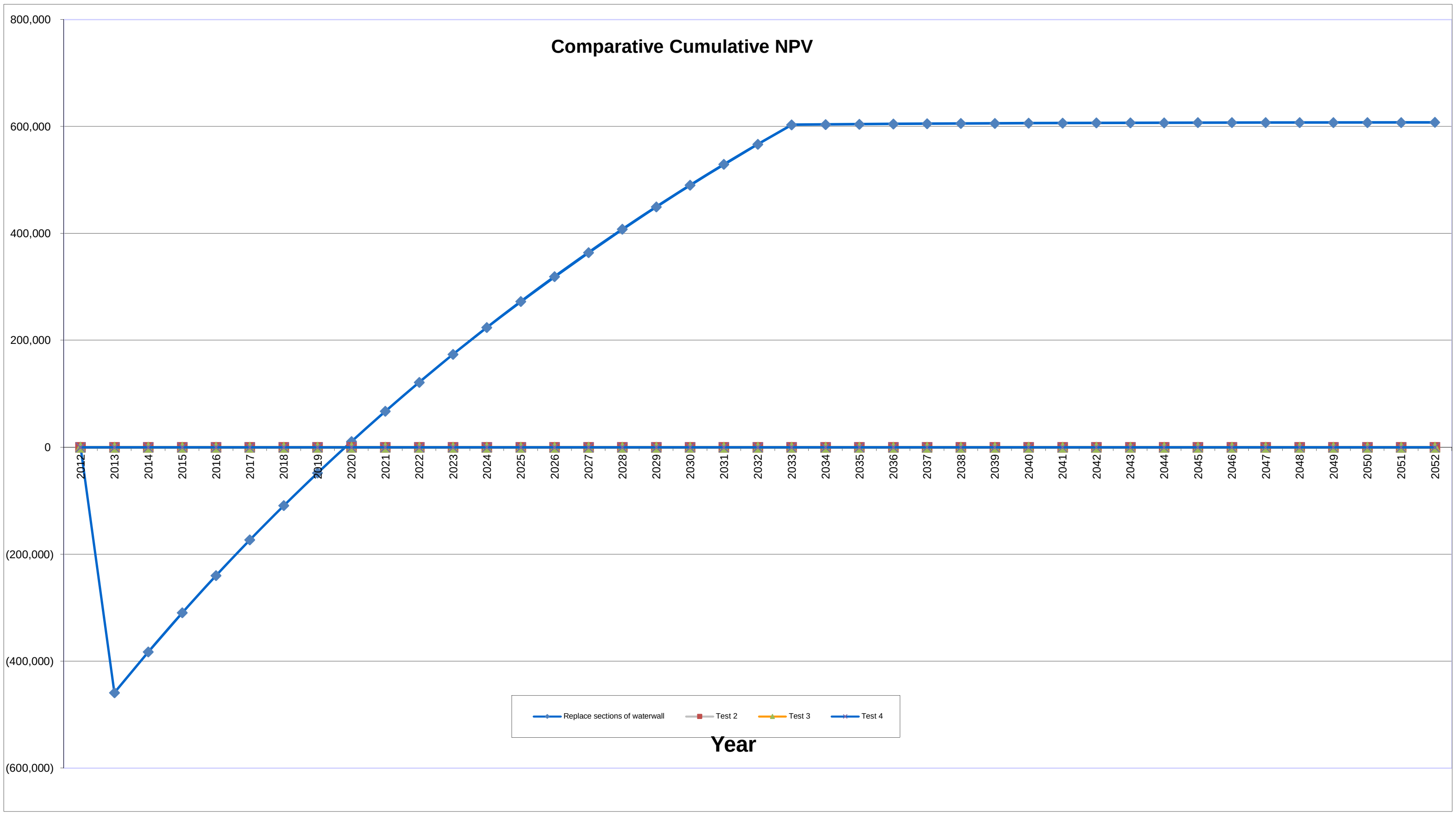
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Waterwall refurbishment 2013
Replace sections of waterwall

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	83,208.2	(553,206.2)	22,901.3	549,631.3	(469,997.9)	(18,695.1)	(488,693.1)	(458,952.939)	0.9	(458,952.9)
2014	-	106,005.2	-	43,970.5	505,660.8	106,005.2	(19,230.8)	86,774.5	76,534.253	0.9	(382,418.7)
2015	-	109,548.0	-	40,452.9	465,207.9	109,548.0	(21,419.5)	88,128.5	72,998.242	0.8	(309,420.4)
2016	-	113,190.1	-	37,216.6	427,991.3	113,190.1	(23,551.8)	89,638.4	69,730.331	0.8	(239,690.1)
2017	-	116,934.1	-	34,239.3	393,752.0	116,934.1	(25,635.4)	91,298.7	66,699.802	0.7	(172,990.3)
2018	-	120,782.6	-	31,500.2	362,251.8	120,782.6	(27,677.6)	93,105.0	63,880.004	0.7	(109,110.3)
2019	-	124,738.2	-	28,980.1	333,271.7	124,738.2	(29,685.0)	95,053.2	61,247.807	0.6	(47,862.5)
2020	-	128,803.8	-	26,661.7	306,610.0	128,803.8	(31,664.0)	97,139.7	58,783.114	0.6	10,920.6
2021	-	132,982.0	-	24,528.8	282,081.2	132,982.0	(33,620.5)	99,361.5	56,468.454	0.6	67,389.1
2022	-	137,275.9	-	22,566.5	259,514.7	137,275.9	(35,559.9)	101,716.0	54,288.622	0.5	121,677.7
2023	-	141,688.4	-	20,761.2	238,753.5	141,688.4	(37,487.4)	104,200.9	52,230.372	0.5	173,908.1
2024	-	146,222.4	-	19,100.3	219,653.2	146,222.4	(39,407.9)	106,814.5	50,282.148	0.5	224,190.2
2025	-	150,881.1	-	17,572.3	202,081.0	150,881.1	(41,325.7)	109,555.4	48,433.857	0.4	272,624.1
2026	-	155,667.7	-	16,166.5	185,914.5	155,667.7	(43,245.4)	112,422.3	46,676.670	0.4	319,300.7
2027	-	160,585.3	-	14,873.2	171,041.3	160,585.3	(45,170.8)	115,414.6	45,002.848	0.4	364,303.6
2028	-	165,637.5	-	13,683.3	157,358.0	165,637.5	(47,105.8)	118,531.7	43,405.600	0.4	407,709.2
2029	-	170,827.4	-	12,588.6	144,769.4	170,827.4	(49,054.0)	121,773.4	41,878.949	0.3	449,588.1
2030	-	176,158.8	-	11,581.6	133,187.8	176,158.8	(51,018.9)	125,139.8	40,417.625	0.3	490,005.8
2031	-	181,635.0	-	10,655.0	122,532.8	181,635.0	(53,003.8)	128,631.2	39,016.971	0.3	529,022.7
2032	-	187,259.8	-	9,802.6	112,730.2	187,259.8	(55,011.7)	132,248.1	37,672.859	0.3	566,695.6
2033	-	193,037.0	-	9,018.4	103,711.8	193,037.0	(57,045.8)	135,991.2	36,381.620	0.3	603,077.2
2034	-	-	-	8,296.9	95,414.8	-	2,572.1	2,572.1	646.224	0.3	603,723.4
2035	-	-	-	7,633.2	87,781.6	-	2,366.3	2,366.3	558.345	0.2	604,281.8
2036	-	-	-	7,022.5	80,759.1	-	2,177.0	2,177.0	482.417	0.2	604,764.2
2037	-	-	-	6,460.7	74,298.4	-	2,002.8	2,002.8	416.814	0.2	605,181.0
2038	-	-	-	5,943.9	68,354.5	-	1,842.6	1,842.6	360.132	0.2	605,541.1
2039	-	-	-	5,468.4	62,886.1	-	1,695.2	1,695.2	311.159	0.2	605,852.3
2040	-	-	-	5,030.9	57,855.3	-	1,559.6	1,559.6	268.845	0.2	606,121.1
2041	-	-	-	4,628.4	53,226.8	-	1,434.8	1,434.8	232.285	0.2	606,353.4
2042	-	-	-	4,258.1	48,968.7	-	1,320.0	1,320.0	200.697	0.2	606,554.1
2043	-	-	-	3,917.5	45,051.2	-	1,214.4	1,214.4	173.405	0.1	606,727.5
2044	-	-	-	3,604.1	41,447.1	-	1,117.3	1,117.3	149.824	0.1	606,877.4
2045	-	-	-	3,315.8	38,131.3	-	1,027.9	1,027.9	129.450	0.1	607,006.8
2046	-	-	-	3,050.5	35,080.8	-	945.7	945.7	111.846	0.1	607,118.6
2047	-	-	-	2,806.5	32,274.4	-	870.0	870.0	96.636	0.1	607,215.3
2048	-	-	-	2,581.9	29,692.4	-	800.4	800.4	83.495	0.1	607,298.8
2049	-	-	-	2,375.4	27,317.0	-	736.4	736.4	72.141	0.1	607,370.9
2050	-	-	-	2,185.4	25,131.7	-	677.5	677.5	62.330	0.1	607,433.3
2051	-	-	-	2,010.5	23,121.1	-	623.3	623.3	53.854	0.1	607,487.1
2052	-	-	-	1,849.7	21,271.4	-	573.4	573.4	46.531	0.1	607,533.6
Total	-	3,003,068.7	(553,206.2)	551,261.2	6,625,769.9	2,449,862.5	(760,060.3)	1,689,802.2	607,533.6		


Comparative Cumulative NPV
800,000
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Replace sections of waterwall
Test 2
Test 3
Test 4
Year

Location: POT
CI# / FP#: 43053
Title: Waterwall refurbishment 2013
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Utility & Unskilled	hr	[redacted]		$ 8,910.00		
				Sub-Total	$ 8,910.00		
2	**012 Materials**						
2.1	Waterwall panels	Lot	1	[redacted]		Cost Support 1	
2.2	Misc. and consumables	Lot	1	$ 5,000.00	$ 5,000.00		
2.3	Shop hydro	Lot	1	[redacted]			
2.4					$ -		
2.5					$ -		
				Sub-Total	$ 55,000.00		
3	**013 Power Production Contracts**						
3.1	Boilermakers & NDE	Lot	1	[redacted]		Cost Support 2	
3.2	Scaffolding	Lot	1			Cost Support 3	
3.3					$ -		
				Sub-Total	$ 486,296.18		
4	**011 Travel Expenses**						
4.1	Travel	Lot	1	$ 500.00	$ 500.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 500.00		
5	**028 Consulting**						
5.1	Consulting	Lot	1	$ 2,000.00	$ 2,000.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 2,000.00		
6	**041 Meals and Entertainment**						
6.1	Meals and expenses	Lot	1	$ 500.00	$ 500.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 500.00		
8	**094 Interest Capitalized**						
8.1	Interest	Lot	1	$ 5,422.63	$ 5,422.63		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 5,422.63		
9	**095 Administrative Overhead**						
9.1	Contracts AO	Lot	1	$ 62,051.40	$ 62,051.40		
9.2	Regular Labour AO	Lot	1	2370.06	$ 2,370.06		
9.3							
				Sub-Total	$ 64,421.46		
Cost Estimate				**Total**	$ 623,050.27		
10	**Original Cost**						
10.1					$337,934.26		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 - 3

Removed due to confidentiality

CI Number: 36603

Title: **LIN3 – Data Acquisition System (DAS) Upgrades**

Start Date: 2013/04
Final Cost Date: 2013/09
Function: General Plant
Forecast Amount: $567,748

DESCRIPTION:

The Data Acquisition System (DAS) consists of original hardware and is difficult to maintain. This system provides the status of most temperature points for the unit, as well as many analog values for positions, conductivity, etc. This information is presented on operator screens to monitor performance of the unit. This project proposes to upgrade the old hardware, including interface cards, a new distributed control system (DCS) hardware platform. The end result will be a current, modern system with spare parts available. This will enhance reliability and lessen the risk of forced outages. DAS hardware has already been replaced on Units 1 and 4.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015.

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

Since December 2007, there have been a number of faults on the analog to digital converter rack that is used to convert all analogs in the DAS system. The DAS system has been replaced on Units 1 and 4 prior to 2009. These replacements yielded a number of spare parts which have been largely consumed to date. Further DAS component failures may result in extended downtime as attempts are made to source/repair old equipment. When signals to this system are lost, the unit operates at risk without key performance information. This information is critical during run-up and operating changes in general.

Why do this project now?

Unit 3 is scheduled for a major maintenance outage in the spring of 2013. This outage provides sufficient time for the DAS to be changed out and verified.

Why do this project this way?

Repair facilities and components are no longer available to fix original equipment hardware. Replacement of the system with current supported technology reduces the risk of outages or delays in run up due to missing or incorrect system data. When signals to this system are lost, the unit operates without key performance information for operator monitoring and control.

CI Number : 36603 - LIN3-DAS Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 301 - 301-Lingan Admin./Common Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		6,598	0	6,598
095		095-Thermal & Hydro Contracts AO		12,122	0	12,122
095		095-Thermal Regular Labour AO		42,869	0	42,869
001	004	001 - THERMAL Regular Labour	004 - DP - Misc.Equipment	161,160	0	161,160
004	004	004 - THERMAL Term Labour	004 - SGP - Misc.Equipment	0	0	0
012	004	012 - Materials	004 - SGP - Misc.Equipment	250,000	0	250,000
013	004	013 - POWER PRODUCTION Contracts	004 - SGP - Misc.Equipment	95,000	0	95,000
028	004	028 - Consulting	004 - DP - Misc.Equipment	0	0	0
			Total Cost:	567,748	0	567,748
			Original Cost:	226,950		

LIN3 DAS Replacement
Summary of Alternatives

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Lingan	**CI Number:**	36603
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace DAS	6.48%	412,397	1	17.20%	7.5 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

Replace DAS to reduce the risk of forced outages.

Notes/Comments :

Replace DAS

Currently repairs are done using spares taken from other units that have already been upgraded , but supply has been exhausted. The integrity of stored, used spares is also difficult to predict. The scenario assumes an outage of up to 2 weeks can occur as a result of a serious DAS failure since available components and OEM support is not ensured. The risk of a serious DAS failure escalates over time as components continue to age and the number of run ups and run downs increases due to renewable load following.

Test 2

No other valid options have been identified.

Test 3

Test 4

LIN3 DAS Replacement
Avoided Cost Calculations

Division :	Production	Date :	31-Oct-12
Department :	Lingan	CI Number:	36603
Originator :		Project No. :	

Replace DAS

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$73,137	$76,067		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	30%	40%	30%	40%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	154	154				
Duration (Hours)	336	336				
Totals	$20,328	$22,403	$21,941	$30,427	$42,269	$52,830
Total Capital Cost of Alternative						$567,748

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

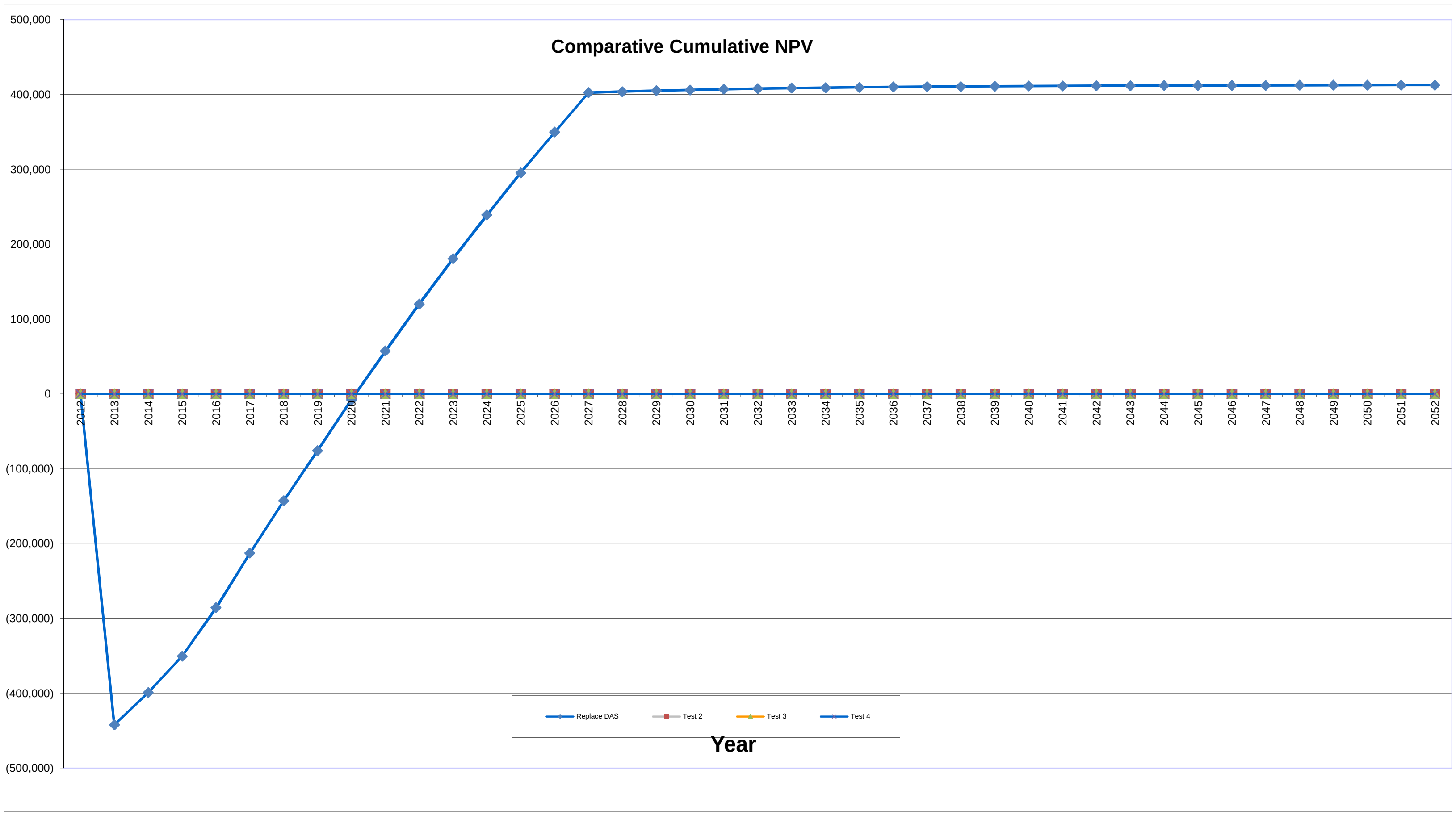
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

LIN3 DAS Replacement
Replace DAS

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	42,268.7	(506,160.0)	20,906.3	501,750.9	(463,891.3)	(6,622.4)	(470,513.6)	(441,879.829)	0.9	(441,879.8)
2014	-	52,829.8	-	40,140.1	461,610.8	52,829.8	(3,933.8)	48,896.0	43,125.771	0.9	(398,754.1)
2015	-	68,120.8	-	36,928.9	424,681.9	68,120.8	(9,669.5)	58,451.3	48,416.155	0.8	(350,337.9)
2016	-	105,415.1	-	33,974.6	390,707.4	105,415.1	(22,146.6)	83,268.5	64,775.191	0.8	(285,562.7)
2017	-	130,513.5	-	31,256.6	359,450.8	130,513.5	(30,769.6)	99,743.9	72,869.537	0.7	(212,693.2)
2018	-	134,668.7	-	28,756.1	330,694.7	134,668.7	(32,832.9)	101,835.8	69,870.248	0.7	(142,822.9)
2019	-	138,969.0	-	26,455.6	304,239.2	138,969.0	(34,879.1)	104,089.8	67,070.561	0.6	(75,752.4)
2020	-	151,387.3	-	24,339.1	279,900.0	151,387.3	(39,384.9)	112,002.4	67,777.087	0.6	(7,975.3)
2021	-	156,249.8	-	22,392.0	257,508.0	156,249.8	(41,495.9)	114,753.9	65,216.122	0.6	57,240.8
2022	-	161,283.0	-	20,600.6	236,907.4	161,283.0	(43,611.5)	117,671.5	62,804.501	0.5	120,045.3
2023	-	166,493.3	-	18,952.6	217,954.8	166,493.3	(45,737.6)	120,755.7	60,528.401	0.5	180,573.7
2024	-	171,887.4	-	17,436.4	200,518.4	171,887.4	(47,879.8)	124,007.6	58,375.645	0.5	238,949.4
2025	-	177,472.0	-	16,041.5	184,476.9	177,472.0	(50,043.5)	127,428.5	56,335.498	0.4	295,284.9
2026	-	183,254.3	-	14,758.2	169,718.8	183,254.3	(52,233.8)	131,020.5	54,398.466	0.4	349,683.4
2027	-	189,241.7	-	13,577.5	156,141.3	189,241.7	(54,455.9)	134,785.8	52,556.148	0.4	402,239.5
2028	-	-	-	12,491.3	143,650.0	-	3,872.3	3,872.3	1,418.015	0.4	403,657.5
2029	-	-	-	11,492.0	132,158.0	-	3,562.5	3,562.5	1,225.182	0.3	404,882.7
2030	-	-	-	10,572.6	121,585.3	-	3,277.5	3,277.5	1,058.572	0.3	405,941.3
2031	-	-	-	9,726.8	111,858.5	-	3,015.3	3,015.3	914.619	0.3	406,855.9
2032	-	-	-	8,948.7	102,909.8	-	2,774.1	2,774.1	790.242	0.3	407,646.1
2033	-	-	-	8,232.8	94,677.0	-	2,552.2	2,552.2	682.778	0.3	408,328.9
2034	-	-	-	7,574.2	87,102.9	-	2,348.0	2,348.0	589.929	0.3	408,918.8
2035	-	-	-	6,968.2	80,134.7	-	2,160.2	2,160.2	509.705	0.2	409,428.5
2036	-	-	-	6,410.8	73,723.9	-	1,987.3	1,987.3	440.392	0.2	409,868.9
2037	-	-	-	5,897.9	67,826.0	-	1,828.4	1,828.4	380.504	0.2	410,249.4
2038	-	-	-	5,426.1	62,399.9	-	1,682.1	1,682.1	328.760	0.2	410,578.2
2039	-	-	-	4,992.0	57,407.9	-	1,547.5	1,547.5	284.052	0.2	410,862.2
2040	-	-	-	4,592.6	52,815.3	-	1,423.7	1,423.7	245.425	0.2	411,107.7
2041	-	-	-	4,225.2	48,590.0	-	1,309.8	1,309.8	212.050	0.2	411,319.7
2042	-	-	-	3,887.2	44,702.8	-	1,205.0	1,205.0	183.214	0.2	411,502.9
2043	-	-	-	3,576.2	41,126.6	-	1,108.6	1,108.6	158.299	0.1	411,661.2
2044	-	-	-	3,290.1	37,836.5	-	1,019.9	1,019.9	136.772	0.1	411,798.0
2045	-	-	-	3,026.9	34,809.6	-	938.3	938.3	118.173	0.1	411,916.2
2046	-	-	-	2,784.8	32,024.8	-	863.3	863.3	102.103	0.1	412,018.3
2047	-	-	-	2,562.0	29,462.8	-	794.2	794.2	88.218	0.1	412,106.5
2048	-	-	-	2,357.0	27,105.8	-	730.7	730.7	76.221	0.1	412,182.7
2049	-	-	-	2,168.5	24,937.3	-	672.2	672.2	65.856	0.1	412,248.6
2050	-	-	-	1,995.0	22,942.3	-	618.4	618.4	56.900	0.1	412,305.5
2051	-	-	-	1,835.4	21,107.0	-	569.0	569.0	49.163	0.1	412,354.6
2052	-	-	-	1,688.6	19,418.4	-	523.5	523.5	42.477	0.1	412,397.1
Total	-	2,030,054.5	(506,160.0)	503,238.8	6,048,574.4	1,523,894.5	(473,312.9)	1,050,581.6	412,397.1		



Comparative Cumulative NPV
500,000
400,000
300,000
200,000
100,000
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(100,000)
(200,000)
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Replace DAS
Test 2
Test 3
Test 4
Year

Location: Lingan
CI# / FP#: 36603
Title: LIN3 DAS Replacement
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	hr	[redacted]		$ 108,240.00		
1.2	Engineering (P.Eng)	hr			$ 17,920.00		
1.3	Maintenance Trades	hr			$ 21,500.00		
1.4	Utility & Unskilled	hr			$ 13,500.00		
1.5							
				Sub-Total	$ 161,160.00		29962
2	**012 Materials**						
2.1	DAS Conversion Equipment (Cabinets, Cards, Wire, etc)	lot	1	[redacted]			29962
2.2	Misc Cables and Interface	lot	1				29962
2.3					$ -		
				Sub-Total	$ 250,000.00		
3	**013 Power Production Contracts**						
3.1	DAS Engineering Contract - Lot Price	lot	1	[redacted]			29962
3.2	LIN Document Control and Misc	lot	1				
3.3	System Commissioning / Unforseen	lot	1				29962
				Sub-Total	$ 95,000.00		
4	**094 Interest Capitalized**						
4.1	Interest Capitalized	lot	1	$ 6,597.85	$ 6,597.85		
				Sub-Total	$ 6,597.85		
5	**095 Administrative Overhead**						
5.1	Thermal Hydro Contracts AO	lot	1	$ 4,750.00	$ 12,122.00		
5.2	Thermal Reg Lab AO	lot	1	$ 33,481.26	$ 42,868.56		
5.3					$ -		
				Sub-Total	$ 54,990.56		
ect Cost Estimate				**Total**	$ 567,748.41		
6	**Original Cost**						
6.1					$ 226,950.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43166

Title: **LIN Mill Refurbishment**

Start Date: 2013/02
Final Cost Date: 2014/03
Function: Generation
Forecast Amount: $548,565

DESCRIPTION:

The purpose of this project is to replace pulverizer components that have reached the end of their useful life. Based on experienced wear characteristics, there is risk that component failures will occur if a replacement plan is not performed. This capital item includes the replacement of welded steel rollers and tables with ceramic wear components, worn gear & shaft, vertical shaft and other non-repairable mill components. The scope of this project is to refurbish two pulverizers with new ceramic tables and rollers. Specific components to be replaced or refurbished will be determined based on the condition assessment when teardown is undertaken as part of the planned outage for each pulverizer. Going forward, regular refurbishments of the Lingan pulverizers will still be required to extend asset life and ensure the reliability of this equipment is maintained.

In 2013, refurbishment is planned for mills 3A and 1B.
Summary of Related CIs +/- 2 years:
2011 CI 39903 LIN 2011 Mill Refurbishment $760,079
2012 CI 40655 LIN Pulverizer Refurbishment $461,279

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Maintenance

Why do this project?

A failed pulverizer could limit peak generation of a unit depending on the fuel blend in service. This makes it imperative that the pulverizers are available and able to operate for extended lengths between scheduled outages. The replacement of components and the upgrading of the ceramics help to achieve this initiative.

Why do this project now?

An evaluation of the pulverizers has identified several areas of concern that need to be addressed for the pulverizers to meet availability targets. Replacement parts are now needed due to age and wear of many of the components. During periods of lower load it is possible to take 1 of 4 pulverizers out of service without affecting generation. Isolated repairs and minor refurbishment are not typically possible for the mills. Because it is often necessary to disassemble major components when performing the work, an overall refurbishment is more effective than isolated repairs.

Why do this project this way?

A phased approach to upgrading the pulverizers allows for scheduled outages of selected pulverizers, reducing the risk of extended unplanned outages. An unplanned outage could require in excess of 16 weeks based on material lead time and labour.

CI Number : 43166 - LIN Mill Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 301 - 301-Lingan Admin./Common Capital **Budget Version** 2012 08/04 Forecast

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		25,215	0	25,215
095		095-Thermal Regular Labour AO		29,473	0	29,473
001	018	001 - THERMAL Regular Labour	018 - SGP - Fuel Hndlg.Coal	110,800	0	110,800
002	018	002 - THERMAL Overtime Labour	018 - SGP - Fuel Hndlg.Coal	0	0	0
004	018	004 - THERMAL Term Labour	018 - SGP - Fuel Hndlg.Coal	0	0	0
012	018	012 - Materials	018 - SGP - Fuel Hndlg.Coal	383,078	0	383,078
013	018	013 - POWER PRODUCTION Contracts	018 - SGP - Fuel Hndlg.Coal	0	0	0
			Total Cost:	548,565	0	548,565
			Original Cost:	93,700		

LIN Mills Refurbishment
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Lingan	**CI Number:**	43166
Originator :	Ron MacNeil	**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Mills	6.48%	583,236	1	41.97%	3.5 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

Refurbish Mills to avoid cost of derating unit when one of four mills is not available

Notes/Comments :

Refurbish Mills

Failure scenario is loss of a Mill during peak unit load. With current coal blends (Low sulf., low BTU) , all four Mills are required for peak load. A derate of approx 15 MW is expected if a mill is not available. A significant Mill repair, incl material lead time is 2 - 4 weeks plus material. This scenario assumes the Mill is unavailable for 4 weeks, including teardown and materials lead

Test 2

No other valid options were identified.

Test 3

Test 4

LIN Mills Refurbishment
Avoided Cost Calculations

Division :	Power Production		**Date :**	**31-Oct-12**
Department :	Lingan		**CI Number:**	43166
Originator :	Ron MacNeil		**Project No. :**	

Refurbish Mills

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$159,400	$175,790		
Events/Outages (#)	2	2	2	2		
Probability of Occurance (%)	30%	50%	30%	50%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	15	15				
Duration (Hours)	672	672				
Totals	$7,920	$10,911	$95,640	$175,790	$103,560	$186,700
Total Capital Cost of Alternative						$548,566

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

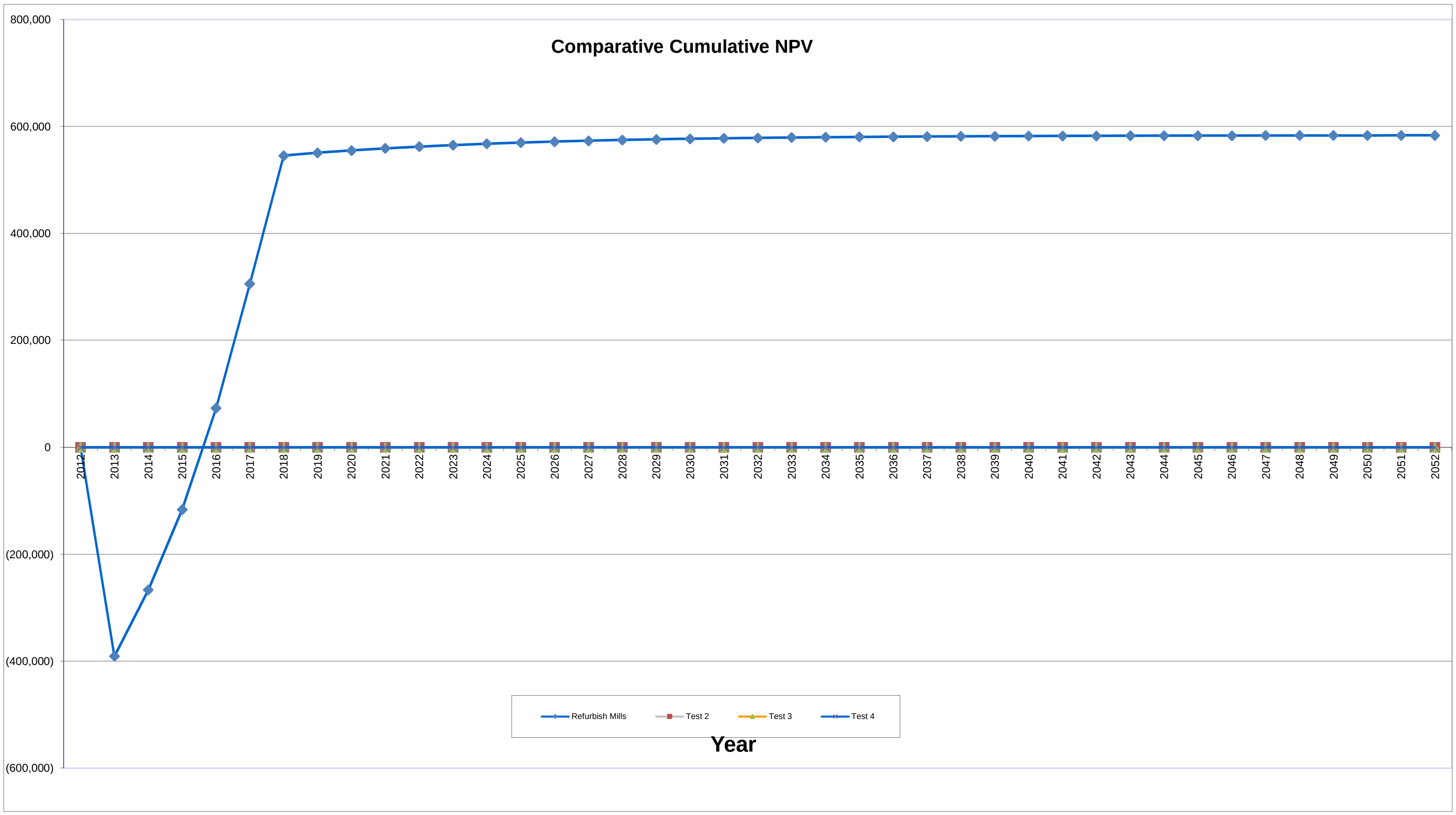
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

LIN Mills Refurbishment
Refurbish Mills

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	103,559.9	(493,878.0)	20,501.0	491,851.6	(390,318.1)	(25,748.2)	(416,066.4)	(390,746.045)	0.9	(390,746.0)
2014	-	186,700.4	-	39,361.4	452,490.2	186,700.4	(45,675.1)	141,025.3	124,382.946	0.9	(266,363.1)
2015	-	246,197.4	-	36,211.4	416,278.9	246,197.4	(65,095.7)	181,101.7	150,009.380	0.8	(116,353.7)
2016	-	338,561.1	-	33,313.5	382,965.4	338,561.1	(94,626.7)	243,934.3	189,758.266	0.8	73,404.5
2017	-	447,432.1	-	30,647.5	352,317.9	447,432.1	(129,203.2)	318,228.9	232,487.388	0.7	305,891.9
2018	-	493,265.0	-	28,194.8	324,123.1	493,265.0	(144,171.7)	349,093.2	239,515.252	0.7	545,407.2
2019	-	-	-	25,938.5	298,184.6	-	8,040.9	8,040.9	5,181.197	0.6	550,588.4
2020	-	-	-	23,862.7	274,321.9	-	7,397.4	7,397.4	4,476.485	0.6	555,064.9
2021	-	-	-	21,953.0	252,368.8	-	6,805.4	6,805.4	3,867.622	0.6	558,932.5
2022	-	-	-	20,196.2	232,172.6	-	6,260.8	6,260.8	3,341.574	0.5	562,274.1
2023	-	-	-	18,580.0	213,592.6	-	5,759.8	5,759.8	2,887.075	0.5	565,161.1
2024	-	-	-	17,093.1	196,499.6	-	5,298.8	5,298.8	2,494.394	0.5	567,655.5
2025	-	-	-	15,725.2	180,774.4	-	4,874.8	4,874.8	2,155.123	0.4	569,810.7
2026	-	-	-	14,466.7	166,307.7	-	4,484.7	4,484.7	1,861.998	0.4	571,672.7
2027	-	-	-	13,309.0	152,998.7	-	4,125.8	4,125.8	1,608.742	0.4	573,281.4
2028	-	-	-	12,243.9	140,754.8	-	3,795.6	3,795.6	1,389.932	0.4	574,671.3
2029	-	-	-	11,264.1	129,490.7	-	3,491.9	3,491.9	1,200.883	0.3	575,872.2
2030	-	-	-	10,362.6	119,128.1	-	3,212.4	3,212.4	1,037.547	0.3	576,909.8
2031	-	-	-	9,533.4	109,594.7	-	2,955.3	2,955.3	896.427	0.3	577,806.2
2032	-	-	-	8,770.4	100,824.3	-	2,718.8	2,718.8	774.501	0.3	578,580.7
2033	-	-	-	8,068.6	92,755.7	-	2,501.3	2,501.3	669.159	0.3	579,249.8
2034	-	-	-	7,422.9	85,332.8	-	2,301.1	2,301.1	578.145	0.3	579,828.0
2035	-	-	-	6,828.8	78,504.0	-	2,116.9	2,116.9	499.510	0.2	580,327.5
2036	-	-	-	6,282.4	72,221.6	-	1,947.5	1,947.5	431.570	0.2	580,759.1
2037	-	-	-	5,779.6	66,442.0	-	1,791.7	1,791.7	372.871	0.2	581,131.9
2038	-	-	-	5,317.1	61,124.9	-	1,648.3	1,648.3	322.156	0.2	581,454.1
2039	-	-	-	4,891.6	56,233.4	-	1,516.4	1,516.4	278.338	0.2	581,732.4
2040	-	-	-	4,500.1	51,733.3	-	1,395.0	1,395.0	240.481	0.2	581,972.9
2041	-	-	-	4,140.0	47,593.3	-	1,283.4	1,283.4	207.772	0.2	582,180.7
2042	-	-	-	3,808.7	43,784.6	-	1,180.7	1,180.7	179.513	0.2	582,360.2
2043	-	-	-	3,503.9	40,280.7	-	1,086.2	1,086.2	155.097	0.1	582,515.3
2044	-	-	-	3,223.5	37,057.2	-	999.3	999.3	134.002	0.1	582,649.3
2045	-	-	-	2,965.5	34,091.7	-	919.3	919.3	115.776	0.1	582,765.1
2046	-	-	-	2,728.2	31,363.5	-	845.7	845.7	100.029	0.1	582,865.1
2047	-	-	-	2,509.9	28,853.6	-	778.1	778.1	86.424	0.1	582,951.5
2048	-	-	-	2,309.0	26,544.6	-	715.8	715.8	74.669	0.1	583,026.2
2049	-	-	-	2,124.2	24,420.3	-	658.5	658.5	64.513	0.1	583,090.7
2050	-	-	-	1,954.2	22,466.1	-	605.8	605.8	55.739	0.1	583,146.4
2051	-	-	-	1,797.9	20,668.2	-	557.3	557.3	48.157	0.1	583,194.6
2052	-	-	-	1,654.0	19,014.3	-	512.7	512.7	41.607	0.1	583,236.2
Total	-	1,815,715.7	(493,878.0)	493,338.3	5,927,526.3	1,321,837.7	(409,937.0)	911,900.7	583,236.2		



Comparative Cumulative NPV
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(400,000)
(600,000)
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Refurbish Mills
Test 2
Test 3
Test 4
Year

Location: Lingan
CI# / FP#: 43166
Title: LIN Mill Refurbishment
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.2	Engineering (P.Eng)	hr	[redacted]		$ 1,120.00		
1.2	Maintenance Trades	hr			$ 103,200.00		
1.3	Utility & Unskilled	hr			$ 6,480.00		
1.4		hr		$ -	$ -		
				Sub-Total	$ 110,800.00		40655
2	**012 Materials**						
2.1	Materials - See list	lot	1	$ 383,078.00	$ 383,078.00	Cost Support 1	40655
2.2					$ -		
				Sub-Total	$ 383,078.00		
3	**094 Interest Capitalized**						
3.1	Interest Capitalized	lot	1	$ 25,214.65	$ 25,214.65		
3.2					$ -		
				Sub-Total	$ 25,214.65		
4	**095 Administrative Overhead**						
4.1	Thermal & Hydro Contracts	lot	1	$ 29,472.80	$ 29,472.80		
4.2	Thermal Regular Labour	lot	1	$ -	$ -		
4.3					$ -		
				Sub-Total	$ 29,472.80		
Cost Estimate				**Total**	$ 548,565.45		
5	**Original Cost**						
5.1					$ 93,700.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Proposed order list for 2013 Mill Refurbishment - 2 Mills plus partials on Unit 2 Mills

Assume Mills

Item	Description	Approx cost	2013 Qty	Total Cost
1	Shaft End Cap 1	[redacted]		
2	Shaft End Cap 2			
3	Journal Head Skirt			
4	Journal Pressure Spring Cup			
5	Journal Head			
6	Trunnion Bushing Retainer (Thrust End)			
7	Trunnion Bushing Retainer (Free End)			
8	Trunning Shafts			
9	Exhauster Fan Blades			
10	Whizzer Blade			
11	Whizzer Disc and Clip Assembly			
12	Ceramic Lined Hub Protector			
13	Spider Arm Protector			
14	Keyless Shaft and Bowl Hub			
15	Grinding Roll			
16	Exhauster Spider			
17	Bull Ring Assembly			
18	Journal Shaft			
19	Trunnion Shaft Bushing			
20	Upper Journal Housing			
21	Journal Stop Bolt			
22	Nut for Journal Stop Bolt			
23	Thrust Plate (Thrust End)			
Local Fabrication :				
1	Roof Liners			
2	Inner Cone			
3	Reject Scraper			
4	Wall Liners			
5	Bowl Ext Ring			
6	Vane Wheel			
7	Elbow Damper			
8	Brushes			
9	Riffle Boxes			
				$ 383,078.00

CI Number: **41303**

Title: **TRE6 - Waterwall Panel Replacements**

Start Date: 2013/04
Final Cost Date: 2014/02
Function: Generation
Forecast Amount: $545,408.61

DESCRIPTION:

This project is the continuation of the waterwall panel replacement program for Trenton Unit 6 based on tube survey and wear measurements in the boiler. Timely replacement of waterwall panels avoids unplanned repair and replacement energy costs. The replacement of waterwall panels is an integral component of the boiler tube failure reduction program. It serves to maintain target heat rates and support reliable boiler operation.

This project includes replacement of three sections of wall panels on the west side of the Unit 6 boiler at the Trenton Generating Station. Non-destructive examination (NDE) completed during the 2010 planned shutdown revealed that areas of the boiler on the west waterwalls in the vicinity of the soot blowers were approaching minimum wall thickness. Replacement of these panels will minimize forced outages due to boiler tube failures in these areas of the waterwalls.

Summary of related CIs +/- 2 years:
2010 CI 34504 TRE6 Waterwall Panel Replacements $631,970
2012 CI 41544 TRE6 O2 Sensor Replacement $72,171

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

NDE performed on the waterwall panels indicated the areas of the boiler on the west waterwalls are approaching a minimal wall thickness and must be replaced. Replacing tubes that have experienced normal wear from erosion/corrosion will ensure reliable operation of the Unit is maintained.

Why do this project now?

Boiler tube failures have historically been a major contributor to the unavailability of thermal units. Replacement of selected waterwall panels now will mitigate the risk of unplanned Unit outages due to waterwall tube leaks.

Why do this project this way?

The waterwall panel replacement program is required to support reliable Unit performance. Replacement is the only viable option as the extent of the thinning precludes padding as an effective method of repair.

CI Number : 41303 - TRE6 - Waterwall Panel Replacements **Project Number**

Parent CI Number : -

Cost Centre : 345 - 345-Trenton unit 6 Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		5,982	0	5,982
095		095-Thermal Term Labour AO		2,155	0	2,155
095		095-Thermal Regular Labour AO		3,942	0	3,942
095		095-Thermal Overtime Labour AO		862	0	862
095		095-Thermal & Hydro Contracts AO		51,168	0	51,168
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	8,100	0	8,100
002	013	002 - THERMAL Overtime Labour	013 - SGP - Boiler	6,480	0	6,480
004	013	004 - THERMAL Term Labour	013 - SGP - Boiler	8,100	0	8,100
012	013	012 - Materials	013 - SGP - Boiler	50,000	0	50,000
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	401,000	0	401,000
001	085	001 - THERMAL Regular Labour	085 Design	2,240	0	2,240
001	087	001 - THERMAL Regular Labour	087 Field Super.& Ops.	4,480	0	4,480
011	087	011 - Travel Expense	087 Field Super.& Ops.	500	0	500
021	087	021 - Telephones	087 Field Super.& Ops.	200	0	200
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	200	0	200
			Total Cost:	545,409	0	545,409
			Original Cost:	350,000		

TRE6 Waterwall Panel Replacements
Summary of Alternatives

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Trenton Generating Station	**CI Number:**	41303
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Panel Replacements	6.48%	8,707,879	1	49.54%	3.6 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

Based on strong economic analysis results, it is recommended to replace the specified waterwall panels in the planned 2013 outage.

Notes/Comments :

Panel Replacements

By replacing waterwall panels (based on findings from previous non-destructive examination inspection) during a planned unit outage, the avoided cost is the replacement energy associated with unplanned unit outages required to perform repairs to the waterwalls. Repairs can range from pad welds, to cut outs, to panel replacements. A conservative unplanned outage of 72 hours was used in this analysis.

Test 2

Test 3

Test 4

TRE6 Waterwall Panel Replacements
Avoided Cost Calculations

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Trenton Generating Station	**CI Number:**	41303
Originator :		**Project No. :**	

Panel Replacements

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$44,000**	**$50,928**		
Events/Outages (#)	**1**	**1**	**1**	**1**		
Probability of Occurance (%)	**30%**	**50%**	**30%**	**50%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**160**	**160**				
Duration (Hours)	**72**	**72**				
Totals	**$45,274**	**$72,115**	**$13,200**	**$25,464**	**$58,474**	**$97,579**
Total Capital Cost of Alternative						**$545,409**

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

Test 3

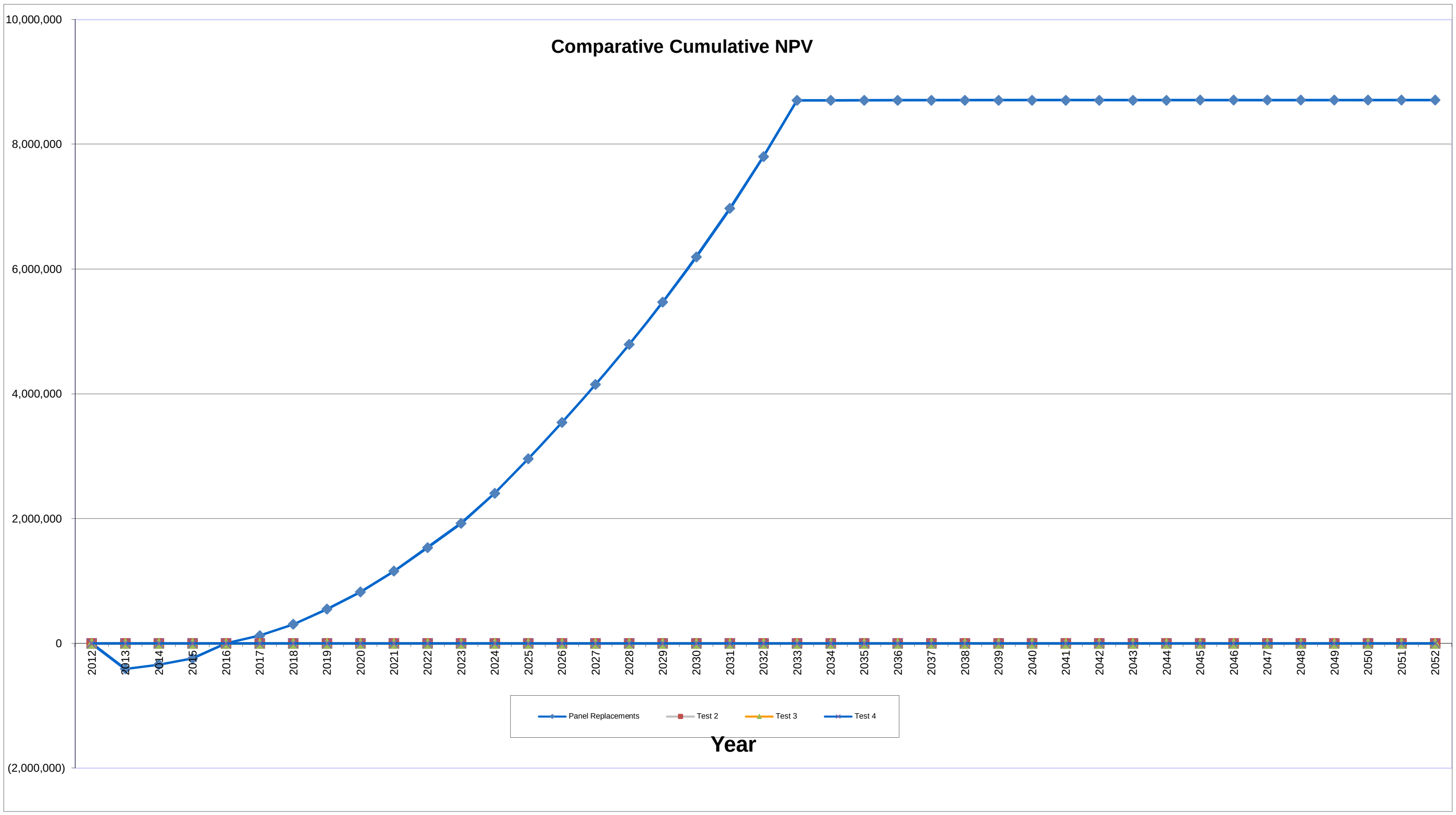
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

TRE6 Waterwall Panel Replacements
Panel Replacements

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	58,473.6	(481,300.0)	19,949.5	478,788.3	(422,826.4)	(11,942.5)	(434,768.9)	(408,310.356)	0.9	(408,310.4)
2014	-	97,579.2	-	38,303.1	440,485.3	97,579.2	(18,375.6)	79,203.6	69,856.823	0.9	(338,453.5)
2015	-	154,596.2	-	35,238.8	405,246.4	154,596.2	(37,000.8)	117,595.4	97,406.104	0.8	(241,047.4)
2016	-	437,033.1	-	32,419.7	372,826.7	437,033.1	(125,430.1)	311,602.9	242,398.186	0.8	1,350.8
2017	-	232,565.4	-	29,826.1	343,000.6	232,565.4	(62,849.2)	169,716.2	123,988.995	0.7	125,339.8
2018	-	372,841.8	-	27,440.0	315,560.5	372,841.8	(107,074.6)	265,767.3	182,344.745	0.7	307,684.5
2019	-	533,686.5	-	25,244.8	290,315.7	533,686.5	(157,616.9)	376,069.6	242,321.496	0.6	550,006.0
2020	-	647,580.6	-	23,225.3	267,090.4	647,580.6	(193,550.2)	454,030.4	274,751.850	0.6	824,757.8
2021	-	842,262.5	-	21,367.2	245,723.2	842,262.5	(254,477.5)	587,785.0	334,045.861	0.6	1,158,803.7
2022	-	1,019,447.1	-	19,657.9	226,065.4	1,019,447.1	(309,934.7)	709,512.4	378,686.279	0.5	1,537,490.0
2023	-	1,116,256.8	-	18,085.2	207,980.1	1,116,256.8	(340,433.2)	775,823.6	388,879.021	0.5	1,926,369.0
2024	-	1,474,407.1	-	16,638.4	191,341.7	1,474,407.1	(451,908.3)	1,022,498.8	481,333.743	0.5	2,407,702.7
2025	-	1,812,725.0	-	15,307.3	176,034.4	1,812,725.0	(557,199.5)	1,255,525.5	555,061.356	0.4	2,962,764.1
2026	-	2,016,346.3	-	14,082.8	161,951.6	2,016,346.3	(620,701.7)	1,395,644.6	579,458.375	0.4	3,542,222.5
2027	-	2,254,473.3	-	12,956.1	148,995.5	2,254,473.3	(694,870.3)	1,559,603.0	608,125.798	0.4	4,150,348.3
2028	-	2,533,512.0	-	11,919.6	137,075.9	2,533,512.0	(781,693.6)	1,751,818.4	641,505.524	0.4	4,791,853.8
2029	-	2,861,094.3	-	10,966.1	126,109.8	2,861,094.3	(883,539.7)	1,977,554.5	680,098.385	0.3	5,471,952.2
2030	-	3,246,316.6	-	10,088.8	116,021.0	3,246,316.6	(1,003,230.6)	2,243,085.9	724,471.242	0.3	6,196,423.4
2031	-	3,700,025.6	-	9,281.7	106,739.3	3,700,025.6	(1,144,130.6)	2,555,895.0	775,265.030	0.3	6,971,688.5
2032	-	4,235,159.7	-	8,539.1	98,200.2	4,235,159.7	(1,310,252.4)	2,924,907.3	833,203.831	0.3	7,804,892.3
2033	-	4,867,158.1	-	7,856.0	90,344.2	4,867,158.1	(1,506,383.6)	3,360,774.4	899,105.127	0.3	8,703,997.4
2034	-	-	-	7,227.5	83,116.6	-	2,240.5	2,240.5	562.931	0.3	8,704,560.3
2035	-	-	-	6,649.3	76,467.3	-	2,061.3	2,061.3	486.379	0.2	8,705,046.7
2036	-	-	-	6,117.4	70,349.9	-	1,896.4	1,896.4	420.237	0.2	8,705,467.0
2037	-	-	-	5,628.0	64,721.9	-	1,744.7	1,744.7	363.090	0.2	8,705,830.0
2038	-	-	-	5,177.8	59,544.2	-	1,605.1	1,605.1	313.714	0.2	8,706,143.8
2039	-	-	-	4,763.5	54,780.6	-	1,476.7	1,476.7	271.053	0.2	8,706,414.8
2040	-	-	-	4,382.5	50,398.2	-	1,358.6	1,358.6	234.193	0.2	8,706,649.0
2041	-	-	-	4,031.9	46,366.3	-	1,249.9	1,249.9	202.345	0.2	8,706,851.4
2042	-	-	-	3,709.3	42,657.0	-	1,149.9	1,149.9	174.829	0.2	8,707,026.2
2043	-	-	-	3,412.6	39,244.5	-	1,057.9	1,057.9	151.054	0.1	8,707,177.2
2044	-	-	-	3,139.6	36,104.9	-	973.3	973.3	130.513	0.1	8,707,307.8
2045	-	-	-	2,888.4	33,216.5	-	895.4	895.4	112.765	0.1	8,707,420.5
2046	-	-	-	2,657.3	30,559.2	-	823.8	823.8	97.430	0.1	8,707,517.9
2047	-	-	-	2,444.7	28,114.5	-	757.9	757.9	84.181	0.1	8,707,602.1
2048	-	-	-	2,249.2	25,865.3	-	697.2	697.2	72.733	0.1	8,707,674.9
2049	-	-	-	2,069.2	23,796.1	-	641.5	641.5	62.842	0.1	8,707,737.7
2050	-	-	-	1,903.7	21,892.4	-	590.1	590.1	54.296	0.1	8,707,792.0
2051	-	-	-	1,751.4	20,141.0	-	542.9	542.9	46.913	0.1	8,707,838.9
2052	-	-	-	1,611.3	18,529.7	-	499.5	499.5	40.533	0.1	8,707,879.4
Total	-	34,513,540.6	(481,300.0)	480,208.1	5,771,762.4	34,032,240.6	(10,550,333.1)	23,481,907.6	8,707,879.4		



Comparative Cumulative NPV
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
(2,000,000)
2012
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2052
Panel Replacements
Test 2
Test 3
Test 4
Year

Location: Trenton Generating Station
CI# / FP#: 41303
Title: TRE6 Waterwall Panel Replacements
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Regular Utility	hr	[redacted]		$ 8,100.00		
1.2	Project Supervision	hr			$ 4,480.00		
1.3	Internal Engineering	hr			$ 2,240.00		
1.4					$ -		
				Sub-Total	$ 14,820.00		
2	**002 Overtime Labour**						
2.1	Overtime Utility	hr	[redacted]		$ 6,480.00		
2.2					$ -		
				Sub-Total	$ 6,480.00		
3	**004 Term Labour**						
3.1	Term Labour - Utility - Prep Work, Manwatch	hr	[redacted]		$ 8,100.00		
3.2					$ -		
				Sub-Total	$ 8,100.00		
4	**012 Materials**						
4.1	Tube Material	lot	1	$ 40,000.00	$ 40,000.00		
4.2	Miscellaneous Materials	lot	1	$ 10,000.00	$ 10,000.00		
4.3					$ -		
				Sub-Total	$ 50,000.00		
5	**013 Power Production Contracts**						
5.1	Tube Removal	lot	1	[redacted]			34504
5.2	Tube Installation	lot	1				34504
5.3	Mobilization/Demobilization	lot	1				
5.4	QA Radiography and Inspection	lot	1				
5.5	Remove/Install Insulation	lot	1				
5.6	Radios, Tugger, CSM, Mill Hog, Etc	lot	1	$ 6,000.00	$ 6,000.00		
5.7					$ -		
				Sub-Total	$ 401,000.00		
6	**011 Travel**						
6.1	Travel	lot	1	$ 500.00	$ 500.00		
				Sub-Total	$ 500.00		
7	**021 Telephones**						
7.1	Telephones	lot	1	$ 200.00	$ 200.00		
				Sub-Total	$ 200.00		
8	**041 Meals and Entertainment**						
8.1	Meals	lot	1	$ 200.00	$ 200.00		
				Sub-Total	$ 200.00		
9	**094 Interest Capitalized**						
9.1	Interest Capitalized	lot	1	$ 5,982.45	$ 5,982.45		
				Sub-Total	$ 5,982.45		
10	**095 Administrative Overhead**						
10.1	Thermal Regular Labour AO	lot	1	$ 3,942.12	$ 3,942.12		
10.2	Thermal Overtime Labour AO	lot	1	$ 861.84	$ 861.84		
10.3	Thermal & Hydro Contracts AO	lot	1	$ 51,167.60	$ 51,167.60		
10.4	Thermal Term Labour AO	lot	1	$ 2,154.60	$ 2,154.60		
				Sub-Total	$ 58,126.16		
Cost Estimate				Total	$ 545,408.61		
11	**Original Cost**						
11.1	Retirement				$ 350,000.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project.

ALSTOM

Nova Scotia Power Incorporated
Trenton Unit # 6
Section: East Waterwall
Visual and UT Assessment

Tube Numbers

Date: April/2010
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ELEV.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	ELEV.
132'6"																																						132'6"
132																																						132
131'6"																																						131'6"
131																																						131
130'6"																																						130'6"
130																																						130
129'6"																																						129'6"
129								0.218		0.222		0.220		0.217		0.212		0.221		0.217		0.214		0.220		0.222		0.214		0.221		0.214		0.218		0.216		129
128'6"																																						128'6"
128																																						128
127'6																																						127'6
127																																						127
126																																						126
125																																						125
124																																						124
123																																						123
122'6"																																						122'6"
122																			0.213	0.221	0.224	0.217		0.205	0.199	0.175	0.168	0.169	0.188	EP 190	EP .190	EP .164	EP .165	EP .145				122
121'6"																																						121'6"
121										0.151	0.176	0.163	0.179	0.159	0.170	0.146	0.177		0.216			0.184	0.180	EP.114 23" Pad	EP .170	EP .162	EP .183	EP	EP .182		EP .164	EP .180	0.182	0.186				121
120'6"													0.170	.139 11" Pad	.122 13" Pad	.108 Pad	0.150	0.181	0.217	0.207	0.204	EP .167	EP .143	EP .186	EP .173	EP .171	EP .190	EP	EP .141	EP .164	0.171	0.181	0.176	0.177				120'6"
120														0.140	0.164	.135 14"	0.171	0.170	0.187	IR 25	IR 25	EP .168	EP .181						0.144	0.158	0.164							120
119'6"																								EP .130					0.110	0.130	0.140	0.151	0.152	0.158	0.170	0.183		119'6"
119															0.162	0.147			0.217	0.223	0.219	0.215	0.157	EP .146	EP .130 4" Pad	EP103 11" Pad	EP .096	EP	0.112	0.128	0.132	.137 20" Pad	0.148	0.146	0.159	0.170		119
118'6"																											13" Pad		34" Pad	30" Pad	20" Pad							118'6"
118																			0.211	0.223	0.218	0.217				0.157	0.122	EP .145	0.122	0.135	0.140	0.152	0.154	0.150	0.184			118
117'6"																																						117'6"
117																																						117
116																																						116
115																																						115
114																																						114
113								0.217		0.222		0.218		0.217		0.220		0.220		0.222		0.217		0.217		0.222		0.221		0.219		0.223		0.224		0.222		113
112'6"																																						112'6"
112																																						112
111'6"																																						111'6"
111																																						111
110'6"																																						110'6"
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109'6"																																						109'6"
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108'6"																																						108'6"
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107'6"																																						107'6"
107																																						107
106																																						106
105											0.210		0.220		0.217		0.220		0.222		0.219		0.219		0.214		0.220		0.219		0.218		0.217		0.210		0.220	105
104																																						104
103																																						103
102																																						102
101																																						101
100																																						100
99																																						99
98																																						98
97								0.217		0.220		0.222		0.216		0.220		0.220		0.223		0.219		0.215		0.216		0.214		0.213		0.222		0.215		0.216		97
96																																						96
95																																						95
94																																						94
93																																						93
92																																						92
91																																						91
90																																						90
89									0.215		0.215		0.222		0.220		0.220		0.222		0.224		0.224		0.220		0.219		0.225		0.215		0.218		0.209		0.220	89
88																																						88
87																																						87
86																																						86
85																																						85
84																																						84
83																																						83
82																																						82
81												0.219		0.219		0.220		0.220		0.222		0.219		0.217		0.215		0.218		0.213		0.209		0.212		0.209		81
80																																						80
79																																						79
78																																						78
77																																						77
76																																						76
75																																						75
74																																						74
73													0.204		0.202		0.203		0.210		0.217		0.211		0.204		0.204		0.182		0.182		0.174		0.176		0.182	73
72																																						72
71																																						71
70																																						70
69																																						69
68																																						68
67																																						67
66																																						66
65'6																																						65'6
65										0.208		0.204		0.210		0.209		0.208		0.198		0.210		0.203		0.205		0.199		0.206		0.196		0.203		0.198		65

Note: For all technical support:

- numbers are wall thickness in inches (nominal 0.200)
- IR indicates a wall blower is at this location
- EP indicates there is an existing pad at this location

ALSTOM

Nova Scotia Power Incorporated
Trenton Unit # 6
Section: East Waterwall
Visual and UT Assessment

Tube Numbers

Date: April/2010
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ELEV.	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	ELEV.
132'6"																																						132'6"
132																						0.215			0.219													132
131'6"																																						131'6"
131														0.160	0.154	0.159						0.213			0.217		0.172	0.140	0.153	0.152	0.162	0.149	0.170	0.162	0.153			131
130'6"														0.165	0.160	0.164	0.178					0.216	0.201	0.215	0.213	0.172	0.148	**0.135**	0.153	0.147	0.158	0.150	0.167	0.160	0.151	0.175	0.170	130'6"
130																						0.137	**IR 30**	**IR 30**	0.204	0.190	0.150	**0.135**	0.150	0.156	0.162	0.150	0.175	0.172	0.148	0.183	0.182	130
129'6"																						0.214	0.202	0.170	0.207	0.178	0.142	EP	0.176	**0.137**	**0.138**	0.144	0.136	0.162	0.159	0.145	0.179	129'6"
129	0.215		0.215		0.213		0.219		0.215		0.213		0.210		0.178		0.210		0.212		0.219	0.213	0.210		0.219	0.195	0.155	**0.126**	**0.138**	**0.127**	**0.130**	EP .183	**0.134**	0.142	**0.124**	0.155	0.149	129
128'6"																																						128'6"
128																						0.218			0.215			0.196	0.166	0.148	**0.137**	EP .174	0.141	0.140	**0.129**	0.159	0.148	128
127'6																																						127'6
127																																						127
126																																						126
125																																						125
124																																						124
123																																						123
122'6"																																						122'6"
122																																						122
121'6"																																						121'6"
121		0.219		0.220		0.227		0.224		0.207		0.214		0.224		0.222		0.223		0.220		0.218		0.220		0.220		0.221		0.216		0.222		0.215		0.222		121
120'6"																																						120'6"
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119'6"																																						119'6"
119																																						119
118'6"																																						118'6"
118																																						118
117'6"																																						117'6"
117																										0.219	0.218	0.217	0.216	0.211	0.212	0.217	0.214	0.211	0.213	0.219		117
116																										0.212	0.217	0.217	0.215	0.212	0.212	0.215	0.216	0.214	0.215	0.212		116
115																										0.219	0.216	0.219	0.222	0.211	0.206	0.219	0.221	0.216	0.215	0.220		115
114																																						114
113	0.223		0.222		0.224		0.219		0.220		0.220		0.214		0.209		0.207		0.218		0.219		0.219		0.217		0.215		0.218		0.220		0.216		0.220		0.220	113
112'6"														0.172	0.155	0.169	.135 3" Pad	0.159	0.180																			112'6"
112											0.147	0.172	0.182	EP 157 Pad	EP .153	EP .153	EP .142			0.180																		112
111'6"														**.100 12"**	EP 6" Repad		EP 6" Repad	EP 6" Repad	EP .135 6" Pad	.127 12" Pad																		111'6"
111											EP	EP	0.154	EP .158	EP .143	EP .144	EP .148	EP	EP	0.170																		111
110'6"											0.148				0.170	EP .162					0.170																	110'6"
110														0.175	0.148	EP .150			EP .154	EP .164	0.170		**IR 2**	**IR 2**														110
109'6"																																						109'6"
109																		.135 16" Pad	0.135	0.145	.137 12" Pad																	109
108'6"																			.135 12" Pad	.135 12" Pad																		108'6"
108																0.160	0.178																					108
107'6"																																						107'6"
107																																						107
106																																						106
105		0.220		0.210		0.215		0.217		0.210		0.215		0.218		0.220		0.216		0.216		0.206		0.211		0.210		0.210		0.209		0.217		0.208		0.210		105
104																										0.211	0.217	0.215	0.210	0.211	0.206	0.216	0.208	0.206	0.212	0.214		104
103																										0.215	0.216	0.218	0.219	0.211	0.211	0.218	0.210	0.211	0.212	0.215		103
102																										0.211	0.213	0.211	0.209	0.208	0.204	0.212	0.211	0.206	0.208	0.212		102
101																																						101
100																																						100
99																																						99
98																																						98
97	0.225		0.210		0.208		0.210		0.209		0.210		0.208		0.202		0.210		0.209		0.210		0.210		0.214		0.212		0.210		0.199		0.205		0.206		0.205	97
96																																						96
95																																						95
94																																						94
93																																						93
92																																						92
91																																						91
90																																						90
89		0.214		0.213		0.206		0.203		0.200		0.190		0.200		0.204		0.196		0.204		0.202		0.204		0.200		0.200		0.198		0.195		0.192		0.199		89
88																																						88
87																								0.193	0.196	0.176	0.188	0.194	0.187	0.190	0.187	0.193	0.187	0.183	0.186	0.193	0.189	87
86																								0.194	0.192	0.193	0.193	0.200	0.195	0.196	0.190	0.198	0.192	0.196	0.193	0.190	0.184	86
85																								0.195	0.196	0.177	0.192	0.180	0.184	0.168	0.170	0.188	0.180	0.170	0.177	0.178	0.176	85
84																																						84
83																																						83
82																																						82
81	0.200		0.170		0.159		0.160		0.196		0.172		0.165		0.172		0.147		0.169		0.164		0.155		0.180		0.172		0.174		0.158		0.162		0.148		0.146	81
80																																						80
79																											1.000											79
78																																						78
77																																						77
76																																						76
75																																						75
74																																						74
73		0.170		0.182		0.182		0.162		0.160		0.159		0.144		0.130		0.134		0.138		0.130		0.128		0.128		0.124		0.117		0.108		0.113		0.109		73
72																																						72
71																																						71
70																																						70
69																																						69
68																																						68
67																								0.179	0.181	0.174	0.176	0.174	0.160	0.170	0.185	0.166	0.181	0.168	0.166	0.159	0.158	67
66																								0.187	0.188	0.187	0.188	0.188	0.178	0.180	0.177	0.176	0.188	0.189	0.187	0.189	0.175	66
65'6																																						65'6
65			0.190		0.200		0.200		0.195		0.193		0.186		0.192		0.182		0.190		0.187		0.183	0.200	0.189	0.190	0.185	0.188	0.187	0.191	0.188	0.192	0.190	0.175	0.171	0.174	0.175	65

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Nova Scotia Power Incorporated
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ELEV.	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	108	110	111	ELEV.
132'6"																																						132'6"
132																																						132
131'6"																																						131'6"
131																																						131
130'6"																																						130'6"
130																																						130
129'6"	0.171																																					129'6"
129		0.207		0.190		0.215		0.214		0.217		0.209		0.215		0.218		0.210		0.212		0.212		0.214		0.213		0.213		0.209		0.212						129
128'6"																																						128'6"
128																																						128
127'6																																						127'6
127																																						127
126																																						126
125																																						125
124																																						124
123																**12" Pad**	**12" Pad**		16" Pad	14" Pad		10" Pad	12" Pad							4" Pad	14" Pad							123
122'6"																																						122'6"
122												0.190	0.154	0.142	0.160	**0.128**	**0.126**	**0.136**	0.173	EP .194	0.167	0.130		0.213	0.215	0.213	0.210	0.217		0.158	0.177	0.179						122
121'6"																		**25" Pad**																				121'6"
121	0.223		0.225		0.222		0.224		0.215		0.166	0.165	**.138 12" Pad**	**.137 12" Pad**	**.129 Pad**		EP .147	**0.135**	**0.109**	**0.090**	0.116	0.158	EP .174	0.221	0.220	0.217	0.216	0.154	0.156	**EP .131**	**0.137**	0.153	0.149	0.147	0.168			121
120'6"										0.191	0.174	0.171	0.150	0.143	**.138 12"**	**0.138**	**EP .138**	**0.120**	0.163	EP	**EP Pad**	**EP .102**	**EP .139**	**.135 5" Pad**	0.197	0.210	0.208	0.170	**.138 7" Pad**	EP	EP	**.133 5" Pad**	**.133 5" Pad**					120'6"
120										0.199	0.191	0.192	0.176	0.173	0.163	0.161	0.144	EP	EP	EP	**EP .135 20"**	**EP .128**	**EP .138**	0.188	**IR 17**	**IR 17**	0.195	0.173	0.156	EP	**EP .138**	0.155	0.151					120
119'6"													0.184	0.184	0.188	0.165	0.143	0.146	EP	EP	0.149	0.143	0.156	0.215	0.209	0.202	0.212			EP	**0.135**	0.146	0.148	0.145				119'6"
119													0.191	0.189	0.190	0.166	0.148	0.144	EP	**0.135**	0.174	EP		0.217	0.213	0.213	0.211			EP .143	0.156				0.165			119
118'6"																																						118'6"
118														0.199	0.182	0.172	0.180	0.160	**0.136**	0.189	0.199	EP .180		0.218	0.212	0.214	0.210	0.208										118
117'6"																																						117'6"
117																																						117
116																																						116
115																																						115
114																																						114
113		0.219		0.212		0.218		0.217		0.222		0.216		0.220		0.217		0.214		0.212		0.223		0.222		0.217		0.215		0.212								113
112'6"																																						112'6"
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107'6"																																						107'6"
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106																																						106
105	0.211		0.216		0.210		0.207		0.218		0.210		0.213		0.211		0.209		0.213		0.210		0.201		0.205		0.217		0.209		0.205							105
104																																						104
103																																						103
102																																						102
101																																						101
100																																						100
99																																						99
98																																						98
97		0.203		0.200		0.203		0.197		0.204		0.198		0.192		0.201		0.199		0.188		0.193		0.190		0.186		0.177		0.178		0.186		0.190		0.185		97
96																																						96
95																																						95
94																																						94
93																0.178	0.181	0.153	0.154	0.155	0.153	0.175	0.176	0.154	0.152	0.150	0.166	0.154	0.148	0.153	0.157	0.158	0.149	0.155	0.157	0.158	0.151	93
92																0.170	0.166	0.153	0.165	0.168	0.158	0.169	0.157	0.157	0.150	0.153	0.154	0.148	0.151	0.155	0.152	0.154	0.140	0.150	0.149	0.140	0.150	92
91																0.156	0.150	0.133	0.135	0.150	0.163	0.152	0.154	0.151	0.146	0.152	0.147	0.158	0.156	0.152	0.144	0.152	0.151	0.147	0.149	0.151	0.150	91
90	0.190		0.176		0.170		0.135		0.134		0.128		0.117		0.128		0.119		0.119		0.128		0.117		0.119		0.125		0.152		0.145		0.147		0.163		0.169	90
89																																						89
88																																						88
87	0.187	0.187	0.186	0.175	0.178	0.179	0.177	0.181	0.170	0.178	0.163	0.165	0.168	0.159	0.120																							87
86	0.181	0.183	0.175	0.170	0.175	0.174	0.173	0.174	0.170	0.165	0.160	0.154	0.159	0.158	0.142																							86
85	0.164	0.184	0.167	0.169	0.154	0.163	0.169	0.162	0.149	0.158	0.160	0.157	0.155	0.158	0.157																							85
84																																						84
83																																						83
82																																						82
81		0.148		0.139		0.152		0.136		0.143		0.142		0.130		0.127		0.135		0.121		0.125		0.131		0.127		0.148		0.148		0.124		0.144		0.168		81
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78																																						78
77																																						77
76																																						76
75																																						75
74																																						74
73	0.119		0.119		0.165		0.124		EP .198		0.125		0.124		0.122		0.130		0.122		0.119		0.143		0.138		0.134		0.144		0.164		0.152		0.158		0.177	73
72																																						72
71																																						71
70																																						70
69																																						69
68																																						68
67	0.160	0.155	0.154	0.153	0.152	0.165	0.154	0.152	0.158	0.160	0.142	0.133	0.158	0.146	0.157	0.164	0.151	0.160	0.145	0.145	0.155	0.152	0.152	0.158	0.154	0.150	0.157	0.149	0.152	0.152	0.159	0.153	0.156	0.165	0.162	0.163	0.167	67
66	0.168	0.165	0.170	0.166	0.169	0.174	0.155	0.159	0.171	0.169	0.162	0.158	0.157	0.166	0.160	0.158	0.159	0.160	0.151	0.152	0.155	0.159	0.160	0.148	0.154	0.155	0.171	0.159	0.155	0.520	0.158	0.157	0.159	0.154	0.170	0.169	0.140	66
65'6																																						65'6
65	0.181	0.175	0.176	0.168	0.170	0.171	0.169	0.168	0.170	0.156	0.161	0.164	0.164	0.158	0.154	0.153	0.158	0.167	0.152	0.160	0.143	0.168	0.152	0.166	0.135	0.170	0.157	0.161	0.152	0.175	0.171	0.161	0.172	0.170	0.181	0.165	0.172	65

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Nova Scotia Power Incorporated
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Section: West Waterwall
Visual and UT Assessment

Tube Numbers

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ELEV.	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	ELEV.
132'6"																																						132'6"
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97	0.153		0.190		0.203		0.199																															97
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89		0.175		0.193		0.179		0.171																														89
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81	0.175		0.189		0.176																																	81
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73		0.168		0.175		0.179		0.171																														73
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Nova Scotia Power Incorporated
Trenton Unit # 6
Section: North Waterwall
Visual and UT Assessment

Tube Numbers

Date: April/2010

ELEV.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	ELEV.
132'6"																																						132'6"
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121'6"																																						121'6"
121									0.168	EP.164	EP .157	EP .163	EP .148										EP .161	EP .156	EP .159	EP .151	EP .169											121
120'6"										EP	EP	EP	EP					0.185	0.189		EP .178	EP .149	EP	EP	EP	EP	EP	EP .167										120'6"
120										EP	EP	EP	EP	EP .160	0.159			**IR 25**	**IR 25**		EP	EP	EP	EP	EP	EP	EP	EP	EP .170									120
119'6"										EP	EP	EP	EP	EP				0.184	0.181		EP .189	EP	EP	EP	EP	EP	EP	EP	EP									119'6"
119										EP .188	EP .175	EP .177	EP .170	EP .185								EP .180	EP .191	EP .191	EP .177	EP .158	EP .170	EP .164	EP .183									119
118'6"																																						118'6"
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Nova Scotia Power Incorporated
Trenton Unit # 6
Section: North Waterwall
Visual and UT Assessment

Tube Numbers

Date: April/2010
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ELEV.	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	ELEV.
132'6"																																						132'6"
132														EP .175																								132
131'6"																																						131'6"
131													EP .155	EP	EP .141	EP .146	EP .188						EP .143	EP .109	EP .165	EP .163	EP .171											131
130'6"								0.174	0.172	0.169	0.159	0.149	EP	EP	EP	EP	EP	0.185	0.188		0.150	0.143	EP	EP	EP	EP	EP											130'6"
130												0.148	EP .146	EP	EP .165	EP	E	**IR 40**	**IR 40**	0.175			EP	EP	EP[	EP	EP											130
129'6"												0.150		EP	EP	EP .171	EP .186	0.186	0.182				EP	EP	EP	EP	EP		0.165	0.174								129'6"
129														EP .170	EP .188								EP	EP	EP	EP	EP	0.143										129
128'6"																																						128'6"
128																							EP .153	EP .165	EP .169	EP .166	0.176	0.155	0.168									128
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Nova Scotia Power Incorporated
Trenton Unit # 6
Section: North Waterwall
Visual and UT Assessment

Tube Numbers

Date: April/2010
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ELEV.	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	108	110	111	ELEV.
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122																							EP .151	EP .171	EP .183													122
121'6"																																						121'6"
121							0.175				0.148		0.160							EP .163	EP .165	EP .146	EP	EP .182	EP .167	EP .186												121
120'6"								0.172	0.160	0.162	0.148	.135 13" Pad	.134 15" Pad	0.152	0.154		0.181	0.189	EP .135 5" Pad	EP	EP	EP	EP			EP												120'6"
120											0.165		0.147			.135 8" Pad	**IR 27**	**IR 27**	EP	EP	EP	EP	EP			EP												120
119'6"													0.149				0.149	0.186	EP	EP	EP	EP	EP	EP .163	EP	EP												119'6"
119																			EP .189	EP .172	EP .171	EP .154	EP	EP .123 4" Pad	.121 7" Pad	EP	0.156	0.158	0.159	EP .176								119
118'6"																																						118'6"
118																							EP .150	EP .165	EP .155	EP .144				EP .149	EP .149							118
117'6"																																						117'6"
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Nova Scotia Power Incorporated
Trenton Unit # 5
Section: West Waterwall
Visual and UT Assessment

Tube Numbers

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ELEV.	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	ELEV.
132'6"																																						132'6"
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131'6"																																						131'6"
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130'6"																																						130'6"
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Visual and UT Assessment

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ELEV.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	ELEV.
132'6"																																						132'6"
132																																						132
131'6"																																						131'6"
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130'6"																																						130'6"
130																		IR 32	IR 32																			130
129'6"																																						129'6"
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122'6"																																						122'6"
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121'6"																																						121'6"
121	0.206		0.213		0.127		0.216		0.202		0.208		0.210		0.209		0.208		0.208		0.203		0.210		0.206		0.209		0.214		0.210		0.207		0.209		0.201	121
120'6"																																						120'6"
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118'6"																																						118'6"
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117'6"																																						117'6"
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116																																						116
115	0.202		0.201			0.206		0.209		0.209		0.211		0.212		0.207		0.208		0.211		0.207		0.207		0.206		0.210		0.205		0.208		0.207		0.202		115
114																																						114
113																																						113
112'6"																																						112'6"
112		0.210		0.213		0.213		0.154		0.143	0.150	0.141	0.144	.115 4" Pad	0.141	0.168	0.205	0.204						0.143	0.156				0.197									112
111'6"																																						111'6"
111										EP	EP		EP	EP	.135 12" Pad	.133 4" Pad	0.205	0.206		0.210	0.140	0.161	0.140	EP	.130 10" Pad	.129 6" Pad	0.157	0.155	EP									111
110'6"										EP	EP		EP	.086 14" Pad	EP	EP				0.187	EP	EP	EP	EP	EP	**EP**	EP	**EP**	EP									110'6"
110								0.158	0.147	EP	0.146	EP	EP	EP	EP	0.152		IR 4	IR 4		0.172	0.142	.134 24" Pad	.124 3" Pad	EP	EP	EP	.133 8" Pad	**EP**	0.159								110
109'6"	0.144									EP		0.140	.162 6" Pad	EP	EP							.137 12" Pad	EP	EP	**EP**	EP	EP	EP	EP	EP	.134 6" Pad							109'6"
109	0.115	**50"**								EP				.133 4" Pad	0.149								.124 8" Pad	**EP**	EP	**EP**	EP	**EP**	EP	EP	EP							109
108'6"	0.117	**Pad**			**SB Weld**																																	108'6"
108	0.115				.114 10" Pad					0.154														0.158	0.148	.125 12" Pad	.100 4" Pad	0.143	.123 4" Pad	EP .131 4" Pad	EP .119 4" Pad							108
107'6"																																						107'6"
107	0.206		0.212		0.204		0.205		0.202		0.201		0.203		0.203		0.200		0.198		0.192		0.199		0.178		0.174		0.175		0.178		0.179		0.192		0.196	107
106																																						106
105																																						105
104																																						104
103																																						103
102																																						102
101																																						101
100																																						100
99		0.181		0.198		0.185		0.178		0.182		0.182		0.187		0.184		0.175		0.164		0.181		0.165		0.170		0.168		0.172		0.165		0.173		0.178		99
98																																						98
97																																						97
96	0.178		0.171		0.169		0.162		0.176		0.161		0.161		0.159		0.162		0.151		0.156		0.150		0.152		0.163		0.158		0.150		0.151		0.148		0.165	96
95																																						95
94																												**2008**	**panel**	**T 21-50**								94
93																												**elev**	**90' 10"**	**66' 10"**								93
92																																						92
91		0.165		0.163		0.168		0.155		0.150		0.155		0.151		0.159		0.131		0.158		0.202		0.211		0.209		0.205		0.210		0.209		0.202		0.207		91
90																																						90
89																																						89
88															0.159	0.145	0.144	0.137	0.146	0.135	0.142																	88
87	0.158		0.152		0.147		0.149		0.151		0.147		0.152		0.147	0.139	0.135	0.143	0.124	0.135	0.112		0.132		0.212		0.204		0.209		0.214		0.216		0.211		0.202	87
86											0.145	0.132		0.131	0.127	0.140	0.144	0.130	0.130	0.131	0.132																	86
85									0.142		0.140	0.124	0.137	0.128	0.138																							85
84									0.123		0.135	0.143	0.143	0.122	0.141	0.144	0.131	0.128	0.131	0.138	0.131																	84
83		0.171		0.143		0.148		0.145	0.133	0.133	0.133	0.129	0.134	0.126	0.130	0.114	0.133	0.110	0.121	0.122	EP	0.212		0.208		0.209		0.200		0.211		0.212		0.208		0.210		83
82									0.127		0.148	0.130	0.128	0.131	0.141	0.135	0.127	0.122	0.129	0.139	0.150																	82
81							0.141		0.132			0.137	0.112	0.121																								81
80							0.129					0.131	0.132	0.126		EP .136		0.107																				80
79	0.190		0.180		0.158		.121 24" Pad		EP .141		EP .148	0.125	EP .162	0.121	0.124	0.120	EP .137		EP .156		EP .137		0.212		0.204		0.202		0.205		0.212		0.215		0.202		0.221	79
78							0.141					0.130		0.125	0.117	0.120	0.118	0.116	0.123																			78
77														0.124	0.122	0.120	0.116		0.137																			77
76														0.137	0.139	0.120	0.139																					76
75		0.170		0.163		0.145		0.148		0.143		0.137		0.131		0.128	0.138	0.126		0.202		0.208		0.189		0.195		0.207		0.212		0.210		0.214		0.218		75
74																0.103		0.136																				74
73																																						73
72																																						72
71	0.182		0.185		0.154		0.156		0.150		0.146		0.144		0.147		0.140		0.145		0.121		0.214		0.210		**0.204**		0.211		0.211		0.222		0.217		0.220	71
70																																						70
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ELEV.	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	ELEV.
132'6"																																						132'6"
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124																																						124
123		0.205		0.202		0.211		0.207		0.205		0.205		0.208		0.204		0.212		0.210		0.204		0.207		0.203		0.206		0.208		0.205		0.209		0.208		123
122'6"																																						122'6"
122																																						122
121'6"																																						121'6"
121								0.140	0.145	0.145	0.161	0.167		.135 4" Pad						0.163	0.183	0.161	0.153	0.146	0.151	0.151												121
120'6"								EP	EP	EP	EP.100 14" Pad	EP	.131 6" Pad	EP	0.146	0.174	0.172			EP	EP	EP	EP	EP	EP	EP												120'6"
120								0.148		EP			EP	EP	EP	EP	EP	IR 19	IR 19	EP	EP	EP	EP	EP	0.145	0.146												120
119'6"										0.160			0.152	EP	0.158	0.193				EP	EP	EP .125 6" Pad	EP .126 6" Pad	EP	EP	EP	0.145											119'6"
119														0.155						0.190	0.150	EP	.128 6" Pad	.137 4" Pad	EP	EP	EP	0.142	0.157	0.158								119
118'6"																																						118'6"
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117'6"																																						117'6"
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116																																						116
115	0.206		0.208		0.210		0.205		0.208		0.209		0.204		0.206		0.199		0.210		0.203		0.206		0.207		0.205		0.205		0.204		0.203		0.205		0.209	115
114																																						114
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107		0.198		0.201		0.194		0.200		0.201		0.200		0.203		0.196		0.201		0.197		0.199		0.187		0.201		0.199		0.198		0.202		0.200		0.196		107
106																																						106
105																																						105
104																																						104
103																																						103
102																																						102
101																																						101
100																																						100
99	0.174		0.177		0.180		0.179		0.182		0.186		0.188		0.192		0.192		0.190		0.191		0.188		0.191		0.190		0.189		0.191		0.186		0.184		0.195	99
98																																						98
97																																						97
96																																						96
95		0.159		0.170		0.173		0.176		0.179		0.172		0.182		0.184		0.190		0.193		0.193		0.880		0.189		0.191		0.184		0.187		0.189		0.191		95
94																																						94
93																																						93
92																																						92
91	0.212		0.208		0.210		0.207		0.213		0.205		0.203		0.172		0.174		0.175		0.181		0.183		0.191		0.188		0.188		0.183		0.186		0.188		0.189	91
90																																						90
89				2008 Panel	T 22-56																																	89
88				Elev 90'-10"	66'-10"																																	88
87		0.215		0.210		0.210		0.220		0.215		0.205		0.212		0.162		0.186		0.166		0.172		0.174		0.174		0.187		0.179		0.177		0.188		0.182		87
86																																						86
85																																						85
84																																						84
83	0.215		0.207		0.209		0.202		0.206		0.202		0.200		0.139		0.136		0.138		0.152		0.145		0.149		0.162		0.160		0.168		0.162		0.174		0.170	83
82																																						82
81																																						81
80																																						80
79		0.211		0.209		0.211		0.203		0.199		0.212		EP .128		EP .184		EP .193		EP .149		0.149		0.144		0.146		0.151		0.159		0.161		0.170		0.171		79
78																																						78
77																																						77
76																																						76
75	0.211		0.211		0.214		0.206		0.210		0.208		0.130		0.142		0.143		0.150		0.146		0.144		0.159		0.161		0.168		0.177		0.177		0.179		0.189	75
74																																						74
73																																						73
72																																						72
71		0.215		0.203		0.226		0.220		0.212		0.218		0.147		0.159		0.163		0.162		0.168		0.164		0.172		0.171		0.176		0.176		0.188		0.151		71
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Nova Scotia Power Incorporated
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ELEV.	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	108	110	111	ELEV.
132'6"																																						132'6"
132																																						132
131'6"																																						131'6"
131																																						131
130'6"																	**IR 34**	**IR 34**																				130'6"
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126																																						126
125																																						125
124																																						124
123	0.200		0.209		0.209		0.211		0.209		0.207		0.209		0.209		0.203		0.204		0.208		0.205		0.207		0.204		0.203		0.204		0.202		0.207		0.201	123
122'6"																																						122'6"
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116																																						116
115		0.208		0.205		0.206		0.208		0.205		0.204		0.208		0.203		0.206		0.208		0.205		0.206		0.200		0.210		0.206		0.207		0.204		0.206		115
114																																						114
113																																						113
112'6"																																						112'6"
112											0.145	0.144	0.156																									112
111'6"																							**26" Pad**															111'6"
111										0.143			**.136 Pad**								0.161	EP .200	**0.135**	0.155														111
110'6"									0.154	0.140	EP .192	0.143	**.131 16"**							0.140	EP	EP	**0.127**	EP	0.165													110'6"
110									0.157	0.149	0.145	0.152	0.140				**IR 6**	**IR 6**		EP	EP	0.172	**0.135**	EP .195	0.166													110
109'6"						0.150					**.121 Pad**		EP				0.183			EP .169	0.170	EP	**0.122**	EP														109'6"
109									0.143	**.130 18" Pad**	**.110 16"**	**.136 12" Pad**	EP .159				0.209			0.192		EP	EP	EP	**.136 8" Pad**	0.146	0.161	0.164	0.153									109
108'6"																																						108'6"
108										0.159	0.152	0.188	0.152									0.165	0.152	0.211	0.201													108
107'6"																																						107'6"
107	0.204		0.200		0.200		0.207		0.203		0.204		0.203		0.204		0.203		0.203		0.202		0.200		0.206		0.205		0.203		0.200		0.204		0.209		0.203	107
106																																						106
105																																						105
104																																						104
103																																						103
102																																						102
101																																						101
100																																						100
99		0.191		0.194		0.198		0.199		0.200		0.200		0.196		0.198		0.197		0.198		0.202		0.204		0.200		0.206		0.200		0.199		0.193		0.197		99
98																																						98
97																																						97
96																																						96
95	0.184		0.189		0.196		0.190		0.164		0.191		0.187		0.200		0.191		0.193		0.198		0.196		0.197		0.208		0.194		0.198		0.197		0.189		0.188	95
94																																						94
93																																						93
92																																						92
91		0.188		0.184		0.189		0.196		0.193		0.194		0.192		0.195		0.196		0.195		0.197		0.196		0.199		0.193		0.195		0.198		0.196		0.191		91
90																																						90
89																																						89
88																																						88
87	0.183		0.194		0.183		0.183		0.180		0.186		0.185		0.183		0.191		0.185		0.185		0.182		0.188		0.185		0.193		0.950		0.192		0.183		0.187	87
86																																						86
85																																						85
84																																						84
83		0.170		0.174		0.178		0.181		0.179		0.180		0.178		0.175		0.180		0.177		0.178		0.179		0.180		0.177		0.180		0.176		0.178		0.177		83
82																																						82
81																																						81
80																																						80
79	0.177		0.179		0.180		0.178		0.182		0.184		0.175		0.176		0.168		0.170		0.177		0.175		0.179		0.177		0.180		0.179		0.175		0.169		0.163	79
78																																						78
77																																						77
76																																						76
75		0.189		0.189		0.200		0.204		0.196		0.199		0.200		0.199		0.201		0.198		0.197		0.186		0.188		0.186		0.182		0.180		0.178		0.176		75
74																																						74
73																																						73
72																																						72
71	0.198		0.200		0.200		0.203		0.209		0.199		0.204		0.202		0.196		0.196		0.194		0.192		0.190		0.191		0.193		0.188		0.187		0.183		0.179	71
70																																						70
69																																						69
68																																						68
67																																						67
66																																						66
65'6																																						65'6
65																																						65

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Nova Scotia Power Incorporated
Trenton Unit # 5
Section: South Waterwall
Visual and UT Assessment

Tube Numbers

Date: April/2010

ELEV.	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	ELEV.
132'6"																																						132'6"
132																																						132
131'6"																																						131'6"
131																																						131
130'6"																																						130'6"
130																																						130
129'6"																																						129'6"
129																																						129
128'6"																																						128'6"
128																																						128
127'6																																						127'6
127																																						127
126																																						126
125																																						125
124																																						124
123		0.209		0.209		0.211		0.207		0.209		0.207		0.209		0.207		0.208		0.211		0.213		0.211		0.212		0.210		0.214		0.208		0.209				123
122'6"																																						122'6"
122																																						122
121'6"																																						121'6"
121					2008	Panel	T 113-126																2008	Panel	T 131-144													121
120'6"					Elev	115'-0"	126'-0"																Elev	115'-0"	126'-0"													120'6"
120																																						120
119'6"																																						119'6"
119																																						119
118'6"																																						118'6"
118																																						118
117'6"																																						117'6"
117																																						117
116																																						116
115	0.201	0.206	0.208	0.211	0.211	0.209	0.211	0.214	0.207	0.211	0.213	0.206	0.213	0.208	0.211		0.211		0.200		0.215		0.214		0.221		0.218		0.221		0.202		0.218		0.215			115
114																																						114
113																																						113
112'6"																																						112'6"
112																																						112
111'6"																																						111'6"
111																																						111
110'6"																																						110'6"
110																																						110
109'6"																																						109'6"
109																																						109
108'6"																																						108'6"
108																																						108
107'6"																																						107'6"
107		0.202		0.203		0.202		0.204		0.202		0.200		0.204		0.204		0.204		0.203		0.211		0.213	0.208		0.210		0.209		0.208		0.211					107
106																																						106
105																																						105
104																																						104
103																																						103
102																																						102
101																																						101
100																																						100
99	0.196		0.197		0.190		0.196		0.189		0.192		0.192		0.190		0.196		0.193		0.190		0.191		0.198		0.198		0.199		0.199		0.200		0.202			99
98																																						98
97																																						97
96																																						96
95		0.191		0.194		0.195		0.195		0.192		0.198		0.196		0.194		0.190		0.204		0.197		0.200		0.205		0.202		0.200		0.201		0.204				95
94																																						94
93																																						93
92																																						92
91	0.182		0.180		0.187		0.190		0.189		0.187		0.191		0.190		0.183		0.182		0.188		0.184		0.193		0.190		0.189		0.201		0.200		0.205			91
90																																						90
89																																						89
88																																						88
87		0.180		0.183		0.189		0.180		0.175		0.174		0.173		0.179		0.188		0.174		0.189		0.182		0.184		0.179		0.184		0.191		0.200				87
86																																						86
85																																						85
84																																						84
83	0.175		0.169		0.171		0.170		0.176		0.167		0.171		0.173		0.178		0.172		0.181		0.178		0.178		0.178		0.176		0.185		0.182		0.184			83
82																																						82
81																																						81
80																																						80
79		0.169		0.169		0.173		0.170		0.171		0.176		0.175		0.173		0.172		0.170		0.171		0.168		0.176		0.179		0.173		0.179		0.182				79
78																																						78
77																																						77
76																																						76
75	0.173		0.177		0.170		0.172		0.177		0.175		0.179		0.175		0.171		0.179		0.173		0.173		0.178		0.179		0.179		0.176		0.189		0.198			75
74																																						74
73																																						73
72																																						72
71		0.185		0.176		0.183		0.184		0.186		0.180		0.189		0.188		0.187		0.187		0.176		0.163		0.176		0.179		0.173		0.190		0.207				71
70																																						70
69																																						69
68																																						68
67																																						67
66																																						66
65'6																																						65'6
65																																						65

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Nova Scotia Power Incorporated
Trenton Unit # 6
Section: West Waterwall
Visual and UT Assessment

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Tube Numbers

ELEV.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	ELEV.
132'6"																																						132'6"
132																									EP .191	EP .200	EP .201	EP .198	EP .197	EP .201								132
131'6"																																						131'6"
131																							EP .181	EP .183	EP .192	EP .203	EP .209	EP .212	EP .209	EP .207								131
130'6"																							0.179	0.187	EP .164	EP .169	EP	EP	EP	EP								130'6"
130																				IR 36	IR 36		EP .168	EP .174	EP .166	EP .191	EP .152	EP	EP	EP								130
129'6"																									EP	EP	EP	EP	EP	EP								129'6"
129																0.200		0.209		0.209		0.211		0.210	EP	EP .185	EP	EP.181	EP	EP .186		0.163		0.168		0.194		129
128'6"																																						128'6"
128																									EP .189	EP .191	EP .186	EP .185	EP .189	EP .197	0.156	0.159	0.161					128
127'6																																						127'6
127																																						127
126																																						126
125																																						125
124																																						124
123																																						123
122'6"																																						122'6"
122																																						122
121'6"																																						121'6"
121		0.220		0.216		0.219		0.218		0.214		0.216		0.210		0.207		0.205		0.199		0.211		0.214		0.208		0.204		0.211		0.215		0.205		0.209		121
120'6"																																						120'6"
120																																						120
119'6"																																						119'6"
119																																						119
118'6"																																						118'6"
118																																						118
117'6"																																						117'6"
117																																						117
116																																						116
115																																						115
114																																						114
113	10" EP.111	0.214		0.216		0.214		0.215		0.198		0.193		0.193		0.148		0.210		0.210		0.208		0.216		0.200		0.193		0.200		0.209		0.204		0.205		113
112'6"	12" Pad																																					112'6"
112										0.141	0.144	0.141	0.140	0.145	0.152	0.144	0.155	0.189									0.171	0.159	0.167									112
111'6"																											12" Pad			0.146								111'6"
111										.131 36" Pad	EP	EP	.138 8" Pad	EP	EP	EP	EP	EP					0.144	0.176	0.160	0.160	EP .136	0.144	0.146	0.137	0.151							111
110'6"											EP	EP	EP	EP	EP		EP .151	.132 12" Pad		0.196	0.193		0.110	EP	EP .186	EP.099 10" Pad	EP	.136 8" Pad	0.144	.127 16" Pad								110'6"
110											.124 14" Pad	EP	0.140	EP	EP	EP.132 15" Pad	EP	EP	0.210	IR 8	IR 8	0.205	30" Pad	EP .169	EP	EP	EP	EP	.127 12" Pad	0.132	.132 10" Pad	0.145	0.140					110
109'6"	.111 24" Pad											EP		EP	EP	EP	EP	EP		0.200	0.208		0.115	EP	EP.109 22" Pad	EP	EP .181	EP .180	EP	EP .145	EP .154							109'6"
109												0.177		0.157	0.146	0.158	0.181	0.154					0.197	.131 8" Pad		.118 12" Pad	EP .135	.118 8" Pad	EP		EP	.124 6" Pad						109
108'6"																											10" Pad											108'6"
108																											EP		.123 12" Pad	.136 6" Pad	EP .125	.132 6" Pad	.132 18" Pad					108
107'6"																															6" Pad							107'6"
107																																						107
106																																						106
105	0.214		0.217		0.216		0.212		0.215		0.218		0.213		0.210		0.209		0.211		0.209		0.209		0.207		0.207		0.206		0.209		0.208		0.207		0.207	105
104																																						104
103																																						103
102																																						102
101																																						101
100																																						100
99																																						99
98																																						98
97		0.202		0.204		0.200		0.196		0.193		0.194		0.186		0.184		0.191		0.192		0.186		0.191		0.188		0.185		0.197		0.200		0.189		0.190		97
96																																						96
95																																						95
94																																						94
93																																						93
92																																						92
91																																						91
90																																						90
89	0.204		0.202		0.196		0.188		0.190		0.184		0.180		0.179		0.180		0.175		0.179		0.175		0.176		0.178		0.175		0.173		0.166		0.178		0.173	89
88																																						88
87																																						87
86																																						86
85																																						85
84																																						84
83																																						83
82																																						82
81		0.203		0.203		0.196		0.190		0.177		0.171		0.173		0.168		0.179		0.177		0.176		0.179		0.162		0.169		0.179		0.172		0.176		0.176		81
80																																						80
79																																						79
78																																						78
77																																						77
76																																						76
75																																						75
74																																						74
73	0.217		0.202		0.196		0.192		0.183		0.175		0.185		0.186		0.176		**0.177**		0.176		0.172		0.162		0.168		0.180		0.170		0.170		0.168		0.172	73
72																																						72
71																																						71
70																																						70
69																																						69
68																																						68
67																																						67
66																																						66
65'6																																						65'6
65		0.192		0.203		0.201		0.203		0.200		0.189		0.203		0.193		0.201		0.200		0.204		0.196		0.185		0.187		0.196		0.192		0.193		0.192		65

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Nova Scotia Power Incorporated
Trenton Unit # 6
Section: West Waterwall
Visual and UT Assessment

Tube Numbers

ELEV.	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	ELEV.
132'6"																																						132'6"
132																																						132
131'6"																																						131'6"
131																																						131
130'6"																																						130'6"
130																																						130
129'6"																																						129'6"
129	0.211		0.209		0.218		0.211		0.216		0.215		0.215		0.218		0.212		0.214		0.213		0.211		0.212		0.214		0.215		0.216		0.210		0.215		0.211	129
128'6"																																						128'6"
128																																						128
127'6																																						127'6
127																																						127
126																																						126
125																																						125
124																																						124
123																																			Pad			123
122'6"																																			51"			122'6"
122											0.175	0.172	0.174	0.160		0.143	0.147		Pad																0.135			122
121'6"																			25" Pad																			121'6"
121	0.211		0.205		0.200		0.179		0.157		0.146	0.144	0.144	EP .125	0.149	0.145	EP .144		0.126		0.211		0.203		EP	EP .191	EP	EP .173	EP	EP .145	0.146	0.160		0.159	0.133			121
120'6"									0.156	0.161	0.147	0.141	0.148	EP	.128 Pad	EP .125	0.155	EP .144	0.138	0.177		0.205	0.200	EP .194	EP .186	EP .167	EP	EP .135	EP	EP .117 8" Pad	0.144	0.161			0.128			120'6"
120														.130 Pad	.135 2"	.128 Pad	.125 17" Pad	EP .129	0.135	0.169	0.163	IR 23	IR 23	EP .195	EP	EP	EP .163	EP Pad	EP	EP .130		.126 8" Pad			0.130			120
119'6"														.138 18"	0.149	.138 10" [ad	0.142	EP .135 16" Pad	0.143	0.168		0.196	0.195	EP .191	EP	EP	EP	EP .128 31"	EP	EP	EP.120 16" Pad	0.144	0.161	0.151	0.133			119'6"
119														0.151	0.151			0.155							EP .211	EP .182	EP .152	EP .151	EP	EP	EP .166		0.160	0.145	0.144			119
118'6"																																						118'6"
118																													EP .166	EP .161								118
117'6"																																						117'6"
117																																						117
116																																						116
115																																						115
114																																						114
113	0.208		0.211		0.209		0.207		0.214		0.212		0.210		0.208		0.213		0.211		0.213		0.205		0.211		0.209		0.208		0.209		0.200		0.209		0.206	113
112'6"																																						112'6"
112																																						112
111'6"																																						111'6"
111																																						111
110'6"																																						110'6"
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109'6"																																						109'6"
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108'6"																																						108'6"
108																																						108
107'6"																																						107'6"
107																																						107
106																																						106
105		0.202		0.208		0.210		0.209		0.197		0.208		0.207		0.200		0.204		0.202		0.206		0.203		0.200		0.205		0.203		0.204		0.207		0.209		105
104																																						104
103																																						103
102																																						102
101																																						101
100																																						100
99																																						99
98																																						98
97	0.189		0.185		0.191		0.195		0.196		0.195		0.194		0.196		0.196		0.196		0.188		0.191		0.195		0.191		0.197		0.200		0.192		0.197		0.199	97
96																																						96
95																																						95
94																																						94
93																																						93
92																																						92
91																																						91
90																																						90
89		0.170		0.185		0.184		0.181		0.176		0.185		0.188		0.173		0.181		0.171		0.181		0.164		0.176		0.165		0.170		0.166		0.163		0.160		89
88																																						88
87																																						87
86																																						86
85																																						85
84																																						84
83																																						83
82																																						82
81	0.179		0.178		0.179		0.171		0.169		0.159		0.158		0.138		0.151		0.154		0.131		0.130		0.147		0.140		0.139		0.150		0.154		0.161		0.160	81
80																																						80
79																																						79
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75																																						75
74																																						74
73		0.171		0.178		0.173		0.173		0.171		0.183		0.175		0.161		0.164		0.185		0.185		0.197		0.189		0.172		0.187		0.191		0.195		0.194		73
72																																						72
71																																						71
70																																						70
69																																						69
68																																						68
67																																						67
66																																						66
65'6																																						65'6
65	0.197		0.199		0.198		0.199		0.204		0.203		0.207		0.205		0.198		0.206		0.211		0.208		0.211		0.213		0.211		0.216		0.216		0.207		0.212	65

ALSTOM

Nova Scotia Power Incorporated
Trenton Unit # 6
Section: West Waterwall
Visual and UT Assessment

Tube Numbers

Date: April/2010
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ELEV.	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	108	110	111	ELEV.
132'6"																																						132'6"
132																	0.148	0.145	EP .151	EP .155	0.162	0.144																132
131'6"																																						131'6"
131															0.188	0.157	.136 15" Pad	EP .126 Pad	EP	EP	EP	.132 4" Pad	EP .196	EP .196									0.165					131
130'6"														0.187		0.156		.130 16"	EP	EP	EP .127	EP	.129 12" Pad	EP	0.188	0.194		.131 10" Pad	.133 20" Pad	0.134	0.148	0.156						130'6"
130																		0.152	EP .141	.138 6" Pad	EP	EP	EP .131	EP .187	IR 38	IR 38	0.208	0.142	0.131	0.130	0.142	0.147		0.162				130
129'6"																0.179					EP Pad	EP	EP .142		0.199	0.198				EP Pad		EP		0.148				129'6"
129	0.208		0.210		0.218		0.207		0.209		0.211		0.213		0.210		0.214	0.175	0.163	0.169	.129 16"	EP .170	0.160		0.209		0.206		0.212	.103 17"		0.148	0.146	0.165	0.162	0.179	0.184	129
128'6"																															.132 10"							128'6"
128																		0.190			0.153									0.161								128
127'6																																						127'6
127																																						127
126																																						126
125																																						125
124																																						124
123																																						123
122'6"																																						122'6"
122	Pad																																					122
121'6"	26"																																					121'6"
121	0.171		0.215		0.215		0.208		0.207		0.213		0.215		0.215		0.212		0.218		0.214		0.210		0.208		0.215		0.222		0.218		0.218		0.216		0.202	121
120'6"	0.134																																					120'6"
120	0.101																																					120
119'6"	0.119																																					119'6"
119	0.186																																					119
118'6"																																						118'6"
118																																						118
117'6"																																						117'6"
117																																						117
116																																						116
115																																						115
114																																						114
113		0.206		0.212		0.208		0.208		0.215		0.206		0.208		0.184		0.181		0.164		0.193		0.211		0.212		0.206		0.210		0.217		0.211		0.208		113
112'6"																																						112'6"
112																0.165	0.153		0.153	0.156	0.162	0.172	0.158															112
111'6"																																						111'6"
111																.133 28" Pad	0.141	.136 22" Pad	EP	EP .161	EP	EP .127 8" Pad	EP	EP .156					EP .165	EP .171	EP .164							111
110'6"																			EP	EP	0.151	EP	EP .142	EP	0.188	0.192	EP .188	EP .158	EP	EP	EP							110'6"
110																			EP	EP	EP	EP	EP	EP .152	**IR 10**	**IR 10**	EP .202	EP .155	EP	EP	EP	EP .142						110
109'6"																			EP	EP	EP	EP	EP	EP .159	0.192	0.190	EP .189	0.142	EP .152	EP .165	EP .152	EP .157						109'6"
109																			0.150	.132 10" Pad	.133 10" Pad	EP .175	EP .144						EP				.136 20" Pad	0.147	.132 26" Pad			109
108'6"																																						108'6"
108																													EP .173	.127 8" Pad	EP .178	EP.138 10" Pad						108
107'6"																																						107'6"
107																																						107
106																																						106
105	0.205		0.208		0.215		0.212		0.204		0.210		0.210		0.211		0.213		0.212		0.207		0.204		0.211		0.202		0.212		0.215		0.211		0.207		0.215	105
104																																						104
103																																						103
102																																						102
101																																						101
100																																						100
99																																						99
98																																						98
97		0.199		0.196		0.204		0.202		0.207		0.205		0.207		0.210		0.210		0.212		0.208		0.211		0.209		0.206		0.200		0.214		0.217		0.212		97
96																																						96
95																																						95
94																																						94
93																																						93
92																																						92
91																																						91
90																																						90
89	0.165		0.163		0.184		0.181		0.177		0.146		EP		EP		0.134		0.179		0.189		0.191		0.187		0.189		0.191		0.194		0.204		0.197		0.189	89
88																																						88
87																																						87
86																																						86
85																																						85
84																																						84
83																																						83
82																																						82
81		0.207		0.205		0.207		0.211		0.213		0.206		0.209		0.209		0.210		0.207		0.206		0.212		0.211		0.206		0.204		0.202		0.194		0.204		81
80																																						80
79																																						79
78																																						78
77																																						77
76																																						76
75																																						75
74																																						74
73	0.199		0.197		0.196		0.183		0.188		0.190		0.197		0.209		0.206		0.210		0.209		0.209		0.216		0.212		0.207		0.212		0.215		0.212		0.210	73
72																																						72
71																																						71
70																																						70
69																																						69
68																																						68
67																																						67
66																																						66
65'6																																						65'6
65		0.212		0.205		0.208		0.213		0.203		0.212		0.214		0.207		0.215		0.215		0.214		0.212		0.213		0.215		0.211		0.216		0.213		0.214		65

ALSTOM

Date: April/2010
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Nova Scotia Power Incorporated
Trenton Unit # 5
Section: West Waterwall
Visual and UT Assessment

Tube Numbers

ELEV.	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	ELEV.
132'6"																																						132'6"
132																																						132
131'6"																																						131'6"
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130'6"																																						130'6"
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125																																						125
124																																						124
123																																						123
122'6"																																						122'6"
122																																						122
121'6"																																						121'6"
121		0.219		0.221		0.215		0.210																														121
120'6"																																						120'6"
120																																						120
119'6"																																						119'6"
119																																						119
118'6"																																						118'6"
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117'6"																																						117'6"
117																																						117
116																																						116
115																																						115
114																																						114
113	0.217		0.217		0.214		0.308																															113
112'6"																																						112'6"
112																																						112
111'6"																																						111'6"
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110'6"																																						110'6"
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108'6"																																						108'6"
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107'6"																																						107'6"
107																																						107
106																																						106
105		0.218		0.210		0.215		0.211																														105
104																																						104
103																																						103
102																																						102
101																																						101
100																																						100
99																																						99
98																																						98
97	0.212		0.210		0.206		0.207																															97
96																																						96
95																																						95
94																																						94
93																																						93
92																																						92
91																																						91
90																																						90
89		0.198		0.210		0.209		0.214																														89
88																																						88
87																																						87
86																																						86
85																																						85
84																																						84
83																																						83
82																																						82
81	0.218		0.216		0.215		0.214																															81
80																																						80
79																																						79
78																																						78
77																																						77
76																																						76
75																																						75
74																																						74
73		0.216		0.203		0.205		0.201																														73
72																																						72
71																																						71
70																																						70
69																																						69
68																																						68
67																																						67
66																																						66
65'6																																						65'6
65	0.212		0.213		0.210		0.211																															65

CI Number: **41511**

Title: **TRE6 - Condenser Waterbox and Cooling Water (CW) Piping Refurbishment**

Start Date: 2013/05
Final Cost Date: 2014/02
Function: Generation
Forecast Amount: $394,545

DESCRIPTION:

The Trenton Unit 6 condenser and cooling water (CW) piping were installed in 1991 and are original equipment to the plant. The function of this condenser is to provide the greatest vacuum possible to the turbine exhaust in order to achieve the most generating capacity possible from the steam and increase efficiency of the unit. Once the steam from the turbine enters the condenser, it flows around the outside of the condenser tubes and condenses when cooled by river water which flowing through the inside of the condenser tubes. The cooling water enters the plant through two large CW pumps, and then flows through large-diameter pipes into the waterboxes of the condenser. After passing through the tubes in the waterbox of the condenser, the water is piped back to the river.

This project includes re-lining of the four condenser waterboxes and the refurbishment of the CW discharge piping. Refurbishment of the CW piping will include replacement of some sections of pipe as well as extending the life of some existing sections through applying a protective coating to the inside of the piping.

Summary of Related CIs +/- 2 years
2011 CI 41514 TRE6 Condenser Actuator Replacement - $250,593

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

The CW piping and the waterboxes are made of carbon steel, and experience normal wear and corrosion over time due to contact with turbulent brackish river water. These components are lined with a coating in order to protect the steel from premature corrosion. The interior surfaces of the waterboxes are lined with neoprene and the CW piping is lined with an epoxy coating. Due to normal wear over time, these linings have deteriorated, and evidence of degradation in the CW piping and waterboxes is now evident.

The condition of the pipes is such that multiple leaks have been recently experienced, resulting in short unplanned outages to complete temporary repairs. In the case of the condenser waterbox, the neoprene lining has started to separate from the interior surfaces of the waterbox, resulting in large pieces of lining covering the condenser tubesheets. This impedes the flow of cooling water through the condenser, which results in de-rating of the Unit and lower efficiency.

Completing this project will extend the life of the existing waterboxes and CW piping, and mitigate the risk of un-planned outages and associated replacement energy costs.

Why do this project now?

The 2013 outage is of sufficient duration to complete this work, and the next scheduled outage of sufficient duration to complete this work is not until 2014. As the piping has recently experienced leaks and the neoprene coating has started to separate from the interior surfaces of the waterboxes, this work must be completed now to mitigate the risk of further deterioration and unplanned unit outages.

Why do this project this way?

Removal of the remaining neoprene lining and replacing it with an epoxy coating will protect the waterboxes from further degradation. Replacement and repair of the CW piping combined with upgrading the internal and external coatings will ensure the reliability of the system. Refurbishing the waterboxes and CW piping is the most cost-effective option.

CI Number : 41511 - TRE6 - Condenser Waterbox and Cooling Water (CW) Piping Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 345 - 345-Trenton unit 6 Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		5,091	0	5,091
095		095-Thermal Regular Labour AO		8,108	0	8,108
095		095-Thermal Overtime Labour AO		862	0	862
095		095-Thermal Term Labour AO		1,373	0	1,373
095		095-Thermal & Hydro Contracts AO		26,592	0	26,592
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	27,120	0	27,120
002	014	002 - THERMAL Overtime Labour	014 - SGP - Circ.Water Sys.	6,480	0	6,480
004	014	004 - THERMAL Term Labour	014 - SGP - Circ.Water Sys.	5,160	0	5,160
012	014	012 - Materials	014 - SGP - Circ.Water Sys.	101,000	0	101,000
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	200,000	0	200,000
001	085	001 - THERMAL Regular Labour	085 Design	3,360	0	3,360
028	085	028 - Consulting	085 Design	0	0	0
011	087	011 - Travel Expense	087 Field Super.& Ops.	500	0	500
013	087	013 - POWER PRODUCTION Contracts	087 Field Super.& Ops.	8,400	0	8,400
021	087	021 - Telephones	087 Field Super.& Ops.	250	0	250
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	250	0	250
			Total Cost:	394,545	0	394,545
			Original Cost:	200,000		

TRE6 Condenser Waterbox and CW Piping Refurbishment
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Trenton Generating Station	**CI Number:**	41511
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish	6.48%	1,898,460	1	41.42%	4.1 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

It is recommended to perform the condenser waterbox and piping refurbishment work. This is supported by favorable economic analysis.

Notes/Comments :

Refurbish

If the refurbishment is not completed, there is a possibility that the waterbox and/or piping will fail, resulting in an unplanned unit outage to perform temporary repairs. Average time to complete repairs is 3-5 days (96 hours was used for this analysis).

Test 2

No other valid options were identified.

Test 3

Test 4

TRE6 Condenser Waterbox and CW Piping Refurbishment
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Trenton Generating Station	CI Number:	41511
Originator :		Project No. :	

Refurbish

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$13,200	$13,464		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	40%	50%	40%	50%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	160	160				
Duration (Hours)	96	96				
Totals	$80,486	$96,154	$5,280	$6,732	$85,766	$102,886
Total Capital Cost of Alternative						$394,545

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

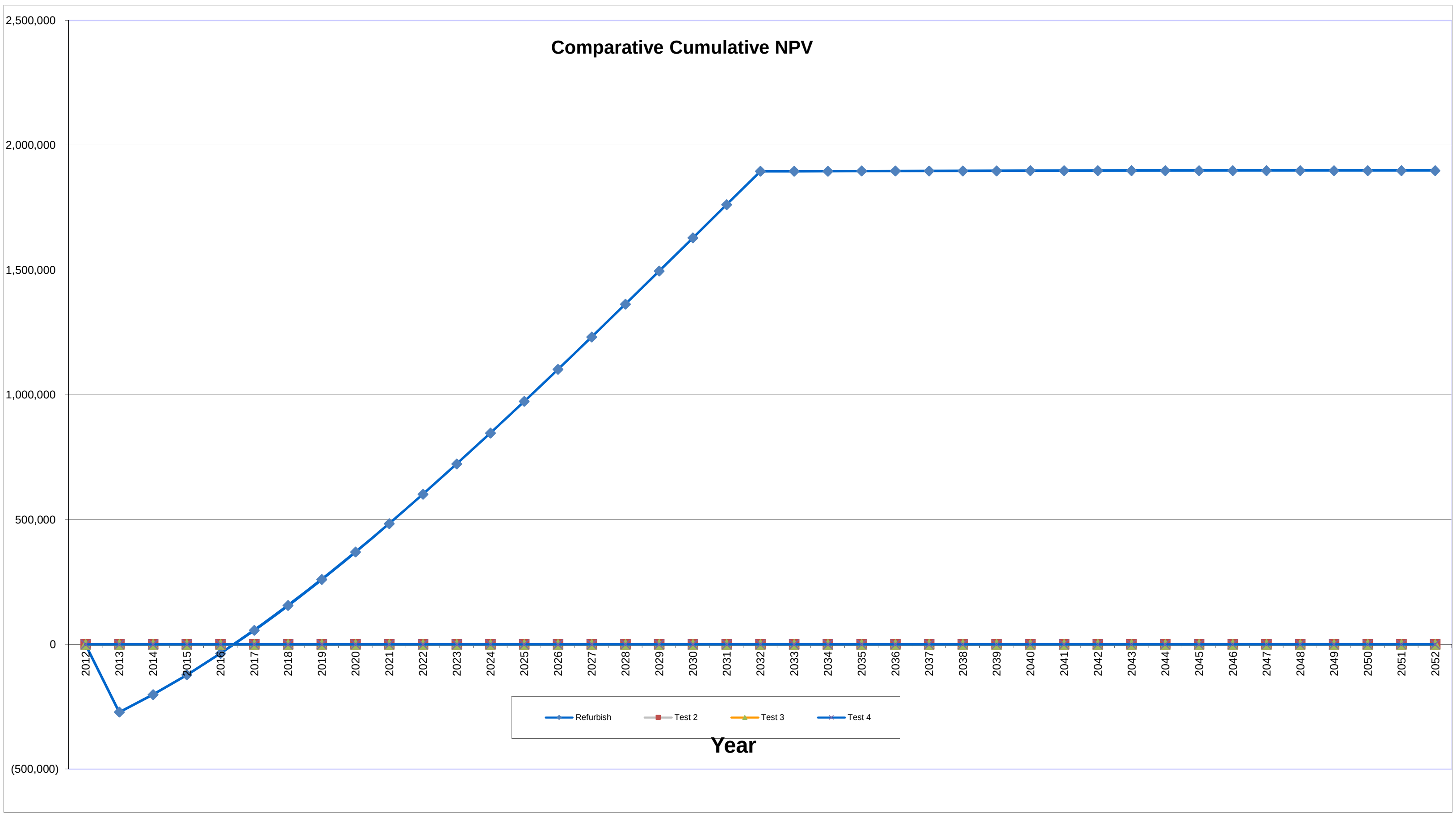
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

TRE6 Condenser Waterbox and CW Piping Refurbishment
Refurbish

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	85,766.4	(352,520.0)	14,544.0	349,056.2	(266,753.6)	(22,078.9)	(288,832.5)	(271,255.205)	0.9	(271,255.2)
2014	-	102,885.6	-	27,924.5	321,131.7	102,885.6	(23,237.9)	79,647.7	70,248.478	0.9	(201,006.7)
2015	-	125,932.0	-	25,690.5	295,441.1	125,932.0	(31,074.8)	94,857.1	78,571.645	0.8	(122,435.1)
2016	-	149,859.0	-	23,635.3	271,805.9	149,859.0	(39,129.4)	110,729.7	86,137.427	0.8	(36,297.7)
2017	-	174,692.8	-	21,744.5	250,061.4	174,692.8	(47,414.0)	127,278.8	92,985.665	0.7	56,688.0
2018	-	200,460.0	-	20,004.9	230,056.5	200,460.0	(55,941.1)	144,518.9	99,155.433	0.7	155,843.4
2019	-	227,188.0	-	18,404.5	211,652.0	227,188.0	(64,722.9)	162,465.1	104,684.865	0.6	260,528.3
2020	-	254,905.0	-	16,932.2	194,719.8	254,905.0	(73,771.6)	181,133.4	109,611.014	0.6	370,139.3
2021	-	283,639.7	-	15,577.6	179,142.2	283,639.7	(83,099.3)	200,540.5	113,969.754	0.6	484,109.1
2022	-	313,421.9	-	14,331.4	164,810.8	313,421.9	(92,718.1)	220,703.8	117,795.700	0.5	601,904.8
2023	-	344,281.9	-	13,184.9	151,626.0	344,281.9	(102,640.1)	241,641.8	121,122.161	0.5	723,026.9
2024	-	376,250.9	-	12,130.1	139,495.9	376,250.9	(112,877.5)	263,373.5	123,981.103	0.5	847,008.0
2025	-	409,361.0	-	11,159.7	128,336.2	409,361.0	(123,442.4)	285,918.6	126,403.132	0.4	973,411.2
2026	-	443,645.0	-	10,266.9	118,069.3	443,645.0	(134,347.2)	309,297.8	128,417.497	0.4	1,101,828.7
2027	-	479,136.6	-	9,445.5	108,623.8	479,136.6	(145,604.2)	333,532.4	130,052.091	0.4	1,231,880.8
2028	-	515,870.4	-	8,689.9	99,933.9	515,870.4	(157,225.9)	358,644.4	131,333.469	0.4	1,363,214.2
2029	-	553,881.9	-	7,994.7	91,939.2	553,881.9	(169,225.0)	384,656.9	132,286.876	0.3	1,495,501.1
2030	-	593,207.5	-	7,355.1	84,584.0	593,207.5	(181,614.2)	411,593.3	132,936.272	0.3	1,628,437.4
2031	-	633,884.6	-	6,766.7	77,817.3	633,884.6	(194,406.5)	439,478.0	133,304.368	0.3	1,761,741.7
2032	-	675,951.5	-	6,225.4	71,591.9	675,951.5	(207,615.1)	468,336.4	133,412.662	0.3	1,895,154.4
2033	-	-	-	5,727.4	65,864.6	-	1,775.5	1,775.5	474.993	0.3	1,895,629.4
2034	-	-	-	5,269.2	60,595.4	-	1,633.4	1,633.4	410.399	0.3	1,896,039.8
2035	-	-	-	4,847.6	55,747.8	-	1,502.8	1,502.8	354.590	0.2	1,896,394.4
2036	-	-	-	4,459.8	51,288.0	-	1,382.5	1,382.5	306.370	0.2	1,896,700.8
2037	-	-	-	4,103.0	47,184.9	-	1,271.9	1,271.9	264.707	0.2	1,896,965.5
2038	-	-	-	3,774.8	43,410.1	-	1,170.2	1,170.2	228.710	0.2	1,897,194.2
2039	-	-	-	3,472.8	39,937.3	-	1,076.6	1,076.6	197.608	0.2	1,897,391.8
2040	-	-	-	3,195.0	36,742.3	-	990.4	990.4	170.736	0.2	1,897,562.5
2041	-	-	-	2,939.4	33,802.9	-	911.2	911.2	147.518	0.2	1,897,710.0
2042	-	-	-	2,704.2	31,098.7	-	838.3	838.3	127.457	0.2	1,897,837.5
2043	-	-	-	2,487.9	28,610.8	-	771.2	771.2	110.125	0.1	1,897,947.6
2044	-	-	-	2,288.9	26,321.9	-	709.5	709.5	95.149	0.1	1,898,042.8
2045	-	-	-	2,105.8	24,216.2	-	652.8	652.8	82.210	0.1	1,898,125.0
2046	-	-	-	1,937.3	22,278.9	-	600.6	600.6	71.030	0.1	1,898,196.0
2047	-	-	-	1,782.3	20,496.6	-	552.5	552.5	61.371	0.1	1,898,257.4
2048	-	-	-	1,639.7	18,856.9	-	508.3	508.3	53.025	0.1	1,898,310.4
2049	-	-	-	1,508.5	17,348.3	-	467.7	467.7	45.815	0.1	1,898,356.2
2050	-	-	-	1,387.9	15,960.4	-	430.2	430.2	39.584	0.1	1,898,395.8
2051	-	-	-	1,276.8	14,683.6	-	395.8	395.8	34.201	0.1	1,898,430.0
2052	-	-	-	1,174.7	13,508.9	-	364.2	364.2	29.550	0.1	1,898,459.6
Total	-	6,944,221.7	(352,520.0)	350,091.3	4,207,849.5	6,591,701.7	(2,044,180.4)	4,547,521.2	1,898,459.6		



Comparative Cumulative NPV
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Refurbish
Test 2
Test 3
Test 4
Year

Location: Trenton Generating Station
CI# / FP#: 41511
Title: TRE6 Condenser Waterbox and Piping Reline
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Reg Mech - Repair Waterbox Doors	hr	[redacted]		$ 7,740.00		34062
1.2	Reg Mech - Disassemble/reassemble valve/pipe	hr	[redacted]		$ 12,900.00		34062
1.3	Reg Utility - Manwatch	hr	[redacted]		$ 6,480.00		34062
1.4	Internal Engineering	hr	[redacted]		$ 3,360.00		
1.5					$ -		
				Sub-Total	$ 30,480.00		
2	**002 Overtime Labour**						
2.1	OT Uitlity - Manwatch	hr	[redacted]		$ 6,480.00		34062
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 6,480.00		
3	**004 Term Labour**						
3.1	Term Mech	hr	[redacted]		$ 5,160.00		34062
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 5,160.00		
4	**012 Materials**						
4.1	Epoxy Coating Waterboxes Material	lot	1	[redacted]		Cost Support 1 (exchange assumed to be 1.0, risk accounted for in line 4.3)	34062
4.2	Replacement Gaskets	lot	1	[redacted]			
4.3	Contingency	lot	1	[redacted]			
4.4					$ -		
				Sub-Total	$ 101,000.00		
5	**013 Power Production Contracts**						
5.1	External Supervision	hr	[redacted]				
5.2	Remove Existing Neoprene	lot	1	[redacted]		Cost Support 1 (exchange assumed to be 1.0, risk accounted for in line 5.7)	34062
5.3	Recoat Waterboxes	lot	1	[redacted]		Cost Support 1 (exchange assumed to be 1.0, risk accounted for in line 5.7)	34062
5.4	Recoat Pipes	lot	1	[redacted]			34062
5.5	Pipe Repairs	lot	1	[redacted]			34062
5.6	Waste Removal	lot	1	[redacted]			
5.7	Contingency	lot	1	[redacted]			
5.8					$ -		
				Sub-Total	$ 208,400.00		
6	**011 Travel**						
6.1	Travel	lot	1	$ 500.00	$ 500.00		
				Sub-Total	$ 500.00		
7	**021 Telephones**						
7.1	Phones	lot	1	$ 250.00	$ 250.00		
				Sub-Total	$ 250.00		
8	**041 Meals and Entertainment**						
8.1	Meals	lot	1	$ 250.00	$ 250.00		
				Sub-Total	$ 250.00		
9	**094 Interest Capitalized**						
9.1	AFUDC	lot	1	$ 5,090.96	$ 5,090.96		
				Sub-Total	$ 5,090.96		
10	**095 Administrative Overhead**						
10.1	Thermal Regular Labour AO	lot	1	$ 8,107.68	$ 8,107.68		
10.2	Thermal Overtime Labour AO	lot	1	$ 861.84	$ 861.84		
10.3	Thermal & Hydro Contracts AO	lot	1	$ 26,591.84	$ 26,591.84		
10.4	Thremal Term Labour AO	lot	1	$ 1,372.56	$ 1,372.56		
				Sub-Total	$ 36,933.92		
Cost Estimate				Total	$ 394,544.88		
11	**Original Cost**						
11.1	Retirement			YR: 1991	$ 200,000.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project.

Attachment 1

Removed due to confidentiality

CI Number: **42978**

Title: **TUC – Circulating Water (CW) Piping Refurbishment**

Start Date: 2013/04
Final Cost Date: 2014/03
Function: Generation
Forecast Amount: $387,840

DESCRIPTION:

The Circulating Water (CW) piping system is critical to plant operation, and the development of leaks can put any of the units at risk for a forced outage. The CW piping system brings seawater from the harbour to the condenser at each unit, lube oil coolers, generator seal oil coolers, distilled water coolers, general service cooling water heat exchangers and vacuum pump coolers, etc.

This project will refurbish several CW piping sections, primarily in the area of Unit 2, to extend the life of the piping and reduce the risk of forced unit outages resulting from leaks in this system. The scope of refurbishment includes pad-welding deteriorated segments of the pipeline, sandblasting piping exterior surface, and applying protective coating to prevent further corrosion.

Summary of Related CIs +/- 2 years:
2012 - 41236 TUC - Cooling Water (CW) Piping Refurbishment $197,626

JUSTIFICATION:

Justification Criteria: Thermal
Sub Criteria: Maintenance

Why do this project?

Several CW piping sections have degraded to the point of requiring refurbishment due to exposure to a harsh operating environment over 30 years. Refurbishment is required to extend the life and reduce the risk of forced unit outages resulting from further deterioration.

Why do this project now?

Failure to address this issue now will increase the risk of forced outages and lead to more extensive and costly repair in the future.

Why do this project this way?

Refurbishment is a more economical approach than allowing further deterioration and completely replacing the piping over extended outages.

CI Number : 42978 - TUC - CW Piping Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 311 - 311-Tufts Cove Admin./Common Capita **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
001		001 - THERMAL Regular Labour		43,760	0	43,760
002		002 - THERMAL Overtime Labour		15,480	0	15,480
012		012 - Materials		158,000	0	158,000
013		013 - POWER PRODUCTION Contracts		135,000	0	135,000
094		094 - Interest Capitalized		4,675	0	4,675
095		095-Thermal Regular Labour AO		11,640	0	11,640
095		095-Thermal Overtime Labour AO		2,059	0	2,059
095		095-Thermal & Hydro Contracts AO		17,226	0	17,226
			Total Cost:	387,840	0	387,840
			Original Cost:	99,913		

42978 - TUC Circulating Water Piping Refurbishment
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :	Power Production		**Date :**	**10-Sep-12**
Department :	Tufts Cove Generating Station		**CI Number:**	42978
Originator :				

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbishment	6.48%	4,719,118	1	80.50%	2.6 years
B	Replacement	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

It is recommended to proceed with the refurbishment.

Notes/Comments :

Refurbishment

If the piping is left unrefurbished, given the current deteriorated condition of the piping, there is significant risk of forced unit outages resulting from the development of leaks, and repair cost would increase due to further deterioration.

Replacement

Replacement of this piping would be much more expensive than refurbishment, and is not considered a viable option. It is not evaluted further.

Test 3

Test 4

42978 - TUC Circulating Water Piping Refurbishment
Avoided Cost Calculations

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Tufts Cove Generating Station	**CI Number:**	42978
Originator :		**Project No. :**	

Refurbishment

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$86,000**	**$87,720**		
Events/Outages (#)	**1**	**1**	**1**	**1**		
Probability of Occurance (%)	**40%**	**45%**	**40%**	**45%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**150**	**150**				
Duration (Hours)	**336**	**336**				
Totals	**$134,447**	**$153,711**	**$34,400**	**$39,474**	**$168,847**	**$193,185**
Total Capital Cost of Alternative						**$387,840**

Replacement

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

Test 3

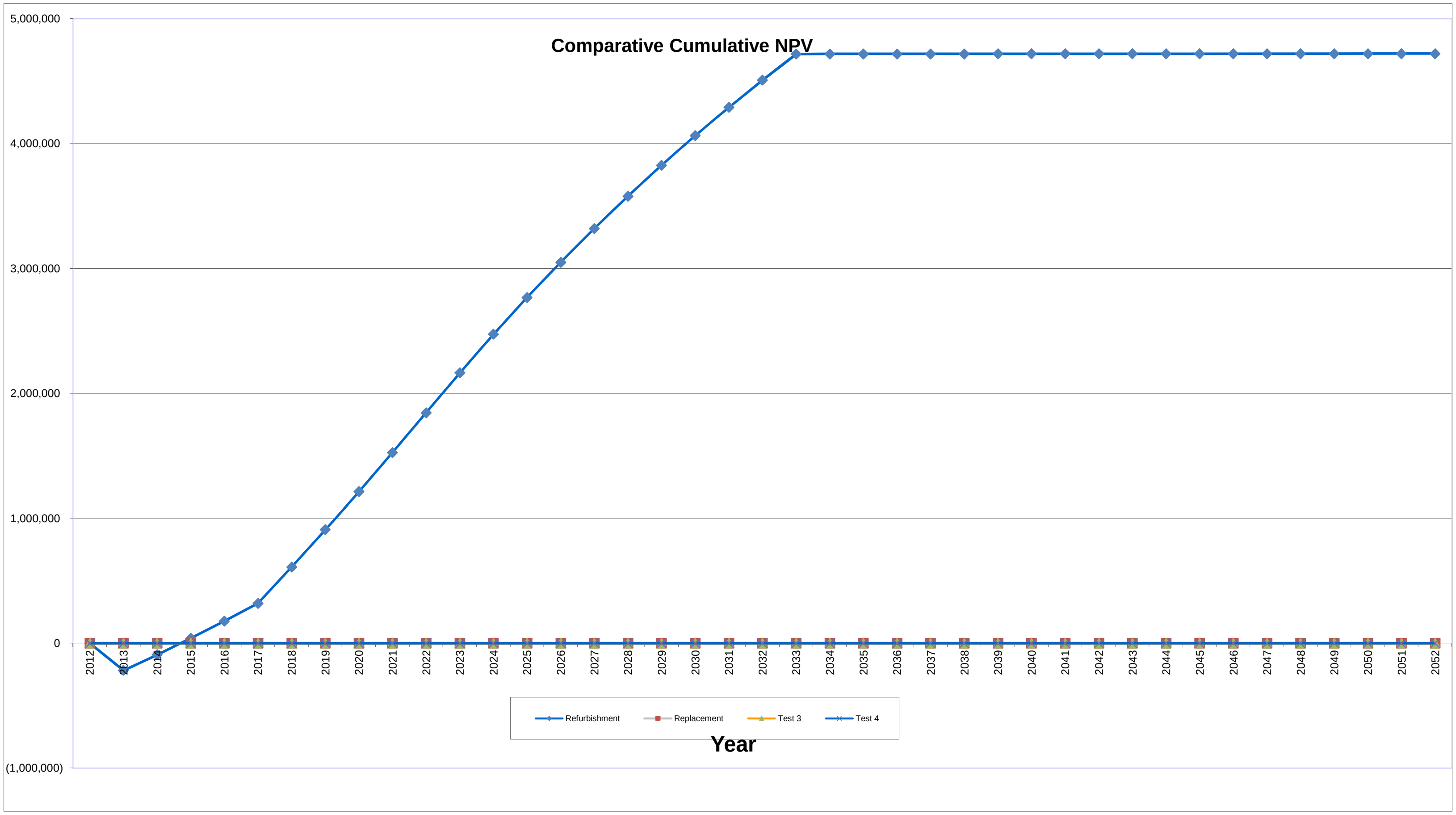
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			**$0**	**$0**		
Events/Outages (#)	**0**	**0**	**0**	**0**		
Probability of Occurance (%)	**0%**	**0%**	**0%**	**0%**		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	**0**	**0**				
Duration (Hours)	**0**	**0**				
Totals	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Total Capital Cost of Alternative						**$0**

42978 - TUC Circulating Water Piping Refurbishment
Refurbishment

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	168,847.0	(352,240.0)	14,460.7	347,056.8	(183,393.0)	(47,859.8)	(231,252.7)	(217,179.494)	0.9	(217,179.5)
2014	-	193,185.4	-	27,764.5	319,292.3	193,185.4	(51,280.5)	141,905.0	125,158.826	0.9	(92,020.7)
2015	-	218,943.5	-	25,543.4	293,748.9	218,943.5	(59,954.0)	158,989.5	131,693.456	0.8	39,672.8
2016	-	245,654.6	-	23,499.9	270,249.0	245,654.6	(68,868.0)	176,786.6	137,523.615	0.8	177,196.4
2017	-	273,346.6	-	21,619.9	248,629.0	273,346.6	(78,035.3)	195,311.3	142,687.908	0.7	319,884.3
2018	-	604,095.9	-	19,890.3	228,738.7	604,095.9	(181,103.7)	422,992.2	290,217.827	0.7	610,102.1
2019	-	663,576.1	-	18,299.1	210,439.6	663,576.1	(200,035.9)	463,540.2	298,683.445	0.6	908,785.6
2020	-	725,193.9	-	16,835.2	193,604.5	725,193.9	(219,591.2)	505,602.7	305,960.278	0.6	1,214,745.9
2021	-	789,011.0	-	15,488.4	178,116.1	789,011.0	(239,792.0)	549,219.0	312,128.297	0.6	1,526,874.2
2022	-	855,090.6	-	14,249.3	163,866.8	855,090.6	(260,660.8)	594,429.8	317,263.541	0.5	1,844,137.7
2023	-	923,497.9	-	13,109.3	150,757.5	923,497.9	(282,220.5)	641,277.4	321,438.208	0.5	2,165,575.9
2024	-	941,967.9	-	12,060.6	138,696.9	941,967.9	(288,271.2)	653,696.6	307,722.831	0.5	2,473,298.7
2025	-	960,807.2	-	11,095.7	127,601.1	960,807.2	(294,410.6)	666,396.7	294,610.525	0.4	2,767,909.3
2026	-	980,023.4	-	10,208.1	117,393.0	980,023.4	(300,642.7)	679,380.6	282,072.379	0.4	3,049,981.6
2027	-	999,623.8	-	9,391.4	108,001.6	999,623.8	(306,972.0)	692,651.8	270,081.179	0.4	3,320,062.8
2028	-	1,019,616.3	-	8,640.1	99,361.5	1,019,616.3	(313,402.6)	706,213.7	258,611.272	0.4	3,578,674.1
2029	-	1,040,008.6	-	7,948.9	91,412.5	1,040,008.6	(319,938.5)	720,070.1	247,638.443	0.3	3,826,312.5
2030	-	1,060,808.8	-	7,313.0	84,099.5	1,060,808.8	(326,583.7)	734,225.1	237,139.808	0.3	4,063,452.3
2031	-	1,082,025.0	-	6,728.0	77,371.6	1,082,025.0	(333,342.1)	748,682.9	227,093.711	0.3	4,290,546.1
2032	-	1,103,665.5	-	6,189.7	71,181.9	1,103,665.5	(340,217.5)	763,448.0	217,479.641	0.3	4,508,025.7
2033	-	1,125,738.8	-	5,694.5	65,487.3	1,125,738.8	(347,213.7)	778,525.1	208,278.150	0.3	4,716,303.8
2034	-	-	-	5,239.0	60,248.3	-	1,624.1	1,624.1	408.049	0.3	4,716,711.9
2035	-	-	-	4,819.9	55,428.5	-	1,494.2	1,494.2	352.559	0.2	4,717,064.5
2036	-	-	-	4,434.3	50,994.2	-	1,374.6	1,374.6	304.615	0.2	4,717,369.1
2037	-	-	-	4,079.5	46,914.6	-	1,264.7	1,264.7	263.191	0.2	4,717,632.3
2038	-	-	-	3,753.2	43,161.5	-	1,163.5	1,163.5	227.400	0.2	4,717,859.7
2039	-	-	-	3,452.9	39,708.6	-	1,070.4	1,070.4	196.477	0.2	4,718,056.1
2040	-	-	-	3,176.7	36,531.9	-	984.8	984.8	169.758	0.2	4,718,225.9
2041	-	-	-	2,922.5	33,609.3	-	906.0	906.0	146.673	0.2	4,718,372.6
2042	-	-	-	2,688.7	30,920.6	-	833.5	833.5	126.727	0.2	4,718,499.3
2043	-	-	-	2,473.6	28,446.9	-	766.8	766.8	109.494	0.1	4,718,608.8
2044	-	-	-	2,275.8	26,171.2	-	705.5	705.5	94.604	0.1	4,718,703.4
2045	-	-	-	2,093.7	24,077.5	-	649.0	649.0	81.739	0.1	4,718,785.1
2046	-	-	-	1,926.2	22,151.3	-	597.1	597.1	70.624	0.1	4,718,855.8
2047	-	-	-	1,772.1	20,379.2	-	549.4	549.4	61.020	0.1	4,718,916.8
2048	-	-	-	1,630.3	18,748.8	-	505.4	505.4	52.722	0.1	4,718,969.5
2049	-	-	-	1,499.9	17,248.9	-	465.0	465.0	45.552	0.1	4,719,015.0
2050	-	-	-	1,379.9	15,869.0	-	427.8	427.8	39.358	0.1	4,719,054.4
2051	-	-	-	1,269.5	14,599.5	-	393.6	393.6	34.005	0.1	4,719,088.4
2052	-	-	-	1,168.0	13,431.5	-	362.1	362.1	29.381	0.1	4,719,117.8
Total	-	15,974,727.8	(352,240.0)	348,086.0	4,183,747.3	15,622,487.8	(4,844,259.0)	10,778,228.8	4,719,117.8		



Comparative Cumulative NPV
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Refurbishment
Replacement
Test 3
Test 4
Year

Location: Tufts Cove Generating Station
CI# / FP#: 42978
Title: TUC - CW Piping Refurbishment
Execution Year: 2012

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Maintenance Trades	hr	[redacted]		$ 34,400.00		
1.2	Utility & Unskilled	hr	[redacted]		$ 9,360.00		
1.3					$ -		
				Sub-Total	$ 43,760.00		39928
2	**012 Materials**						
2.1	Piping, steel plates, etc	lot	1	[redacted]			
2.2	Pipe Coating	lot	1	[redacted]			
2.3							
				Sub-Total	$ 158,000.00		39928
3	**013 Power Production Contracts**						
3.1	Staging & Enclosure Frames	lot	1	[redacted]			
3.2	Tight Seal Enclosure	lot	1	[redacted]			
3.3	Ultrasonic Thickness Assessment	lot	1	[redacted]			
3.4	Sandblasting & Protective Coating	lot	1	[redacted]			
3.5	Sump and Piping Cleaning & Misc.	lot	1	$35,000.00	$ 35,000.00		
3.6							
				Sub-Total	$ 135,000.00		39928
4	**002 Overtime labour**						
4.1	Maintenance trades	hr	[redacted]		$ 15,480.00		
4.2							
4.3							
				Sub-Total	$ 15,480.00		39928
5	**094 Interest Capitalized**						
5.1	Interest Capitalized	lot	1	$ 4,675.48	$ 4,675.48		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 4,675.48		
6	**095 Administrative Overhead**						
6.1	Thermal & Hydro Contract (AO)	lot	1	$ 17,226.00	$ 17,226.00		
6.2	Thermal overtime labour (AO)	lot	1	$ 2,058.84	$ 2,058.84		
6.3	Thermal regular labour (AO)	lot	1	$ 11,640.16	$ 11,640.16		
				Sub-Total	$ 30,925.00		
Project Cost Estimate				**Total**	$ 387,840.48		
7	**Original Cost**						
7.1					$ 99,912.82		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43424

Title: **TRE5 Analytical Panel**

Start Date: 2013/06
Final Cost Date: 2014/02
Function: Generation
Forecast Amount: $382,109

DESCRIPTION:

A modern high-pressure steam generator consists of a boiler, turbine, condenser and feedwater components. High pressure steam is produced in the boiler for the turbine. The steam is then condensed and returned through the feedwater system to the boiler. This is referred to as the steam/water cycle. The high pressure steam/water must be of high purity and within a certain pH band as it comes in contact with the various metallic surfaces of the steam/water cycle equipment. Proper chemical treatment in fossil fuel fired generating stations is critical for corrosion prevention. The temperatures and pressures which modern steam producing generators operate at require strict chemical regimes and tight control. Proper treatment is dependent on timely and accurate measurement of chemical parameters.

Samples from various points in the steam/water cycle are tubed back to a centralized panel. There, the samples are conditioned (pressure reduction, cooling) and introduced to analyzers which measure various chemical parameters. The results of the analyzers are transmitted to the plant Data Acquisition System (DAS) for control room monitoring. Alarm conditions are indicated in the control room.

The analytical equipment is crucial to the long term life of the boiler. By having accurate knowledge of the water condition at all times, the operations group is able to treat the water appropriately by dosing with the correct chemicals in the right concentrations, and avoid unplanned outages due to water quality.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015.

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

A Chemical Asset Review was undertaken by NS Power Engineering personnel in 2010. The recommendations resulting from this review, as documented in the Gap Analysis Report, include upgrading the feedwater sampling system on Unit 5 to an analytical panel to eliminate unnecessary risk to the unit due to inaccurate data.

Why do this project now?

The analytical equipment and sample cooling is no longer reliable and must be replaced with a more comprehensive and accurate system.

Why do this project this way?

Replacement of the analytical panel and sample cooling system is the best method to provide reliable analysis of boiler and steam chemistry. New technology for sample analysis will be employed to ensure long term performance of the analytical system for boiler chemistry monitoring.

CI Number : 43424 - TRE5 Analytical Panel **Project Number**

Parent CI Number : -

Cost Centre : 340 - 340-Trenton Unit 5 Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		5,860	0	5,860
095		095-Thermal Regular Labour AO		7,038	0	7,038
001	011	001 - THERMAL Regular Labour	011 - SGP - Plant Control and Inst	20,860	0	20,860
002	011	002 - THERMAL Overtime Labour	011 - SGP - Plant Control and Inst	0	0	0
004	011	004 - THERMAL Term Labour	011 - SGP - Plant Control and Inst	0	0	0
012	011	012 - Materials	011 - SGP - Plant Control and Inst	334,500	0	334,500
015	011	015 - Frt, Post & Delivery	011 - SGP - Plant Control and Inst	5,000	0	5,000
001	085	001 - THERMAL Regular Labour	085 Design	2,240	0	2,240
001	087	001 - THERMAL Regular Labour	087 Field Super.& Ops.	3,360	0	3,360
011	087	011 - Travel Expense	087 Field Super.& Ops.	2,500	0	2,500
021	087	021 - Telephones	087 Field Super.& Ops.	250	0	250
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	500	0	500
			Total Cost:	382,109	0	382,109
			Original Cost:	30,000		

TRE5 Analytical Panel
Summary of Alternatives

Division :	Power Production		**Date :**	**31-Oct-12**
Department :	Trenton		**CI Number:**	43424
Originator :			**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Install Analytical Panel	6.48%	1,445,489	1	88.90%	2.0 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

It is recommended to proceed with installation of an analytical panel based on favorable economic analysis.

Notes/Comments :

Install Analytical Panel

This analysis compared the cost of installing an analytical panel on Trenton Unit 5 versus the avoided cost of returning the unit to sevrice in the event of a gross contamination of the boiler and balance of plant. Assumptions include 3% annual (1 in 33 years) chance of catastrophic failure due to feedwater contamination, $7M in avoided cost of repair, including materials and labour. Assume 30 weeks of downtime of the Unit.

Test 2

Test 3

Test 4

TRE5 Analytical Panel
Avoided Cost Calculations

Nova Scotia POWER An Emera Company

Division :	Power Production	Date :	31-Oct-12
Department :	Trenton	CI Number:	43424
Originator :		Project No. :	

Install Analytical Panel

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$7,000,000	$7,140,000		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	3%	3%	3%	3%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	155	155				
Duration (Hours)	4320	4320				
Totals	$27,842	$26,864	$210,000	$214,200	$237,842	$241,064
Total Capital Cost of Alternative						$382,109

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

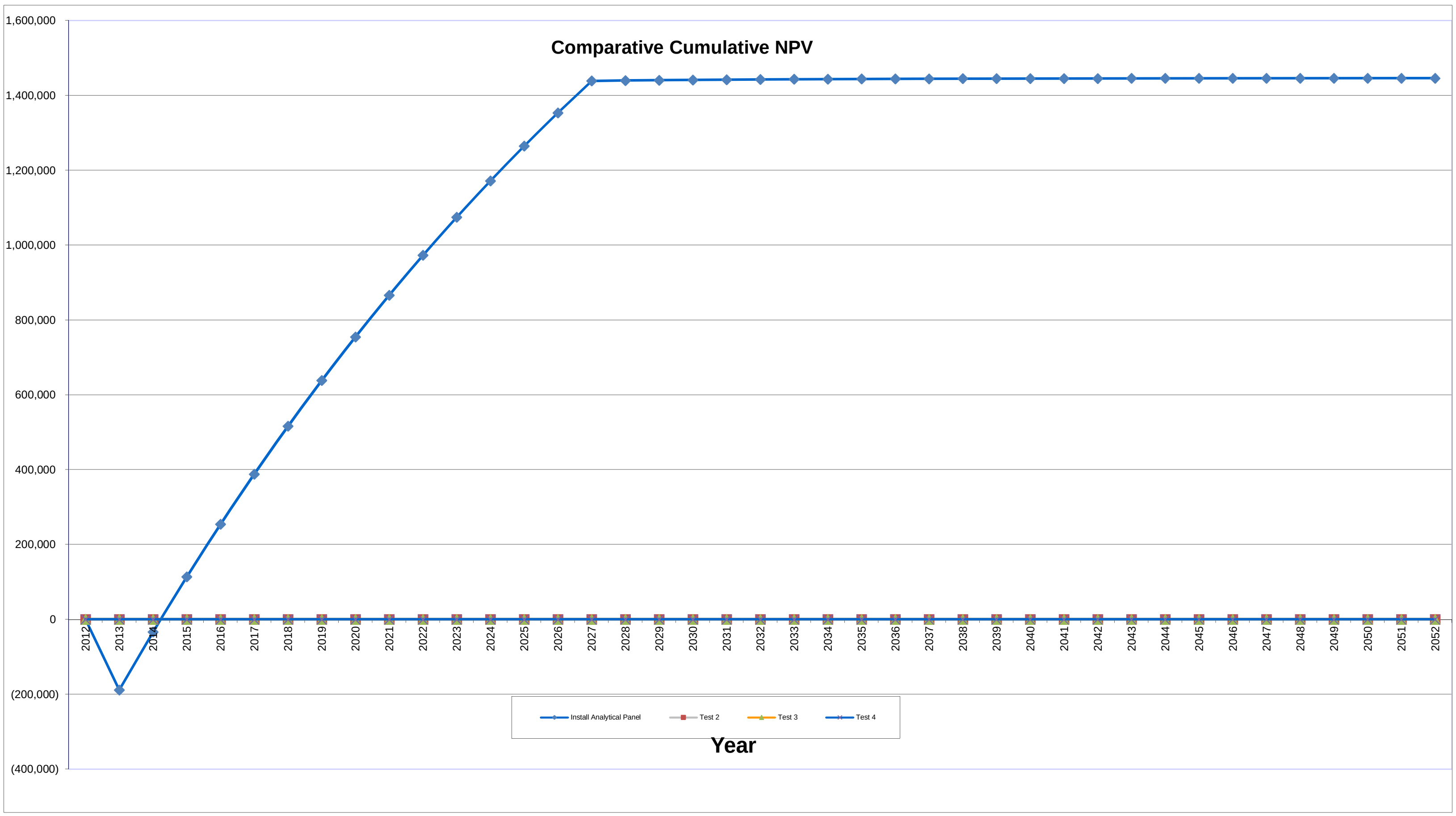
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

TRE5 Analytical Panel
Install Analytical Panel

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	237,842.0	(369,210.9)	14,852.9	356,469.4	(131,368.9)	(69,126.6)	(200,495.5)	(188,294.089)	0.9	(188,294.1)
2014	-	241,063.7	-	28,517.6	327,951.9	241,063.7	(65,889.3)	175,174.4	154,502.144	0.9	(33,791.9)
2015	-	245,885.0	-	26,236.1	301,715.7	245,885.0	(68,091.1)	177,793.8	147,269.410	0.8	113,477.5
2016	-	250,802.7	-	24,137.3	277,578.5	250,802.7	(70,266.3)	180,536.4	140,440.564	0.8	253,918.0
2017	-	255,818.7	-	22,206.3	255,372.2	255,818.7	(72,419.9)	183,398.9	133,985.070	0.7	387,903.1
2018	-	260,935.1	-	20,429.8	234,942.4	260,935.1	(74,556.6)	186,378.4	127,875.519	0.7	515,778.6
2019	-	266,153.8	-	18,795.4	216,147.0	266,153.8	(76,681.1)	189,472.7	122,087.249	0.6	637,865.9
2020	-	271,476.9	-	17,291.8	198,855.2	271,476.9	(78,797.4)	192,679.5	116,598.006	0.6	754,463.9
2021	-	276,906.4	-	15,908.4	182,946.8	276,906.4	(80,909.4)	195,997.0	111,387.664	0.6	865,851.5
2022	-	282,444.5	-	14,635.7	168,311.1	282,444.5	(83,020.7)	199,423.8	106,437.967	0.5	972,289.5
2023	-	288,093.4	-	13,464.9	154,846.2	288,093.4	(85,134.8)	202,958.6	101,732.316	0.5	1,074,021.8
2024	-	293,855.3	-	12,387.7	142,458.5	293,855.3	(87,255.0)	206,600.3	97,255.575	0.5	1,171,277.4
2025	-	299,732.4	-	11,396.7	131,061.8	299,732.4	(89,384.1)	210,348.3	92,993.907	0.4	1,264,271.3
2026	-	305,727.0	-	10,484.9	120,576.9	305,727.0	(91,525.0)	214,202.0	88,934.630	0.4	1,353,205.9
2027	-	311,841.6	-	9,646.1	110,930.7	311,841.6	(93,680.6)	218,161.0	85,066.090	0.4	1,438,272.0
2028	-	-	-	8,874.5	102,056.3	-	2,751.1	2,751.1	1,007.430	0.4	1,439,279.5
2029	-	-	-	8,164.5	93,891.8	-	2,531.0	2,531.0	870.432	0.3	1,440,149.9
2030	-	-	-	7,511.3	86,380.4	-	2,328.5	2,328.5	752.063	0.3	1,440,901.9
2031	-	-	-	6,910.4	79,470.0	-	2,142.2	2,142.2	649.792	0.3	1,441,551.7
2032	-	-	-	6,357.6	73,112.4	-	1,970.9	1,970.9	561.428	0.3	1,442,113.2
2033	-	-	-	5,849.0	67,263.4	-	1,813.2	1,813.2	485.080	0.3	1,442,598.2
2034	-	-	-	5,381.1	61,882.3	-	1,668.1	1,668.1	419.115	0.3	1,443,017.4
2035	-	-	-	4,950.6	56,931.7	-	1,534.7	1,534.7	362.121	0.2	1,443,379.5
2036	-	-	-	4,554.5	52,377.2	-	1,411.9	1,411.9	312.877	0.2	1,443,692.4
2037	-	-	-	4,190.2	48,187.0	-	1,299.0	1,299.0	270.329	0.2	1,443,962.7
2038	-	-	-	3,855.0	44,332.1	-	1,195.0	1,195.0	233.568	0.2	1,444,196.3
2039	-	-	-	3,546.6	40,785.5	-	1,099.4	1,099.4	201.805	0.2	1,444,398.1
2040	-	-	-	3,262.8	37,522.7	-	1,011.5	1,011.5	174.362	0.2	1,444,572.4
2041	-	-	-	3,001.8	34,520.8	-	930.6	930.6	150.651	0.2	1,444,723.1
2042	-	-	-	2,761.7	31,759.2	-	856.1	856.1	130.164	0.2	1,444,853.2
2043	-	-	-	2,540.7	29,218.4	-	787.6	787.6	112.464	0.1	1,444,965.7
2044	-	-	-	2,337.5	26,881.0	-	724.6	724.6	97.170	0.1	1,445,062.9
2045	-	-	-	2,150.5	24,730.5	-	666.6	666.6	83.956	0.1	1,445,146.8
2046	-	-	-	1,978.4	22,752.1	-	613.3	613.3	72.539	0.1	1,445,219.4
2047	-	-	-	1,820.2	20,931.9	-	564.3	564.3	62.674	0.1	1,445,282.0
2048	-	-	-	1,674.6	19,257.3	-	519.1	519.1	54.152	0.1	1,445,336.2
2049	-	-	-	1,540.6	17,716.7	-	477.6	477.6	46.788	0.1	1,445,383.0
2050	-	-	-	1,417.3	16,299.4	-	439.4	439.4	40.425	0.1	1,445,423.4
2051	-	-	-	1,304.0	14,995.5	-	404.2	404.2	34.928	0.1	1,445,458.3
2052	-	-	-	1,199.6	13,795.8	-	371.9	371.9	30.178	0.1	1,445,488.5
Total	-	4,088,578.3	(369,210.9)	357,526.5	4,297,215.7	3,719,367.4	(1,156,626.1)	2,562,741.4	1,445,488.5		


Comparative Cumulative NPV
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
(200,000)
(400,000)
Year
Install Analytical Panel
Test 2
Test 3
Test 4

Location: Trenton Generating Station
CI# / FP#: 43424
Title: TRE5 Analytical Panel
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Reg Elec - Installation	hr	[redacted]		$ 3,280.00		
1.2	Reg Instr	hr	[redacted]		$ 9,840.00		
1.3	Reg Mech - Piping	hr	[redacted]		$ 7,740.00		
1.4	Internal Engineering	hr	[redacted]		$ 2,240.00		
1.5	Internal Supervision	hr	[redacted]		$ 3,360.00		
1.6					$ -		
1.7					$ -		
				Sub-Total	$ 26,460.00		
2	**002 Overtime Labour**						
2.1					$ -		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ -		
3	**004 Term Labour**						
3.1					$ -		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ -		
4	**012 Materials**						
4.1	Analytical Panel	lot	1	[redacted]		Cost Support 1	28554
4.2	Contingency / Escalation on Panel	%	[redacted]				
4.3	Piping, valves, fittings	lot	1	$ 10,000.00	$ 10,000.00		
4.4					$ -		
				Sub-Total	$ 334,500.00		
5	**015 Freight Postage & Delivery**						
5.1	Freight/Shipping	lot	1	$ 5,000.00	$ 5,000.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 5,000.00		
6	**028 Consulting**						
6.1					$ -		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ -		
7	**011 Travel**						
7.1		lot	1	$ 2,500.00	$ 2,500.00		
				Sub-Total	$ 2,500.00		
8	**021 Telephones**						
8.1		lot	1	$ 250.00	$ 250.00		
				Sub-Total	$ 250.00		
9	**041 Meals and Entertainment**						
9.1		lot	1	$ 500.00	$ 500.00		
				Sub-Total	$ 500.00		
10	**094 Interest Capitalized**						
10.1	Interest Capitalized	lot	1	$ 5,872.81	$ 5,860.44		
				Sub-Total	$ 5,860.44		
11	**095 Administrative Overhead**						
11.1	Thermal Regular Labour AO	lot	1	$ 7,038.36	$ 7,038.36		
11.2					$ -		
				Sub-Total	$ 7,038.36		
Cost Estimate				Total	$ 382,108.80		
12	**Original Cost**						
12.1	Retirement				$ 30,000.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project.

Attachment 1

Removed due to confidentiality

"**FINAL REPORT**"

NSPI GENERATING FACILITY CHEMICAL ASSET REVIEW
GAP ANALYSIS REPORT 2010 - GENERATION SERVICES
Power Production General Findings and Thermal Plant Specific Findings

Prepared by:

Mike McCarthy
Chemical Asset Specialist

October 31, 2010

"FINAL REPORT"

Table of Contents

1.0 Introduction

Nova Scotia Power currently has five fossil fuel Generating Stations located at Lingan, Pt. Aconi, Point Tupper, Trenton and Tuft's Cove. Tuft's Cove has two additional natural gas fired LM6000 units.

A gap analysis review of the chemistry programs and processes was conducted in 2002 by Mike McCarthy, Senior Chemical Environmental Supervisor. A report was issued to all plants with findings and recommendations for actions.

The following report is a follow up to the 2002 gap analysis with additional information on the current state of Chemical Assets in Power Production.

Power Production management has requested a review of the cycle chemistry programs and practices currently being used at all the generating stations as well as a status report on the condition of chemical assets and associated equipment.

2.0 Purpose and Scope

The purpose of this project was to review the current status of cycle chemistry programs, procedures and operating practices at Nova Scotia Power Inc., as well as condition of related operating and monitoring equipment, material and other resources.

The Scope will include the following:

a) Review of the 2002 "Power Production Facility Cycle Chemistry Practices, Gap Analysis Report." as completed by Mike McCarthy, Senior Chemical Environmental Supervisor.

b) Water chemistry and equipment status for the following areas in each plant will be reviewed.

- Water Treatment Plant
- Condensate Polishing Plant
- Boiler/Feedwater cycle.
- Cooling Water, General Service and Circulating systems.
- Ferrous Sulfate Treatment.
- Monitoring and Instrumentation.
- General Condition of Chemical Tanks and Piping.
- Procedures/Chemical records and Quality Control/Tasks

c) A comparison of the Current EPRI (Electric Power Research Institute), guidelines and the NSPI Chemistry Operating practices and recommendations will be done, to see if our standards are still

Within the accepted industry standard for prevention and reduction of cycle component corrosion.

d) Laboratory Staffing Resources and Chemical Technician Apprenticeship.

e) Chemical Related Boiler Tube Failures 2002-2010.

3.0 Organization of Report

The remainder of this report will be organized as follows:

Section 4.0 will discuss any recent updates to the EPRI standards and guidelines that may impact our Cycle Chemistry practices.

Section 5.0 will list deficiencies that are common to all plants based on 2010 plant inspections and discussions with plant staff.

Section 6.0 includes a current status report of chemical assets in individual plants with an update on actions completed, and a list of current deficiencies.

Section 7.0 includes status of laboratory staffing resources and discussion of current in-house Chemical Technologist Apprenticeship program.

Section 8.0 includes any chemical related boiler tube failures from all plants and current guidelines for boiler tube deposit analysis.

Section 9.0 gives a summary report.

4.0 Standards Comparison

The current documents that are being used by Nova Scotia Power laboratories for operations and chemical control are as follows:

"Chemical Handbook, Thermal Production Division, Revision 3", Prepared by: Peter Whitehouse, published June 1984 Revised 2003 by Mike McCarthy.

"Standard Methods for the Examination of Water & Wastewater", 21st Edition, 2005.

"Environmental Wastewater and Water Quality Manual", Nov. 2009.

"Modern Power Station Practice, Chemistry & Metallurgy", Volume E, 3rd Ed."

These documents contain the various procedures, guidelines, operating limits and recommendations for monitoring cycle chemistry and for minimizing corrosion and deposit formation in the various stages of cycle chemistry. They also provide guidance for analysis and quality control of samples. The new Environmental Wastewater and Water Quality Manual were revised in 2009 to replace the Interim Quality Assurance Manual from 1995.

The Chemical Handbook was revised in 2003 to bring our chemical parameters more in line with industry standards for boiler and feed water treatments. At that time we adjusted our limits for chloride and sulfate in our boilers. Equilibrium phosphate treatment was introduced in boilers that indicated the occurrence of "phosphate hideout". Parameters for boilers on AVT (All Volatile Treatment) were also updated.

Some recent changes have been made to the EPRI guidelines and standards and there is no guidelines for HRSG (Heat Recovery Steam Boiler) cycle chemistry, in our current Chemical Handbook. Tuft's Cove will be installing a new HRSG on site in 2010. The Chemical Handbook will be revised in 2010 to reflect these guidelines.

Section five of the Chemical Handbook contained various procedures for Thermal Plants as guidelines for operating and testing. At a Plant Chemist meeting in April 2010, it was agreed that these procedures were outdated and that new procedures and guidelines needed to be developed to reflect current practices. It was recommended that a common SharePoint site be developed to store reference documents.

This report will also review our current practices regarding chemical piping and chemical storage tanks with reference to selection of materials and inspection /repair frequency. The document will include comparisons with industry standards for chemical asset management.

5.0 General Findings

5.01 The NSPI Chemical Handbook was updated in 2003 to reflect EPRI guidelines for Cycle chemistry. EPRI has since then added or updated some of the boiler water and feedwater parameters as well as provided guidelines for cycle chemistry treatment for HRSG's (heat recovery steam boilers). The 2003 Chemical Handbook needs to be revised to reflect these changes.

5.02 The old 1984 Chemical Handbook contained some guidelines and procedures in Section 5. This section of the manual was not updated in 2003. Plant Chemists have agreed that the old procedures do not reflect modern day practices and that a new list of procedures needs to be developed to reflect operation of our current equipment.

5.03 All plants are unable to meet the temperature standard for boiler water and feedwater samples in summer months. Sample temperature should be regulated to 25 deg. C +/- 1 deg. See Chemical Handbook Rev. 3, .2003, Section 2 (1.10)

Also, three plants cannot meet the temperature standard year round due to inadequate cooling water to analytical panels. In addition, three plants require analytical panel upgrades or complete replacements due to aging and defective equipment.

5.04 Although all plants have online analytical equipment available there are problems with reliability of several dissolved oxygen analyzers. This is a key parameter for monitoring cycle chemistry. Additionally, EPRI recommends online sodium analyzers for monitoring steam and feed water sodium levels. None of our thermal units have sodium analyzers.

5.05 In 2003 online information was available but was not accessible to lab staff. Today all plants have access to the PI system for monitoring online parameters. In addition some plants use the Fossil Power system for online monitoring of cycle chemistry and other related equipment. Checks for accuracy of the online analytical monitors are being done by the plants but there is no consistency in the frequency and quality of these checks. Past practice was to complete them on a weekly basis.

5.06 There is an inconsistency in the procedures that are being used for the application of Ferrous Sulfate as a corrosion inhibitor in our once through circulating cooling water systems. Lack of consistent treatment has led to tube failures. A new procedure is being developed by Generation Services to be implemented in 2010.

5.07 In 2003 , it was recommended that the thermal stations use a database to record results of cycle chemistry testing. Infocalc was purchased for at least four stations. This program was designed for cycle chemistry data analysis and had built in programs for quality control and trending. Only one station has been using the program on a consistent basis since the last gap analysis. It is strongly recommended that Infocalc or other database be used for data entry in the future.

5.08 There is inconsistency in the current practices for maintenance and inspection of chemical assets throughout Power Production. The guidelines are included in TMP-30 but this is not always being followed. TMP-30 is currently being reviewed by Generation Services and the Thermal Plants.

5.09 As part of the succession planning for Power Plant Technicians, (Chemical), the In-house Chemical Apprenticeship Program is being updated and is in use to assist with the development of new Chemical Technician apprentices currently in the thermal plants. The program will be finalized by the end of 2010.

5.10 Due to aging and performance issues, all plants will need to replace condensate polisher resin in the next one to five years. There may be an opportunity to purchase resin in bulk to reduce the cost for all thermal stations.

NSPI Thermal Station Chemical Asset Gap Analysis Report – 2010
Pt. Tupper Plant Specific Findings.

"**FINAL REPORT"**

6.0 Plant Specific Findings

Pt. Tupper > **Audit results and review**.

6.01 Water Treatment Plant

The Pt. Tupper Water Treatment Plant still has the same treatment system that existed during the 2002 review. Raw water is supplied from Landrie lake to a reactivator /clarifier treated with Poly Aluminum Chloride to remove color and turbidity by precipitation and filtration. The Water treatment plant has two demineralizer trains.
The Graver consists of two sand filters, two carbon filters and two primary trains
with one mixed bed. The Sternson train consists of one sand filter, carbon filter, cation, anon and mixed bed.
The reactivator is still producing excellent quality effluent but the collector flume at the top of the vessel has deteriorated and is being replaced at the summer outage in 2010. The Graver splitter box has deteriorated and needs to be replaced. This also will be replaced in the 2010 summer outage.

The Graver unit is PLC controlled. In the 2002 review it was recommended that the Sternson train also be converted to PLC control. This is still not completed.

Since the 2002 review, the ion exchange resins were sampled and replaced as follows.
All the Graver vessels were sampled and tested in 2006 and resin replaced in the Graver "B" train and Mixed Bed in 2009. The Graver "A" train resin was replaced in 2010. The Sternson primary train and Mixed Bed resin was last sampled in 2004 and was replaced in 2008. Average throughput before the resin change for the Sternson in 2008 was 289, 000 U.S. Gal. The average throughput after the resin change in 2009 was 356,000 U.S. Gallons.
Average throughput before the resin change for the Graver "B" train was 134,000 U.S. gallons in 2008. The average throughput for Graver train "B" after the resin change is 197,000 U.S. Gallons in There were 67 regenerations on the Sternson and 34 regenerations on the Graver system in 2008. In 2009 this was reduced to 58 regenerations on the Sternson and 19 on the Graver in 2009.
An internal inspection was done on all demin vessels for the Graver and Sternson systems in 2008/2009. Some flow problems were noticed in the Sternson anion. There was damage to the Graver "B" cation lateral and to the rubber liner in Graver "B" train and mixed bed Vessels.

Actions Taken: The Graver splitter box has been defected for repair and will be completed after an isolation valve is installed during the collector flume replacement in the 2010 outage. The Graver "B" cation lateral was repaired and the vessel returned to service. Screen socks were replaced in the Sternson anion in 2008 to restore distribution flow. The Sternson Carbon Filter was inspected and carbon replaced in 2002. Some minor repairs were done to the liner.
New acid and caustic dilution water lines were installed with new acid/caustic skids in 2006.

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Finding #1: The rubber liner in the Graver "B" train and the Mixed Bed needs to be replaced. Internal inspection revealed extensive deterioration to the liners.

Finding #2 The carbon in the Graver Carbon filters was last changed in 1979.This needs to be replaced. The vessel also needs to be inspected.

Finding #3: The 2002 review recommended that the Sternson plant be upgraded to PLC control. This has not been completed. This is still recommended with the ability to monitor parameters on the PI system.

Finding #4: All three sand filter pressure vessels need to be inspected externally and internally for corrosion and integrity of the internals. This has not ever been done on these vessels. The age of the Graver vessels is 42 years and the Sternson is 37 years.

<u>Maintenance and Equipment</u>:

There are several pneumatic diaphragm valves on the Sternson and Graver demin systems that control the service and regeneration modes for operation of the vessels. Most of these valves are original 1968-1973, and some flow problems have impacted the service and regeneration efficiency since the last review in 2002. These valves should be refurbished or replaced in the next five years to ensure continued good performance of these units. The flow meters on the Sternson and Graver "" trains were also not working.
during the 2002 review. There was no Raw Water meter to monitor water usage at the Pt. Tupper plant. The water usage was being estimated for reporting to Nova Scotia Environment Dept.
A registered Potable water system is in place at Pt. Tupper. The carbon in the potable water carbon filter was replaced in 2009. There are some problems with leakage in the current valve/controller piping. There is a plan in place to upgrade and repair this system in 2010.

Action taken: New flow meters were installed on the Sternson train and Graver "A' train in 2003. A new Raw Water meter was installed in the WTP in 2008. The Sternson flow control valve and associated check valve were replaced in 2009.

Finding #5: The potable water system does not have a flow meter in place to accurately measure potable water usage. The current piping/valve arrangement has leaked on several occasions and is currently leaking. This should be repaired or replaced.

Finding #6: An attempt was made to regenerate the Sternson anion in counter current mode after the repairs to the lateral, and the resin was replaced. The up flow regeneration was still not successful. It is recommended that the pneumatic valves on this vessel be replaced or refurbished to return the vessel to its normal up flow regeneration mode.

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6.02 Condensate Polishers

Pt. Tupper has three Degremont polishers that are capable of polishing 100 % of the condensate at full load. The design flow rate is 34 gal/min/sq.ft of surface area. The cation to anion resin ratio in the two original polishers is 2:1. An old Degremont polisher from Glace Bay was installed as a third polisher in 2005 with original Glace Bay resin at a 1:1 cation/anion ratio. At normal design flow of 25 gals/min/ft^2 , they will polish 826 gals/minute of water. The polisher resin was replaced in the East & West polishers in 1998.
Since the 2002 review, the condensate polishers have experienced several problems with pneumatic valves, notably the service inlet & outlet and the backwash inlet valves. The valves on the third polisher were refurbished or replaced during installation.
It was recommended that the polishers be converted to PLC control during the 2002 review. During the review in 2002 flow through the polishers could not be accurately determined with the old flow meters.
Due to deterioration of the condenser, the polishers were in service more frequently during the many condenser leaks. This increased the number of regenerations and reduced the throughput. In 2008 there was 63 regenerations and average throughput of 10 million gallons vs 21 regenerations in 2001 with average throughput of 12 million gallons.

Actions Taken: The pneumatic inlet and outlet and backwash inlet valves were all replaced on both polishers from 2006-2008. A new condenser was installed in 2009 and regenerations were reduced to 26. Current throughputs are averaging 12 million gallons. With the installation of the 3rd polisher from Glace Bay, Pt. Tupper was able to do regenerations without dropping load or incurring overtime. All three polishers are now PLC controlled with manual backup. A software program is used to determine accurate flows from the PI system flow points.

Finding # 7: There are still several old pneumatic diaphragm valves on the East and West Polishers, notably the acid block and bleed and acid and caustic inlet valves as well as vent valves. These are at risk for failure and should be refurbished or replaced. It is difficult to find replacement parts for the old valves.

6.03 Boiler/Feed water Cycle Chemistry

The boiler water treatment program at Pt. Tupper is currently on equilibrium phosphate treatment with pH control 9.2-9.9. The average pH runs 9.5-9.6 for 95 % of the time. Phosphate levels average 0.9 ppm for 95 % of the time. Sodium is consistently below 5 ppm.
From 2005-2010, chloride values were below the 1.0 ppm limit as Cl for more than 90 % of the time. The 9.3 % of high readings were attributed to condenser leak contamination that got by the polishers. The chloride was controlled by boiler blow down.
In April 2008, the unit experienced a major condenser leak when the hot well conductivity exceeded 3000 umhos. The boiler pH dropped below 7.0 causing an “Acid Excursion” condition. A combination of online condenser leak checks, boiler blow down

and caustic addition were used to reduce the contamination in the boiler. The condenser was scheduled to be retubed later that year.

In the 2003 review it was recommended by the auditor that the hydrazine levels in the feed water be controlled between 0.02-0.04 parts per million by automating the hydrazine feed system. The old limit was 0.04-0.08 ppm as N_2H_4. The feed water pH limits are 8.8-9.2 as per EPRI guideline.

In 2010, Pt. Tupper conducted a field trial test using Cortrol OS5900, a replacement oxygen scavenger for Hydrazine Hydrate. Cortrol contains Diethylhydroxylamine, a chemical that is much less toxic than Hydrazine. The initial trial was successful and more testing will be conducted throughout 2010.

Action Taken: The old condenser tubes were removed and replaced in 2008 with new Aluminum Brass tubes. A boiler tube sample was collected in the 2010 outage to check deposit loading on the boiler tubes.
During the 2010 outage inspection of the hot well, deaerator, boiler drum and economizer header indicated good magnetite coating on the metal surfaces after the trial with Cortrol OS5900.

Finding # 8: More than 40 % of the hydrazine values in 2009/2010 exceeded 0.080 parts per million. The feed water pH was within the EPRI guideline 80% of the time. A combination of high hydrazine and high pH at the condenser can contribute to deposit load increases in the high pressure heaters and boiler. Automation would give the plant better control over the feed water chemicals and thus reduce cost. It is recommended that both pumps be upgraded to automated controls to better manage these guidelines.

Finding # 9 Although iron and copper testing was during the field trial with Cortrol, this testing is not being done regularly. EPRI recommends weekly testing for iron and copper in the feed water.

6.04 (a) General Service Cooling Water/Circulating Cooling Water

Since the 2002 chemical review, the makeup to the GSCW has been good. Chemical additions are required after an outage due to dilution of the water in the storage tanks.
Chemical usage has been reduced considerably since the bottom storage tank was replaced in 2004. Since 2005 the average molybdate concentration has been 55 mg/l.
The guidelines for treatment are 60-80 mg/l as molybdate. Some small bore piping was replaced after the 2002 chemical review. The makeup supply is still from the clear well.
In 2009 there was a contamination issue in the closed cooling water system caused by changes to the raw water supply from Landrie lake. Filters were getting plugged on a more frequent basis leading to increased cost for supplies and labor. Several sections of the small bore cooling water piping contain heavy scale restricting cooling water flow. Sodium Hypochlorite additions for biological control have been minimal.

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Action Taken: The lower GSCW storage tank was replaced in 2004. The contamination issue in 2009 was relieved by blowing down the system to remove the contamination caused by increased salts in the raw water supply.

Finding #10: Since 2005, the average molybdate has been 55mg/l but the concentration was outside the 60-80 mg/l guideline more than 70 % of the time. This needs to be improved to protect the tanks and piping. Some small bore piping contains heavy scale, restricting cooling water flow.

Finding #11: The GSCW storage tanks have not been inspected since 2004.

6.04 (b) Circulating Cooling Water (Seawater) Ferrous Sulfate Treatment.

In 2002, Pt. Tupper was treating the condenser with one 22.5 kg bag of Ferrous Sulfate per day to prevent condenser leakage. Because of safety issues with Ferrous Sulfate dust, a liquid Ferrous Sulfate system was installed using a 40 % Ferrous Sulfate solution in tote tanks. After using the liquid system, the condenser tubes continued to deteriorate and had to be replaced in 2008 with new Aluminum Brass tubes. After a few months with the new tubes in place there was rapid deterioration of the new tubes with increasing tube leaks. A consultant was hired to review the root cause of the failures. The failures were determined to be caused by sulphide attack from polluted seawater. Another consultant recommended increased usage of ferrous sulfate to prevent further damage to the tubes.
The recommended dosage was 3.0 mg/l as Fe at the condenser inlet. To achieve this rate using the liquid system would have increased the chemical cost by a factor of 4. Pt. Tupper was able to achieve the recommended dose rate by returning to mixing the 22.5 bags of Ferrous Sulfate Heptahydrate in a tote tank.
Pt. Tupper continues to use chlorine for mussel control with a limit of 0.5 mg/l at the condenser outlet. A new inline Total Chlorine Residual monitor was installed since the 2002 review but does not perform consistently due to inlet sample quality.

Action Taken: Pt. Tupper has discontinued the use of liquid Ferrous Sulfate and returned to mixing eight 22.5 bags of dry Ferrous Sulfate per tote tank. A dust control ventilation system has been installed to control the dust hazard. Since Jan 2009 the average Fe at the condenser inlet has been 3.4 mg/l and 1.2 at the condenser outlet.
Replacement tubes for the tubes corroded by the sulphide have been purchased and will be installed during the 2011 outage.

Finding #12: Although a new Total Residual Chlorine monitor has been installed at the condenser, it does not consistently give good reliable data due to inlet sample quality. Manual sampling is being done for regulatory compliance. A new design for sample collection should be investigated.

6.05 Monitoring and Instrumentation

Since the 2002 gap analysis, Pt. Tupper has purchased a database software program (Infocalc) to monitor and trend cycle chemistry data. Data is available since the last review. The data has been used to troubleshoot problems in the cycle chemistry program.
Also since 2002, the PI system has been available to monitor data from online instruments throughout the plant. Lab staff has access to this system in the main lab.
The weekly instrument checks for the online instruments have been reduced to monthly checks.
Three new conductivity meters were upgraded on the analytical panel since the 2002 review. The Pt. Tupper analytical panel that houses most of the online instrumentation has several problems that can affect the reliability of the online instruments. The plant is presently investigating an upgrade for this panel. The dissolved oxygen monitors do not perform consistently. Old conductivity monitors should upgraded to digital monitors.
The high pressure valves are leaking and require double isolation to meet the standard.
EPRI recommends addition of a sodium analyzer to monitor the extraction pump and steam samples.
The current analytical monitors on the sternson panel are also out dated and need to be replaced.
A DX -120 Ion Chromatograph was purchased for anion analysis in 2002.
The DX-100 Ion Chromatograph for boiler/feed water analysis and the associated software is outdated and should be upgraded for reliability sample results.

Action Taken: An assessment of the unit #2 analytical panel has been completed and a new panel will be installed via a capital project in 2011. The new panel should include a pH meter for the feed water, a sodium analyzer for the extraction pump sample and new dissolved oxygen meters. All old meters should be replaced with digital meters.

Finding # 13: Some outdated analytical monitors need to be replaced on the Sternson panel.

6.06 Procedures/Chemical Control Records/Tasks

Since the 2002 review, Pt. Tupper lab has been using Infocalc database for daily testing results and trending. Online monitoring and trending is available in the lab for cycle chemistry instruments. The Water Treatment plant instrumentation is not currently on the PI system.
All the old lab procedures that were available at the 2002 review have been downsized or reviewed and revised. These procedures are now available on the Pt. Tupper EMS website under lab procedures. Access and training has been provided to lab staff to view the procedures.
Other procedures related to cycle chemistry operation are stored on the Pt. Tupper Sharepoint home website under Operations Procedures. Access is available for all personnel to view these procedures.

A common Sharepoint site is being developed in 2010 for all Power Production labs to access common procedures and documents related to the operation of Water Treatment Plants, Wastewater, Cycle Chemistry and other chemical related processes.

Action Taken: Pt. Tupper lab is currently using a storage database for daily chemical analysis and they have access to data from online instrumentation via the PI system.
Lab and operational procedures have been updated to electronic format.

Finding # 14: Although the lab has access to online instrumentation, the Water Treatment Plant data is not connected to the PI system.

Finding #15: To ensure continued reliability of daily testing for cation analysis the old DX-100 Ion Chromatograph analyzer and outdated software need to be replaced.

Finding #16: The Leco WR12 Carbon analyzer is > 20 years old and finding replacement parts is getting more difficult. The instrument should be replaced.

6.07 <u>General Condition of Chemical Tanks and Piping.</u>

This section of the report discusses the general condition of chemical assets, such as bulk tanks, day tanks, water tanks treated with chemicals, piping and chemical pumps.
The main acid bulk tank at Pt. Tupper was thickness tested in 2003 and several points on the tank had corroded beyond 50 % of the original metal thickness. The tank was 35 years old at this time .A new rubber lined tank was installed in 2006 to replace this tank.
The two acid transfer pumps were refurbished at the same time the tank was replaced.
The main caustic bulk tank was thickness tested in 2007 and the readings were satisfactory for corrosion rate. The tank is now 42 years old. The two caustic transfer pumps that are 42 years old are still working well.
The third bulk tank contains caustic and is located in the Wastewater plant. This tank is 24 years old and has never been thickness tested. The vent on this tank has never been checked for blockage.
Acid tote tanks are also being used for temporary storage of 93 % Sulfuric Acid at the WWTP and condensate polishers. Both 1000 liter tanks are located outside on containment units. The WWTP tank was replaced 2008 and the polisher tank in 2006. The expected life of these plastic tanks is 10 years.
Due to a history of leakage in the chemical piping and day tanks, the Graver and Sternson day tanks and associated piping were replaced in 2006 complete with new acid & caustic pumps. Pumps were reduced from eight with two systems to four on one system. All materials used were within the guidelines in TMP-30. The dilution water lines were replaced with this project. The acid transfer piping from the bulk tank to the acid day tank was upgraded at this time.
A new alloy 20 acid transfer line was installed from the polisher acid tote tank to the polisher acid pumps in 2010. The polisher acid pumps are 10 years old and working well.

The polisher acid pump discharge piping and block and bleed system have evidence of corrosion at flanges and have threaded fittings at several locations. Threaded fittings are not recommended. The piping appears to contain dissimilar metals.
The polisher caustic day tank and caustic metering pumps are original, 37 years old. The day tank has never been thickness tested and the pumps are working okay. There is no record of maintenance on the caustic pumps. The caustic transfer line from the WTP to the polishers was thickness tested once prior to the 2002 review but has not been tested since.

The hydrogen gas transfer piping has never been tested since installation.

Pt. Tupper has two stainless steel day tanks for High Pressure boiler dosing including two Milton Roy high pressure dose pumps. The day tanks are in good condition. The dose pumps are 37 years old and receive regular maintenance checks and lubrication.

Pt. Tupper > Summary and Recommendations

1/ Several improvements have been made to the Pt. Tupper Water Treatment Plant since the 2002 review. Notably, all demineralizer vessels have new resin in 2009/2010. This has improved throughputs and reduced regenerations. Repairs to the reactivator flume and Graver splitter box were completed in 2010. The acid/caustic dilution water lines were replaced in 2006. A new Raw Water meter was installed in 2008.
New acid and caustic skids with day tanks and pumps were added in 2006 as well as a new bulk acid tank. Bulk chemical tank inlet piping and containment was upgraded in 2003.

Recommendations: (a) Replace rubber liner in Graver "B" train and mixed bed.
(b) Replace carbon in Graver carbon filters and inspect vessels.
(c) Upgrade monitors on Sternson panel and add PLC control.
(d) External and internal inspection of Graver and Sternson sand filters.
(e) Refurbish or replace Sternson pneumatic diaphragm valves to restore up flow regeneration capability of the anion unit.

2/ Pt. Tupper made some significant improvements to the condensate polishing plant since the 2002 review. A third polisher was installed in 2005, allowing regenerations without a load drop or overtime costs. Regenerations increased threefold in 2008 due to the deteriorating condenser. The polishers were upgraded to PLC control and several new pneumatic valves replaced. The acid tote tank was replaced in 2006 and acid transfer piping upgraded in 2010. A new software program was added to measure flow. The resins are currently 12 years old. Samples have been collected for analysis.

Recommendations: (a) Upgrade polisher acid pump discharge piping and block /bleed piping and valves to TMP-30 guidelines.
(b) UT test caustic transfer piping from WTP to polishers.

(c) Clean and check condition of caustic day tank. Do thickness Testing of day tank and associated piping.
(d) Replace or refurbish acid/caustic inlet pneumatic valves as well Pneumatic vent valves on the East & West polisher.
(e) Replace all three resins pending sample analysis results.

3/ Pt. Tupper #2 continues to operate on Phosphate & Caustic treatment. The boiler did experience a major condenser leak with an "Acid Excursion" condition in the boiler in April 2008. There were no boiler leaks as a result of the excursion. There have been some inconsistencies with the feedwater treatment being outside the guidelines for pH and Hydrazine levels. Hydrazine levels have exceeded the limit of 80 ppb more than 40 % of the time. This can impact the magnetite loading on boiler tubes.
Pt. Tupper has conducted a field trial with Cortrol OS5900, a less toxic oxygen scavenger to replace Hydrazine Hydrate. Preliminary results have been positive. The trial will continue further into 2010 with another similar product.
A boiler tube sample has been collected to check magnetite loading in 2010.

Recommendations: (a) Replace current manual LP dose pumps with automated systems to control pH and oxygen scavenger levels.
(b) Continue feedwater field trial with alternate oxygen scavengers.
(c) Complete magnetite loading test on boiler tube sample.

4/ The closed cooling water system (GSCW) continues to be treated with a molybdate based corrosion inhibitor within the 60-80 mg/l guideline. The system has been tight since the lower storage tank was replaced in 2004. No inspections of the upper or lower storage tanks have been done since 2004. The average concentration of molybdate has been 55mg/l but it has been outside the guideline more than 70 % of the time. In 2009 the GSCW supply was contaminated from the Raw water supply.

Recommendation: (a) Inspect the upper and lower GSCW storage tanks to see if there has been any corrosion impact from the treatment and the raw water contamination from 2009.
(b) Replace small bore piping where the cooling water flow is restricted.

5/ Since the 2002 chemical review, Pt. Tupper has experienced a deterioration of the original condenser until its replacement in 2008. After a few months operation the new condenser also experienced multiple leaks. After investigation the root cause of the corrosion was determined to be hydrogen sulfide in polluted seawater. Pt. Tupper had been treating the condenser with liquid Ferrous Sulfate for corrosion control. It was determined that the amount used was insufficient. The recommended concentration of Ferrous Sulfate as Fe at the condenser inlet was 3.0 mg/l. This was achieved by adding approximately 1.5 bags (22.5 kg) per day over 30-60 minute time period. This action has stopped the multiple leaks. Pt. Tupper will replace the plugged tubes from the new condenser in the 2011 outage. Pt. Tupper continues to use liquid chlorine for mussel control in the condenser. The Total Residual Chlorine monitor was replaced but does not consistently produce accurate data due to inlet sample quality.

Recommendation: (a) Continue with current Ferrous Sulfate Treatment program.
(b) Complete tube replacement program in 2011 outage.
(c) Investigate a new design for the condenser TRC sample.

5/ since the 2002 review Pt. Tupper has been using Infocalc database for cycle chemistry data storage. This program has been used for trending and troubleshooting chemistry issues. Also the PI system is used for monitoring of online cycle chemistry instrumentation. There are no PI points to measure performance in the Water Treatment Plant The lab does the online instrument checks monthly. The unit #2 analytical panel is scheduled for replacement in 2011. The new panel will include a sodium analyzer, feed water pH and new dissolved oxygen analyzers. The cooling water currently does not adequately cool samples to the standard temperature of 25 deg. C. The panel should include an improved cooling water supply and a new high pressure sample design with double isolation.
The DX-100 Ion Chromatograph for measuring boiler and feed water parameters is out of date and needs to be replaced. Replacement parts are difficult to obtain.

Recommendations: (a) Continue with capital project to replace unit #2 analytical panel. The panel should include updated analyzers including additional sodium analyzer, pH and dissolved oxygen analyzers.
(b) The above capital project should include an improved cooling water supply to meet the standard for sample temperature. This may require additional sample chillers in the design.
(c) Replace old DX-100 Ion Chromatograph with modern unit.

6/ Pt. Tupper stores cycle chemistry results in the Infocalc database program. The program is not currently compatible with Microsoft programs. The program has good trending and graphing capabilities. The lab also has access to the PI online trending program. The Water Treatment plant instrumentation is not currently on the PI system.
Pt. Tupper has an electronic share point site for lab procedures. The procedures were downsized and revised since the 2002 review. A common share point site is being developed in 2010 for additional chemical reference documents for all Power Production labs. A new Environmental Reporting Database is being developed for regulatory data storage and reporting in 2010.

Recommendations: (a) Upgrade the Infocalc software to be compatible with Microsoft database programs.
(b) Upgrade WTP instrumentation to be compatible with the PI online system.

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7/ Pt. Tupper has made several improvements and upgrades to some major chemical assets within the last five years. This includes a new bulk acid tank, acid/caustic skids and dilution water pipeline in the WTP. Both the acid storage tote tanks have been replaced in the last five years. Acid transfer piping at the WTP bulk system and at the polishers was upgraded to the TMP-30 standard.
The bulk caustic tank in the WTP is 42 years old and was UT tested in 2007 satisfactorily. The tank has never been cleaned or inspected internally. The WWTP caustic bulk tank is 24 years old and has never been UT tested or internally inspected.
The condensate polisher caustic transfer piping and day tank have not been UT tested in ten years. Some of the discharge acid piping and block/bleed valves at the polisher acid pumps need to be upgraded to meet the requirements of TMP-30.
The hydrogen gas line piping has never been tested.

Recommendations: (a) Clean and internally inspect both bulk caustic storage tanks.
(b) Conduct UT testing of polisher caustic day tank and caustic transfer piping to the condensate polishers.
(c) Replace piping and valves on the polisher acid discharge and block/bleed system to meet TMP-30 standard.
(d) Create PM program in Directline to ensure future inspections and testing of Chemical Assets. as per TMP-30.

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NSPI Thermal Station Chemical Asset Gap Analysis Report – 2010
Tuft’s Cove Plant Specific Findings.

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6.0 Plant Specific Findings

Tuft’s Cove > **Audit results and review**.

6.08 Water Treatment Plant

The plant continues to use Dartmouth City water for raw water supply. Pretreatment for the old unit #1 & 2 Cochrane units and the #3 Sternson unit, is still sand filters and organic traps for organics removal. The organic traps were averaging over 800,000 US gallons between regenerations in 2005. Resin samples were collected in 2007. Resin in both traps has been replaced and the average throughput for 2010 is 655,000 US gallons between regenerations.

The plant continues to experience water pressure problems that are having an impact on the design flow to the Cochrane and Sternson Plants. It was recommended to install a booster pump to restore water pressure to 85 psi, during the 2002 gap analysis report. Current flow rates for each Cochrane unit are 30 usgpm and the Sternson is 140 usgpm. The design flow rates for each Cochrane are 60 usgpm and the Sternson is 180 usgpm. It was recommended in the 2002 gap analysis that the Cochrane plant be replaced to restore some capacity to the Water Treatment Plant.

With the addition of the Tuft’s Cove LM6000 units in 2004 /2005, Tuft’s Cove had to increase the capacity of their Water Treatment Plant. An Osmonics, Reverse Osmosis system with electrodeionization has added an additional 126 usgpm to provide makeup and N0x control to the LM6000 unit #4 & Unit #5. This unit has its own raw water line with multi media filtration prior to the RO. The RO has a clean-in place membrane cleaning program. There is no manual control when the PLC shuts down.

Water Treatment plant usage in 2005 was 58 % EDI, 35 % Sternson and 7 % Cochrane.

Further study in 2010 has indicated that the HRSG will require 10 usgpm flow for normal operation and 65 usgpm for startup. Peak daily average flows with 100 % oil could be in the range of 343-397 usgpm. The current available daily average flow with the EDI, Cochrane and Sternson in service is 326 usgpm.

Changes to the treatment at the city Water Treatment Plant have increased the raw water conductivity by an average 38 % compared to 2003/2004 analysis. Chloride has increased by an average 53 % and sulfates an average of 16 % from 2004 to 2009. The resin in the Sternson is also more than 10 years old. The impact from the raw water changes and the resin age has lowered the throughputs on the Sternson plant from an average 400,000 in 2002 to an average 354,000 in 2006 and 289,000 US gallons between regenerations. This has increased the number of regenerations by 25 % and also increases the demand on water usage. The zinc from the city water also has increased the frequency of RO membrane cleanings.

Actions Taken: The WTP organic trap resins were replaced in 2007 and 2009.A new RO/EDI Water Treatment system was installed in 2004/2005 to increase WTP capacity by 126 usgpm for the two LM6000, 50 MW gas units.

Finding #1: The throughput capacity of the Sternson WTP has been reduced by 28 % since the 2002 gap analysis. Raw water changes and resin age are contributing factors.

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Recommend changing all resin in the Sternson Plant. Resin samples in 2010 indicate degraded resin quality.

Finding #2 The current flow capacity of both the Cochrane and the Sternson plants is below design by 50% on the Cochrane and 22 % on the Sternson. Installation of a booster pump to increase system pressure is recommended to restore some flow capacity.

Finding #3: Water balance studies done at Tuft's Cove from 2003-2010 indicate that if Tuft's Cove units #1-#3 were 100% oil fired and Tuft's Cove #4 & #5 LM6000 were at maximum capacity with the addition of the HRSG combined cycle online that the current Water Treatment plant capacity would not be adequate for peak flows and startups. It is recommended that the old Cochrane plant be replaced with a new unit capable of supplying a minimum 130 usgpm.

Finding #4: The online silica analyzer in the Water Treatment Plant is not working. It is recommended that the unit be replaced with a new analyzer. This is to prevent silica contamination to demin storage.

Finding #5: When the PLC fails on the RO system the lab has no manual control to keep the system running. This is a risk to reliability of the plant. It is recommended that some discussion take place with the OEM on the feasibility of having manual controls on the RO system.

<u>Maintenance and Equipment</u>:

Membranes were replaced in the RO after seven years and some of the EDI ion-exchange units have been replaced after five years. Three are yet to be replaced. Resin samples from the Sternson were taken for analysis. The Sternson plant was upgraded to PLC control in 2009.
One acid transfer pump and one caustic transfer pump have been replaced. There is still three each of the old acid/caustic pumps in service. A new stainless steel acid transfer line from the bulk tank to the WTP and polishers has been installed to replace old carbon steel piping.
A new brine tank for the WTP has been added and a new acid metering pump for the Cochrane Water plant.

Finding #6: There is a problem with the laterals on the Sternson anion. This could be impacting throughput levels. Recommend inspection and repair as soon as possible.

Finding #7: There has been virtually no maintenance done on the #3 Sternson train pneumatic valves. It is recommended that a program for refurbishment or replacement of these valves be set up in the Asset Management program.

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6.09 Condensate Polishers

The Tuft's Cove plant has one Gaco-Sternson polisher on each of the unit #1 and #2 units. After a damaged lateral was repaired and the vessel thoroughly inspected, it was determined that these polishers are only capable of polishing 740 usgpm each and not the 1200 usgpm design flow. The restriction is with the number of bottom strainers that allow only 10 usgpm each. There are 74 strainers in the vessels. Trying to put 100 % feedwater flow through these polishers would lead to high differential pressures and damage to the internals in the vessel. The unit #1 & #2 polishers are not on PLC controls. The resin was changed in the #1 polisher in 2008. The unit #1 & #2 polisher average throughputs were 19.54 and 22.9 million respectively in 2003 versus 16.3 and 15.8 million in 2010.
Tuft's Cove unit #3, also has two Degremont polishers each designed to treat 939 usgpm of condensate. The unit #3 polisher average throughputs in 2003 were 20.9 and 19.3 million for the East and West polishers versus 15.6 and 15.2 million in 2010. The resin in these polishers is more than 20 years old.

Actions Taken: The unit #3 polishers were upgraded to PLC control. They are also capable of manual control. A new pneumatic outlet valve was installed on the west polisher.
New conductivity meters and pump controllers were added to the Unit #1 & #2 polisher panel. A damaged lateral was replaced on #1 polisher and new resin added in 2008.
#2 polisher resin was replaced in 2005.

Finding # 8: During an inspection and repair of unit #1 polisher, it was determined that flow through the polisher is restricted by the size and number of bottom strainers. Design flow indicates 1200 usgpm but the strainers limit the flow to 740 usgpm for this polisher. Trying to put full flow through this polisher could cause high differential pressure and damage to internals.

Finding #9: Unit #1 and #2 polishers are still operated on old timers and regeneration controls. These should be upgraded to PLC control for reliability.

Finding #10: The resin in the Unit #3 condensate polishers was ten years old in 2002 and test samples in 2010 indicate degradation of the resin. It is recommended that resin be replaced in both polishers. Throughputs have dropped by 30% since 2002.

6.10 Boiler/Feed water Cycle Chemistry

Tuft's Cove is still currently operating three fossil fueled boilers approximately 80 MW, 100 MW and 150 MW respectively from Unit's #1, #2 & #3. In 2004/2005, Tuft's Cove added two LM6000 gas fired turbine units each 50 MW. In 2010, Tuft's Cove is adding an additional 50 MW to the station by using the exhaust heat from the LM6000 in a combined cycle HRSG unit. The chemistry for the boiler feed system for this unit is currently being developed prior to commissioning in December 2010.
Unit's #1, #2 & #3 are currently on Phosphate Treatment with Caustic addition. The pH levels monitored by the lab for the most part have been within the guidelines. Unit #2 has

experienced some sustained high levels of chloride in the boiler due to condenser leaks. These high levels of chloride coupled with low phosphate levels are putting the #2 boiler at risk of having boiler tube failures. This unit has a history of tube failures due to high deposit loading originating from corrosion products formed during startups when the unit was two-shifted. Unit #3 also has a history of tube failures related to high deposit loading causing overheating and under-deposit corrosion. It has been recognized that condensate polishing is required when starting up a unit to reduce the amount of corrosion products into the boiler.
EPRI recommends lower chloride limits when operating on low phosphate treatment. Minimum phosphate limit on Continuum Phosphate treatment is 0.2 ppm.
Tuft's Cove plant has good program for feedwater treatment and are now measuring copper and iron levels in the feedwater. Parameters are within the EPRI guidelines.

Action Taken: Acid cleans were completed on unit #3 in 2003 and a multi-stage acid clean was done on unit #2 in 2006. Boiler tube samples have been taken from all units to monitor deposit loading on tubes. A program of increased condensate polishing has been implemented on unit #3. The units have not been two-shifted since 2008 while been fired on natural gas.

Finding # 11: From February to May of 2010, 52% of chloride values for #2 boiler exceeded the EPRI guideline of 2.0 ppm as Cl. Also for the same time period, 37.9 % of sulfate values for #1 boiler exceeded the EPRI guideline of 2.0 ppm as S04. The #2 boiler chloride is related to condenser leaks and inability of the #1 polisher to polish 100% of the condensate. The sulfate in #1 boiler is related to polisher regeneration efficiency. The sulfate may be reduced by increasing slow rinse times during regeneration.

Finding # 12 The design of the bottom strainers on the #1 & #2 condensate polishers limits the protection from chloride ingress during condenser leak events. They are not designed for 100% polishing. Additional polishing capacity is recommended to prevent contamination into the boiler.

6.11 (a) General Service Cooling Water/Circulating Cooling Water

Tuft's Cove has one Closed Cooling Water system for unit's #1 & #2 and one separate General Service Closed Cooling Water system for unit #3. The systems consist of an upper and lower storage tank treated with a molybdate based corrosion inhibitor and caustic for pH control. The control guidelines for molybdate treatment are 60-80 mg/l as molybdate. A review of the lab results from 2006-2010 has indicated that there has been extended time periods when the molybdate levels have been below the minimum of 60 mg/l. Some of the values have been attributed to poor mixing in the #1 & #2 GSCW tanks. The chemical is currently being added to the upper GSCW storage tank. The plant has experienced some history with makeup control.

Action Taken: The GSCW storage tanks for unit #1 & #2 were inspected in 2009.
The plant is investigating a modification to have the molybdate chemical added to the lower storage tank to improve mixing.

Finding #13: Since 2006, the average molybdate concentration in unit #1 & #2 GSCW has been 62 mg/l but the concentration was outside the 60-80 mg/l guideline 67 % of the time. Also the average molybdate concentration for the #3 GSCW was 65 mg/l for the same time period but was outside the guideline 39 % of the time. Leaking valves and poor mixing may be contributing to this condition. This needs to be improved to protect the tanks and piping.

Finding #14: The unit #1 & #2 GSCW storage tanks have extensive rusting on the outside of the tanks. Thickness testing is recommended to ensure the integrity of the tanks.

Finding #15: The unit #3 GSCW storage tanks have not been inspected internally for more than ten years.

6.04 (b) Circulating Cooling Water (Seawater) Ferrous Sulfate Treatment.

Tuft's Cove uses Ferrous Sulfate for control of corrosion on the cooling water side of the condenser for all three fossil fired units. There is presently no treatment for biological or mussel control. The Ferrous Sulfate system consists of adding solid Ferrous Sulfate Heptahydrate in 22.5 kg bags to a day tank and pumping the solution into the condenser inlet.
In 2003 the air extraction zone tubing was replaced in unit #3 with 90/10 Cu/Ni. The unit experienced an increase in condenser tube leak outages in 2007 and 367 tubes were plugged in the main condenser and 58 tubes in the air extraction zone after tubes were identified with more than 70 % tube wall loss by eddy current testing.. The failures were caused by internal wall pitting and inlet end corrosion. There was also significant material loss on plugs. Unit #2 was also experiencing condenser tube failures.

Action Taken: Eddy current testing on unit #3 to identify tubes with more than 70 % loss. New plugs with improved metallurgy were installed. Improved sources of air ingression, replaced condenser doors, and added additional sacrificial anodes.
The Ferrous Sulfate dosing system was investigated a liquid Ferrous Sulfate system was developed but changed back to powder based on history from Pt. Tupper.
The Ferrous Sulfate dosing was increased on all three units to try and meet the suggested guidelines of 2.5-3.0 mg/l as Fe at the condenser inlet.
New sample points were installed on the condenser inlets for measuring the Fe concentration.
The plant is also investigating the possible installation of an impressed current system to improve cathodic protection in the #3 condenser.

Finding #16: Tuft's Cove is currently mixing Ferrous Sulfate powder in day tanks and injecting solution into the condenser inlet but the injection time is too fast (10-15 minutes). The recommended injection time as per guidelines is 30-45 minutes for proper distribution of the Ferrous Sulfate. Samples should be taken at the inlet and outlet of the condenser, 10 minutes after injection starts.

Finding #17: There has been an increase in the amount of bio-fouling in the condenser as observed by operations and maintenance personnel. The plant is currently investigating bio-fouling control methods. This includes investigation of possible changes in the water chemistry of cooling water.

6.12 Monitoring and Instrumentation

Tuft's Cove lab has access to the Fossil Power system and PI system for monitoring of online instrumentation.
The unit #1 & #2 analytical panel is basically in good shape although there is some extensive rusting on the sample coolers and cooling water for the samples is not adequate to keep the sample temperature at the standard 25 deg. C as per EPRI guideline.
In addition the dissolved oxygen meter for unit #1 is not working. Two new conductivity meters have been added and a new pH meter. The analytical equipment meets the EPRI standard except there is no sodium analyzer for steam and extraction pump samples.
The unit #3 analytical panel has extensive rusting on the main panel, with several out of date monitors. The valve systems and coolers, including the sample flow meters are in poor shape. The dissolved oxygen meters on the panel are not working and cooling water is inadequate. This is impacting the reliability and accuracy of online monitoring.

Action Taken: An assessment of the unit #3 analytical panel has been completed and a contractor has been hired to create a package for replacement of the panel in 2011. It is recommended that the package include a sodium analyzer and secondary cooling, i.e. Chiller.

Finding # 18: The cooling water to units #1 & #2 and unit #3 analytical is not adequate To meet the EPRI sample temperature of 25 deg. C. It is recommended that the cooling water inlet piping to the analytical panels be inspected for restrictions and replaced where necessary. It is also recommended that secondary cooling such as chillers be added to the analytical sample system.

Finding #19: Dissolved oxygen meters are not working on unit #1 and unit #3.It is recommended that these meters be replaced with reliable dissolved oxygen monitors.

Finding #20: The sample coolers on unit #1 & #2 panel have extensive rusting. It is recommended that they be replaced where required.

6.13 Procedures/Chemical Control Records/Tasks

Tuft's Cove lab has initiated a SharePoint site for electronic access to lab procedures. The Environmental Water and Wastewater Quality Manual is also available on the Core Manual site for analytical testing procedures and QA/QC controls for lab data. Lab staff is also using section five of the old Chemical Operation's Handbook from 1984 for testing procedures.
Prior to 2010, Tuft's Cove lab was entering cycle chemistry analysis data into daily sheets and logbooks. In 2010, a spreadsheet was created in Microsoft Excel for recording

and storage of cycle chemistry and WTP data. Procedures for Ion Chromatography are from equipment manuals.

Action Taken: A new excel spreadsheet has been initiated for cycle chemistry and WTP data recording and storage. This is available electronically for viewing and analysis of results. A SharePoint site has been created for electronic storage of lab procedures. Procedures are being updated and new ones added as required. There may be some training required for lab staff for access and awareness. Tuft's Cove lab currently has access to PI and Fossil Power for online monitoring of cycle chemistry.

Finding # 21: Prior to 2010, there was no electronic storage of cycle chemistry data. It is recommended that a software package similar to Infocalc be used for future data storage and retrieval of cycle chemistry data. Chemistry and water balance audits are very difficult and time consuming when data is taken from logbooks and sheets.

Finding #22: The Tuft's Cove lab is still currently using old outdated procedures from the 1984 version of the Chemical Operations Manual. New procedures have been developed in the Environmental Wastewater and Water Quality Manual in electronic form. Also Tuft, s Cove has started a new SharePoint site with updated lab procedures.
All procedures should be brought up to current standards.

Finding #23: The Lecco SC432 Sulfur/Carbon analyzer is > 30 years old and finding replacement parts is getting more difficult. The instrument should be replaced.

6.14 <u>General Condition of Chemical Tanks and Piping.</u>

This section of the report discusses the general condition of chemical assets, such as bulk tanks, day tanks, water tanks treated with chemicals, piping and chemical pumps.
The main acid bulk tank at the Tuft's Cove WTP was cleaned and inspected internally with thickness testing in November 2009. The old carbon steel acid transfer piping from the bulk tank to the WTP and polishers was replaced with 316 SS piping in 2009. The bulk tank and acid day tank vents and overfills were also inspected in 2009. One of four acid transfer pumps was replaced. One acid metering pump was replaced on the Cochrane system in 2008.
None of the bulk caustic tanks or day tanks including the vents and overflow lines has been inspected. None of the caustic transfer line has been NDE tested. There was some obvious cracking at the bottom of the WTP containment system for the caustic pumps.

The caustic transfer system in the WWTP was upgraded and installed in 2005-2006. It was further upgraded with new caustic valves in 2009. In addition to the caustic system upgrades in the WWTP, a new Floc pump was installed and some small metering pumps.

There is an old acid day tank in the WTP that is not being used. This should be disposed of to prevent accidental release of acid.
The unit #3 LP chemical dose pumps are on a regularly scheduled maintenance program in Directline. There are four LP dose pumps available for Units #1, #2 and #3. All pumps

except one newer pump on unit #3 are ten years old. Ammonia and Hydrazine is mixed and pumped into the feed systems with auto control on conductivity. LP dose systems are working reasonably well.
The hydrogen trailer is inspected on 6 month and five year intervals by Air Liquide. The hydrogen panel is inspected annually. Hydrogen gas piping has not been tested.

Tuft's Cove has one day tank with a divider wall for caustic and phosphate for high pressure boiler dosing including one original chemical dose pump. This pump is due for replacement.
Unit #3 has one stainless steel day tank and one chemical dose pump for high pressure boiler dosing.
Tuft's Cove added two 50 MW gas fired LM6000 turbine units in 2004/2005, including an additional 126 usgpm RO/EDI water treatment system to supply water to the LM 6000's. In 2010, construction has begun on a once-through Heat Recovery Steam Generator combined cycle unit with an additional 50 MW. A proposal for a new chemical treatment program for this unit is being reviewed. In addition, the HRSG has a new condenser with titanium tubes and a Graver Powdex condensate polishing plant.
Recommended chemical treatments for this type of unit, as per EPRI guidelines are AVT (O), AVT (R) or Oxygenated Treatment.

Tuft's Cove > Summary and Recommendations

1/ Capacity of the Tuft's Cove conventional Water Treatment plant has slowly deteriorated since the 2002 review. Contributing factors are ion-exchange resin age, deteriorating city water quality and pressure and some maintenance issues. New capacity of 126 usgpm was added in 2004/2005 with the addition of the two LM6000, 50 MW units. The new capacity addition was a combination Reverse Osmosis/ Electrodeionization treatment plant. This unit requires no regenerations. An addition was added to the RO to reduce the production of wastewater. In 2010, an additional 50 MW will be added to the LM6000 units with a combined cycle HRSG unit. This will require an additional 10 usgpm for normal operation and a peak 65 usgpm for startup of the unit. With the diminished capacity in the Cochrane and Sternson units, water studies have shown that with 100% oil firing and the two LM6000's in service, and the additional combined cycle unit in service ,that the Water Treatment plant is at risk of not having enough capacity to meet the peak flow conditions.

Recommendations: (a) Repair/refurbish valves and internals in Sternson unit.
(b) Replace resin in all Sternson vessels.
(c) Complete replacement of old EDI units.
(d) Replace old Cochrane plant with 130 usgpm capacity
(e) Install booster pump on city water system to improve pressure to demineralizers.

2/ Condensate polisher resin was changed in #1 polisher in 2008 along with repairs to the vessel internals. Unit #2 polisher resin was replaced in 2005. The Unit #3, East & West polisher resin in excess of 20 years old. Unit #3 polishers have been upgraded to PLC

control but unit #1 & #2 polishers remain on old timer controls. A design problem with bottom strainers restricts flow through the unit #1 & #2 polishers, creating a risk of contamination in the boiler during condenser leak events.
Unit #3 polisher throughputs have been reduced by 30 % due to resin condition.

Recommendations: (a) Replace condensate polisher resin in East & West polishers.
(b) Upgrade unit #1 & #2 polishers to PLC control for reliability.
(c) Investigate replacement of bottom strainers in unit #1 & #2 condensate polishers to increase flow through units or add additional condensate polishing capability.

3/ Tuft's Cove fossil boilers are currently on phosphate treatment with caustic addition for pH control. The feed system is ammonia/hydrazine for dual metallurgy corrosion control. Since the 2002 chemistry review, both unit #2 and unit #3 have experienced boiler tube failures associated with high deposit loading from two-shifting and condenser leaks. Boiler cleans were done on both of these units since 2002. It is recognized that deposit from startups and contamination from condenser leaks can be prevented with 100 % condensate polishing. The inability to polish 100% has allowed chloride contamination into unit #2 boiler on several occasions. Low phosphate dosage coupled with the chloride excursions is placing the boiler at risk of tube failures.
LM6000 units use demineralized water from the TUC water treatment plant.

Recommendations: (a) Increase minimum phosphate in boilers to 0.2 mg/l and reduce chloride limit in all boilers from 2.0 mg/l to 1.0 mg/l. (EPRI Phosphate Continuum Treatment)
(b) Achieve 100% polishing on all units during startups and condenser leaks.
(c) Continue boiler tube sampling program as per TMP-029.

4/ The closed cooling water system (GSCW) continues to be treated with a molybdate based corrosion inhibitor within the 60-80 mg/l guideline. The molybdate for corrosion control has been outside the guidelines on the low side for 67 % of the time for unit's #1 & #2 and 39 % of the time for unit #3 GSCW from 2006-2010. Makeup to the GSCW has been impacted by steam supply leaking into the system, leaking valves and poor mixing of chemical that may be contributing to the performance. Conditions with the closed cooling treatment may be contributing to poor cooling performance in small bore piping to the analytical panels and other equipment.

Recommendation: (a) Repair any steam leaks and leaking valves on either system.
(b) Change the molybdate injection station from the upper storage tank to the lower storage tank to improve mixing of chemical.
(c) Inspect GSCW storage tanks and small bore piping for any evidence of corrosion or deposit in the cooling water lines.

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5/ Condenser tube failures have continued to impact on boiler chemistry for units #2 & #3. Extensive repairs were done to unit #3 condenser including replacing air extraction zone tubes, eddy current testing, resulting in over 400 tubes plugged in unit #3 and improved plug metallurgy for corroding plugs. Repairs to improve air in leakage have been completed. Additional anodes have been added and an increase in Ferrous Sulfate dosage has lowered the frequency of leaks. The plant is currently looking at improving the Ferrous Sulfate dosage system for efficient and safer use of the product. New sample points have been added at the condenser. There has also been a recent increase in the amount of bio-fouling in the unit. There is no current treatment being used for mussel control or bio-fouling. The plant is also investigating the use of an impressed current system to improve cathodic protection of the condenser.

Recommendation: (a) Continue with Ferrous Sulfate Treatment program improvements. with recommended concentrations at condenser inlet.
(b) Investigate extent of biofouling and proper treatment.
(c) Continue program of 100 % polishing during condenser leak excursions and unit startups.
(d) Continue investigation to improve cathodic protection of the condenser.

6/ Tuft’s Cove currently uses the Fossil Power system and the PI system for monitoring online cycle chemistry instrumentation. The lab conducts manual checks periodically to check the accuracy of the online information. The accuracy of sample data is dependent on the reliability of the instruments and sample conditions at the analytical panels. A review of the analytical panels at Tuft’s Cove indicates that the unit #1 & #2 panel is generally okay with the exception of poor cooling of samples. The unit #3 analytical panel and monitors are in poor shape and should be replaced. It also has inadequate cooling water supply to meet the sample standard temperature of 25 deg. C. The dissolved oxygen meters are in poor shape on all units and should be replaced. Tuft’s Cove is currently looking at a project to replace the #3 analytical panel. Tuft’s Cove has no sodium analyzers on all three units. This is an EPRI core parameter and is recommended for steam and extraction pump samples.
Since the 2002 cycle chemistry review, Tuft’s Cove lab has upgraded all the Dionex analytical equipment for conducting analysis of cycle chemistry and wastewater Parameters.
The RO system in the Tuft’s Cove #4 WTP has no manual backup when the PLC Fails.

Recommendations: (a) Continue with capital project to replace unit #3 analytical panel. The panel should include updated analyzers including additional sodium analyzer, pH and dissolved oxygen analyzers.
(b) The above capital project should include an improved cooling water supply to meet the standard for sample temperature. This may require additional sample chillers in the design.
(c) Improve cooling water supply to #2 analytical panel.

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Consider secondary cooling using a chiller.
(d) Recommend installing sodium analyzers on all three fossil units. (EPRI core parameter).
(e) Recommend contacting the OEM for the RO system to see if manual backup is possible when the PLC fails.

7/ Prior to 2010, Tuft's Cove lab was collecting and storing cycle chemistry data on sheets and logbooks. This type of system does not allow easy access to data for trending and troubleshooting. In 2010, the lab created a Microsoft Excel spreadsheet to begin collecting data electronically. This is an improvement on the old method. Generation Services is currently looking at a standardized software package for all plants to use for collecting and storing cycle chemistry data. Some new procedures are being developed in electronic form, but the lab is still using the old Chemical Handbook for reference for others.

Recommendations: (a) Continue collecting and storing cycle chemistry data in the Excel spreadsheet until a standard software package is available for all plants.

(b) Review procedures that are currently being used from the old Chemical Handbook and update where necessary.

8/ Tuft's Cove has made several improvements and upgrades to some major chemical assets within the last five years. The main Sulfuric Acid bulk acid tank was cleaned, inspected and NDT tested including vents and overfills in 2009. All the acid transfer piping was replaced with stainless steel 316 as per TMP-30. The acid day tank, including vents and overfills were also inspected at this time. A new acid injection pump was installed in 2008.
A new caustic transfer system upgrade was installed in the WWTP in 2005/2006 with upgraded caustic valves in 2009.
The hydrogen trailer is inspected by Air Liquide on 6 month and 5 year intervals. The hydrogen pipeline has not been inspected or tested.
Tuft's Cove has PM's in Directline for bulk caustic tank inspections and day tank inspections as well as vent and overfill inspections but these have not been completed.
Caustic transfer piping has also not been thickness tested.
Since 2002 Tuft's Cove has added two LM6000 gas units with installation of WTP#4 to supply water to these units. In addition the plant is adding an additional 50 MW with the addition of the combined cycle HRSG unit in 2010. The cycle chemistry program for this unit will be tested in December 2010.
Recommendations: (a) Clean and internally inspect the bulk caustic storage tank.
(b) Conduct UT testing of caustic day tanks and caustic

(c) Create PM program in Directline to ensure future inspections and testing of Chemical Assets. as per TMP-30.

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NSPI Thermal Station Chemical Asset Gap Analysis Report – 2010
Lingan Plant Specific Findings.

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6.0 Plant Specific Findings

Lingan > **Gap Analysis Results**.

6.15 Water Treatment Plant

In 2006 the Raw Water consumption at Lingan peaked at 591,343 $m^{3.}$ By effectively managing the WTP assets, the plant has been able to reduce Raw Water consumption in 2009 to 378, 818 m^3. This 36 % Raw Water usage improvement has been achieved by recycling treated waste water for use in the flyash vacuum pumps on unit #1 & #2, by improving makeup to the GSCW closed cooling system and restoring the WTP throughputs to design capacity.
The plant struggled with several problems that were created from the New Waterford water supply. The RO was getting fouled and was being partially bypassed. The WTP was only achieving an average 742,000 liters between regenerations.
The chlorine from the town water supply was causing problems with resin performance so a sulfite injection system was installed in 2007/2008 to remove chlorine.
Lingan is currently investigating the possible replacement of the RO system in 2011.
The Lingan WTP was upgraded to PLC control in 2003. A silica monitor was installed in the WTP since the 2002 review to monitor any silica breakthrough in demineralizers.
The number of regenerations in the WTP in 2009 was 174 versus 367 in 2001.

Actions Taken: The ion-exchange resin was replaced in the WTP in 2007. The RO membranes were replaced in 2008. The New Waterford water treatment process was changed in 2008 and this allowed Lingan to eliminate treatment chemicals in the clarifier. This reduced the number of RO cleanings and restored the average throughput for the WTP to 1791 m^3 in 2009 and 2096 m^3 in 2010. Sulfite injection installed to remove chlorine. Clear well pumps were also replaced in the WTP.

WTP Maintenance and Equipment:

Since the 2002 chemical review, there were some repairs to laterals on the A & B trains.
All the pneumatic valves on the ion-exchange vessels in the WTP were refurbished or replaced. The vessels were last spark tested in 2001. The acid dilution water line was pressure tested in 2010.
The 30 year old bulk acid tank was cleaned, inspected internally, thickness tested and repaired as required in 2008. Two acid pumps were replaced in 2003.
The acid day tanks in the WTP are 15 years old and difficult to inspect internally because they are sealed on top.
The bulk caustic tank is over thirty years old and has not been inspected internally. There was a new SS316 caustic fill line installed in 2010 and new cladding installed.
The WTP caustic skid and pumps are original over 25 years old.

Action Taken: Lingan has created PM’s in the Directline work management system for regular inspections of chemical tanks and chemical piping. This also includes tank vent inspections. The bulk caustic tank vent was checked.

Finding #1: The Bulk Caustic tank has not been inspected internally or thickness tested. The tank is more than 30 years old.

Finding #2: The WTP caustic skid including the day tank and pumps is more than 25 years old and needs to be upgraded.

Finding #3; The acid day tanks for the WTP and Polishers are 15 years old and cannot be cleaned because the top is sealed. It is recommended that the tanks be replaced with SS 316 tanks with removable top and current standard safety features.

Finding #4: The caustic transfer line to the condensate polishers needs to be NDT thickness tested.

6.16 Condensate Polishers

Lingan has two condensate polishers for each of their four units. In 2002, only one caustic pump was available for both the WTP and condensate polishers. The normal complement of two caustic pumps for the WTP and two for the condensate polishers were available during this review. There are no day tanks or pumps at the polishers. Acid transfer is done from the WTP with centrifugal positive displacement pumps. The acid transfer piping to the polishers was replaced in 2001 including a double block and bleed valve system. A 156W PM is in place for regular inspection of the piping. All resins were changed in the polishers in 2001. Condensate polisher resin changes are scheduled for unit #1 in 2010 and the remaining polishers over the next three years. There was 97 polisher regenerations in 2009 compared to 118 in 2001. The average polisher throughputs before regeneration in 2009 and 2010 were 55.3 and 54.2 million liters.

Actions Taken: 3A polisher liner was spark tested in 2002. It was good. Unit #1 polishers are scheduled to be spark tested in 2010 with the resin change.
The condensate polishers and panels were upgraded with new dilution water flow meters, flow counters, conductivity meters and Acid /Caustic strength meters since the 2002 review.

Finding # 5: Polisher operational controls are outdated. Polishers are currently being regenerated in manual mode with toggle switches. It is recommended that the panels be upgraded to PLC controls.

Finding #6: Most of the pneumatic control valves on the condensate polishers are original 25-30 years old. These valves should be in an asset management plan for refurbishment or replacement .These types of valves have a history of diaphragm failure.

Finding #7: The average polisher throughputs before regenerations in 2009 & 2010 were 55.3 and 54.2 million liters. Normal throughputs should be 70-80 million liters.

This 25 % loss in capacity can be attributed somewhat to condenser salt leak activity in all units, some lateral problems in U4A and deterioration of resin due to age. It is recommended that Lingan continue with plans to replace resins.

Boiler/Feed water Cycle Chemistry

The boiler water treatment program at Lingan is phosphate treatment with pH control 9.2-9.6. Phosphate levels are 2-4 mg/L as PO4. Lingan uses Mono/Di sodium phosphate on units 1 &2 and Mono-sodium phosphate on units 3 & 4, for boiler water treatment. Chloride and Sulfate are limited to 2.0 mg/l as Cl and S04.
Control of boiler and feedwater chemistry is good with a few exceptions outside the limits. Feedwater chemistry remains the same for mixed-metallurgy; ammonia and hydrazine are used for pH and dissolved oxygen control. The pH limits are 8.8-9.2 and hydrazine 20-40 ppb.
The LP dose pumps on all four units have automatic feed capability to control feedwater conductivity. The plant currently has 6 LP dose pumps. Ammonia and Hydrazine are mixed in the same tanks. All units were on auto control during this review with the exception of pump 3A, that was under repair. Hydrazine and ammonia testing is done weekly.

Action Taken: A silica monitor was installed on the demin effluent makeup after the 2-002 audit. The HP dose tanks on units #1 & #2 have been replaced since the 2002 review. Unit's #3 & #4 are okay.

Finding # 8: Regular testing for copper and iron in the feedwater is not being done. This is recommended by EPRI to monitor feedwater quality.

Finding # 9: There are no online sodium analyzers for monitoring sodium in feedwater and steam samples. Sodium is a core parameter for EPRI. It is recommended that sodium analyzers be installed on all four Lingan units on the steam sample and extraction pump.

6.17 (a) General Service Cooling Water/Circulating Cooling Water

The closed cooling system is treated with a Molybdate based corrosion inhibitor in the range of 60-80 mg/l as Molybdate.
After the 2002 review, it was recommended that weekly testing for molybdate and iron be done to monitor corrosion in the GSCW system. Lingan has had trouble maintaining a Molybdate residual in both the #1 /#2 closed cooling system and in the #3/#4 closed cooling water systems. This was also evident in the 2002 review. This will have an impact on small cooling water piping and on general condition of the GSCW storage tanks.
It is recognized that planning an outage for the GSCW storage tanks is difficult since the GSCW tanks are common to two units.

Action Taken: Make up has been improved slightly and regular testing is done for Molybdate concentration.

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Finding #10: Since 2005, the average molybdate in units #1 & #2 has been 47.2 mg/l and the concentration was outside the 60-80 mg/l guideline more than 70 % of the time. Also the average molybdate in units #3 & #4 has been 37.4 mg/l as Molybdate and the concentration of molybdate has been outside the 60-80 mg/l guideline more than 87 % of the time. This needs to be improved to protect the tanks and piping. It also impacts on the cost of the corrosion inhibitor chemical. It is recommended that the system be checked for valve leaks and overflow as well as external sources of water into the system.

Finding #11 The GSCW storage tanks have never been inspected internally.
It is recommended that all GSCW storage tanks be internally inspected and thickness tested.

6.04 (b) Circulating Cooling Water (Seawater) Ferrous Sulfate Treatment.

The current condenser tube pluggage in the four Lingan units is as follows. Unit #1, 185 tubes, #2, 45 tubes, #3, 230 tubes, #4, 102 tubes. Unit #2 experienced tube leaks from the steam impingement design on the return side of the condenser.
Lingan currently treats the circulating cooling water (seawater) with Ferrous Sulfate for protection of the aluminum brass condenser tubes. The system consists of a 1250 liter tote tank shipped by the supplier to Lingan in a 40 % solution as Ferrous Sulfate Heptahydrate. This raw product is then pumped into a 400 liter day tank at the rate of 50 liters per tank. The mixed solution is then pumped into the condenser inlet over a 30 minute period. This is done twice a day for each unit.

Action Taken: Lingan did Plastocor treatment on Unit #4 condenser tubes in 2008 and on unit #2 in 2009 to prevent further tube failures. Lingan converted the old solid Ferrous Sulfate feed system to a liquid feed system since the 2002 chemical review. Tote tanks of 40 % solution feed into a day tank, and the final solution is pumped into the condenser inlet of each unit.

Finding #12: Calculations done on the Lingan Ferrous Sulfate system vs. the mixed solid
Ferrous Sulfate system at Pt. Tupper indicate that the final solution in the day tanks at Lingan at the current feed rate of 50 liters per tank is 10,000 mg/L as Fe, while the solution in the Pt. Tupper day tank calculates to 18,000 mg/l as Fe. To achieve the 2.5-3.0 mg/l Fe recommended by EPRI at the condenser inlet, it is recommended that Lingan increase the volume of concentrated liquid Ferrous Sulfate from 50 to 100 liters and reduce the frequency from twice a day to once per day for each unit. Chemical should be pumped from the day tank to the condenser over a 30 minute time frame.

6.18 Monitoring and Instrumentation

Lingan has access to cycle chemistry and Water Treatment Plant parameters via the Fossil Power system or PI online system. The DCMS system is also available for on line parameters. The lab does periodic calibration checks of online instrumentation. The lab also does the calibration for the online Wastewater instruments. The analytical panels are in good condition. All units are having trouble with sample temperature in the summer months due to in adequate cooling. Lingan has upgraded several pH and conductivity meters to dual channel meters. Cation conductivity meters have been replaced on all units.

Action Taken: Lingan has upgraded or replaced several analytical instruments such as cation conductivity and boiler water pH and conductivity on all units. Several meters have also been changed on the condensate polisher panels.

Finding # 13: The DA Inlet dissolved oxygen sample on #2 analytical panels was capped off with no flow. This is core parameter for cycle chemistry.

Finding #14: There is inadequate cooling of the water samples to all analytical panels in the summer months. Water sample should be cooled to 25 deg. C .It is recommended that cooling water lines to the panel be checked for corrosion buildup and chillers added or upgraded to meet the temperature standard for water samples.

Finding # 15: The bottom header sample points for boiler samples need to be designed differently to prevent pluggage in the sample line. The bottom header sample location is the preferred location for boiler sampling.

6.19 Procedures/Chemical Control Records/Tasks

Lingan has several operational procedures completed or in development for operation and regeneration of the WTP and condensate polisher systems. There are also procedures in place for chemical control and Gross Contamination situations. Daily results for cycle chemistry are shared with operations by electronic sheet. The lab has a task list developed to assist with daily work planning and to ensure necessary work is being done on a regular basis. This is used along with Directline work orders and PM's.

Action Taken: Lingan has a new Dionex Ion Chromatograph for daily boiler and feedwater testing. Lingan is currently using a combination of paper, logbooks and electronic documents for data storage. Staff is familiar with online systems such as PI, Fossil Power and DCMS for cycle chemistry monitoring.

Finding # 16: Although cycle chemistry data is being collected and stored in various areas, it is difficult to graph and trend as well as monitor the quality control of the data. It is recommended that the Lingan lab use Infocalc or other database to store data for ease of retrieval and quality control monitoring.

6.20 General Condition of Chemical Tanks and Piping.

This section of the report discusses the general condition of chemical assets, such as bulk tanks, day tanks, water tanks treated with chemicals, piping and chemical pumps.
The main acid bulk tank at Lingan was cleaned out and inspected internally in 2008. The tank is 30 years old. Thickness testing was also done and some small repairs.
Two sulfuric acid pumps were replaced in 2003 and the acid transfer line to the condensate polishers replaced with SS316. The general condition of the acid day tanks in the water treatment plant is not known since they are sealed on top and cannot be cleaned out. They are 15 years old and should be replaced soon.
The bulk caustic tank is more than 30 years old and has never had an internal inspection.
Also the caustic skid including day tanks and pumps is more than 25 years old and needs to be upgraded .A new caustic fill line was installed in 2010.
The acid and caustic transfer lines to the polishers need to be thickness tested to determine the corrosion rate as per TMP-30.
LP dose pumps are generally in good shape. New boiler dose pumps were added to units #3 & 4.
GSCW storage tanks and small bore piping need to be inspected internally for corrosion.

The hydrogen gas transfer piping has never been tested since installation.

Lingan: > Summary and Recommendations

1/ Since 2001 Lingan has reduced raw water usage by 36 %, WTP regenerations by more than 50 % and increased throughputs in the demineralizers back to design by taking advantage of improvements to the town Water Treatment system, and by improving major assets in the WTP. All resins were replaced in the demineralizers, valves were replaces or refurbished, a sulfite system was installed to remove chlorine and the RO membranes were replaced in 2008.
The acid day tanks and caustic skid system in the WTP are aging and getting more difficult to maintain.
Lingan is investigating the possibility of replacing the RO system in 2011.

Recommendations: (a) Continue with investigation for RO replacement.

(b) Replace/upgrade acid day tanks and caustic skid in the WTP.

(c) Complete thickness testing and internal inspection of bulk caustic tank in the WTP.

2/ Lingan have made some recent upgrades to the condensate polishers including new flow meters and counters, conductivity meters and acid/caustic strength meters. Throughputs are averaging 55 million liters or about 25 % less than normal due to resin deterioration, condenser leaks and some maintenance issues. The plant has a plan in place to replace all polisher resins in the next four years. The polisher vessels are aging

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and will need upgrades. Regenerations are done with toggle switches.

Recommendations: (a) Upgrade polisher controls to PLC for automatic control during regenerations.

(b) The pneumatic valves on the polisher are near 30 years old and have a history of diaphragm failure. Recommend a plan for refurbishment or replacement of these valves

.

(c) Replace unit #1 polisher resins in 2010 and continue with plan for resin replacement in the next three years.

3/ The boiler water treatment program at Lingan is phosphate treatment in the 2-4 ppm range with pH control 9.2-9.6. Feedwater treatment is for mixed-metallurgy on ammonia for pH control and hydrazine as an oxygen scavenger. Chloride and Sulfate limits are set at 2.0 mg/l as per EPRI guidelines. Control of boiler and feedwater chemistry is good with some exceptions outside the guidelines. The plant has auto control of the feedwater chemicals using six LP dose pumps. Trace metal analysis is not being done regularly.

Recommendations: (a) Start a program of regular testing for iron and copper in the feedwater. This is an EPRI recommendation.

(b) Install sodium analyzers on all four units to measure sodium in steam and extraction pump samples. Sodium is an EPRI core parameter.

4/ The closed cooling water system (GSCW) continues to be treated with a molybdate based corrosion inhibitor within the 60-80 mg/l guideline. Although there has been some improvement in makeup control, there is still a problem with maintaining the recommended 60-80 mg/l molybdate required for corrosion control. Unit #1 & #2 were lower than the guideline more than 70 % and unit #3 & #4 were lower than the guideline more than 87 % from 2005-2010. The storage tanks have not been inspected internally for more than 10 years.

Recommendation: (a) Inspect the upper and lower GSCW storage tanks to see if there has been any corrosion impact from the low levels of molybdate.

(b) Inspect small bore piping for evidence of corrosion and replace where required. This may have an impact on cooling to to the analytical panels or other equipment.

(c) Investigate and mitigate the cause for low levels of molybdate. Look for makeup leaks from valves, overflow from operations, possible ingress of other water supplies into the GSCW.

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5/ Although Lingan continues to have periodic condenser leakage in all four units the percentage of failures is averaging below 1%. Unit #2 experienced tube leaks from a steam impingement design flaw on the return side of the condenser. Lingan is currently using a liquid Ferrous Sulfate treatment system for corrosion control. They add 50 liters of 40 % Ferrous Sulfate to each unit twice per day. They have also added preventative measures with plastocor treatment on unit #4 in 2008 and unit #2 in 2009.

Recommendation: (a) Extend the plastocor treatment to units #1 and #3.

(b) Based on calculations for Ferrous Sulfate treatment that were done earlier in this report, it is recommended that the Ferrous Sulfate daily treatment be changed from 50 liters per unit, twice a a day, to 100 liters per unit once per day. The 100 liters is added to the day tank and pumped to the condenser inlet over 30 minutes to produce an estimated concentration of 2.5-3.0 mg/l Fe as recommended by EPRI.

6/ Lingan has improved monitoring of cycle chemistry and water treatment parameters by using the Fossil Power system, PI data and the DCMS. The WTP is now on PLC controls. The lab does periodic checks of online instrumentation and calibration for the waste water online instruments. The plant has made several upgrades to analytical panel instrumentation and condensate polisher panels. All the units are experiencing sample cooling problems in the summer months. Hot samples give inaccurate results and can also damage measuring devices. The plant has experienced some problems with dissolved oxygen meters. Secondary coolers are in place on units #3 and #4.

Recommendations: (a) Water samples at the analytical panels cannot be cooled to the the 25 deg. C standard in summer months. It is recommended that cooling water supplies to the panels be investigated for restricted flow and/or add additional chillers to the four units to achieve the proper sample temperatures.

(b) The DA Inlet dissolved oxygen sample on #2 analytical panel is capped off with no flow. This is one of the EPRI core samples. The sample needs to be restored to normal operation.

(c) It is recommended that the boiler bottom header sample points be redesigned to prevent pluggage in sample lines. The bottom header sample is the preferred location for boiler sampling.

7/ Lingan have several procedures in place for operation of the WTP and for chemical control and Gross Contamination situations. Daily cycle chemistry results are shared electronically with operations. The lab has a list of tasks developed to ensure core work is completed. The lab has a new Dionex Ion Chromatograph for daily water analysis. The plant currently uses a combination of hard copy sheets, logbooks and electronic spreadsheets for data storage. The Infocalc database software is available but was not being use during this review.

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Recommendations: (a) Improve data storage and quality control by transferring cycle Chemistry data and water usage information into the Infocalc database or equivalent for ease of retrieval and quality control monitoring. Generation Services is currently looking at an upgrade for the Infocalc program.

8/ Lingan has made several improvements to the Sulfuric Acid systems sine the 2002 review. The 30 year old bulk tank has been cleaned and inspected internally and repaired as required. New transfer piping and pumps have been added. The WTP acid day tanks are 15 years old and cannot be inspected or cleaned properly because the top is sealed.
The 30 year old caustic tank has not been inspected internally nor thickness tested. The fill line and cladding was replaced. The WTP caustic skid is in poor shape and should be replaced. It is more than 25 years old.
The acid and caustic piping to the polishers need to be thickness tested.
LP dose pumps are in good shape. New boiler dose pumps were installed in units #3 & #4.

Recommendations: (a) Clean and internally inspect the bulk caustic storage tank.

(b) Conduct UT testing of the acid and caustic transfer piping to To determine corrosion rate as per TMP-30.

(d) Create PM program in Directline to ensure future inspections and testing of Chemical Assets. as per TMP-30

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NSPI Thermal Station Chemical Asset Gap Analysis Report – 2010
Trenton Plant Specific Findings.

6.0 Plant Specific Findings

Trenton > **Gap Analysis Results**.

6.21 Water Treatment Plant

In 2003 the Raw Water consumption at Trenton peaked at 418,262 $m^{3.}$ By effectively managing the WTP assets, the plant has been able to reduce Raw Water consumption in 2009 to 305,000 m^3. This 27 % Raw Water usage improvement has been achieved by managing the use of town water in the #5 lube oil coolers by using the Auxiliary CW Booster pump on a more frequent basis, and more efficient operation of water treatment plant and condensate polishers. Also one of the #6 polishing plant collector outlet valves has been replaced to reduce water losses.
With the improvements to the treatment of the town water supply, Trenton no longer has to add treatment chemicals to the clarifier. This in turn has reduced fouling and the need for frequent demineralizers cleanings.
Chlorine removal is currently done with carbon filters as pre-treatment before the demineralizers. The carbon was changed about five years ago. The carbon filter pressure vessels are over 40 years old and have deteriorated considerably. The water treatment plant does not have any silica monitors to measure silica breakthrough in the demineralizers. The plant still continues to struggle with make-up from time to time. The organic trap resin was changed in 2000. The #5 WTP train resin is ten years old and was last tested in 2002. The #6 WTP resin is more than 12 years old. The plant has plans to change the #6 resin and screen socks in 2010 and spark test the pressure vessels. Unit #6 regenerations were reduced from 150 in 2004 to 134 in 2009.

Actions Taken: A new makeup meter was commissioned in unit #5 WTP in 2005. Carbon in the carbon filter was changed in 2005. Some repairs made to the pressure vessels. A regular raw water testing program is in place to monitor and changes to town water quality that could impact the WTP performance.
#5 lube oil coolers have been retubed to improve heat transfer ability.
A new backwash system is also in place on both the #5 and #6 lube oil coolers.

Finding #1: The carbon filter pressure vessels are more than 40 years old and should be replaced. There is obvious deterioration of the vessels.

Finding #2: The ion-exchange resins in #6 WTP are greater than 12 years old and the average throughput in the last 2 years has been 160,000 US gallons. The plant plans to change the resins in 2010 and the screen socks on the laterals. Spark testing of the liner is also planned at this time. These actions are highly recommended.

Finding #3: The unit #5 WTP resin and the organic trap resins are ten years old and have not been tested since 2002. It is recommended that the resin be tested for capacity and fouling.

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Finding #4: There is no silica monitors in either #5 or #6 WTP to monitor for silica breakthrough into the demin storage system. Trenton had a silica excursion since the last chemical review in 2002. It is recommended that online silica analyzers be installed on each unit.

WTP Maintenance and Equipment:

Improvements to the caustic heating system control in the WTP have reduced iron fouling in the demineralizers. The clear well pump pressure to the demineralizers is only 60 psi. The operational design pressure is 80 psi. There may be an opportunity to increase flow capacity to the #6 demin by increasing the pressure at the clear well pumps or bypassing the clear well. A recent discovery of a defective butterfly valve on the unit #5 Demin system has allowed the plant to meet or exceed the design flow capacity of the plant.
Trenton has one 19, 600 liter bulk acid tank and one bulk caustic tank in the Water Treatment plant. The bulk caustic tank was cleaned and inspected about ten years ago. The bulk acid tank has never been cleaned or inspected internally.
The caustic day tank in the WTP is currently not being used. The two original caustic pumps in the WTP are working and the new pump is not working.
There are only two original acid pumps available for unit five and six in the WTP.
The acid/caustic strength meters are not working and the acid dilution water flow meter needs to be replaced on unit #5 WTP. The caustic dilution water flow meter is new.

Action Taken: Design flow to unit #5 WTP demin plant has been restored by repairing a defective butterfly valve. The carbon has been changed in the #6 WTP carbon filters. A new caustic dilution water flow meter has been added. Several acid valve bonnets in both unit #5 & #6 water treatment systems have been replaced with alloy 20 material, and this has reduced incidents of acid leaks.

Finding #5: The bulk Caustic tank was last cleaned out and internally inspected 10 years ago. It is recommended that the tank be cleaned and internally inspected as per TMP-30.

Finding #6: The bulk Acid tank in the WTP has never been cleaned or inspected internally. It is recommended that the tank be cleaned, internally inspected and thickness tested as per TMP-30.

Finding #7: The acid/caustic strength meters on both unit #5, and #6, WTP are not working and should be replaced to ensure efficient monitoring of WTP regenerations.

Finding #8: The pneumatic valves on the #5 Water Treatment Plant is original and should be added to an asset management plan for refurbishment or replacement. These valves have a history of diaphragm failures and can impact on the reliability of the plant.

Finding #9: There is only two original acid pumps available for both unit #5 & #6 WTP. To ensure continued reliability for the WTP operation, two new acid pumps should be purchased.

Finding # 10: There is water getting into the instrument air lines in the Water Treatment Plant. It is recommended that this be investigated before damage occurs to instrumentation.

6.22 Condensate Polishers

During the 2002 chemistry review, Trenton had two Degremont polishers on unit #5 and three Gaco condensate polishers on unit #6.There was 42 polisher regenerations on unit #5 in 2009 compared to 54 in 2004. The average polisher throughput on unit #5, before regeneration in 2009 was 9.2 million USG. compared to 10.4 million USG. in 2004. There were 28 polisher regenerations on unit #6 in 2009 compared to 33 in 2004. The average throughput on unit #6 before regeneration was 19.2 million USG. in 2009 compared to 19.9 million USG. in 2004. Trenton added a third polisher from Glace Bay on unit #5 in 2007 and replaced the old resin in 2009. The historical throughput for the #5 polishers is 12-15 million US Gallons. The historical throughput for the #6 polishers is 25-30 million US Gallons. Condenser leakage, resin age and maintenance issues have contributed to lower throughputs in the Degremont polishers. Resin losses and inaccurate acid/caustic strength monitoring may be contributing to lower throughputs in the Gaco polishers. #6A polisher seems to be consistently lower in throughput than the other two polishers.

Actions Taken: Polisher resin was changed in all three Gaco polishers in 2004. The #5-3 polisher was added to the #5 polisher system in 2007 and new resin added in 2009.
New socks were added to the 5-3 polisher in 2009. Several repairs have been completed to replace acid valve bonnets with alloy 20 material reducing acid valve leakage.

Finding # 11: The service inlet and outlet pneumatic valves on the unit #5 polishers, are sticking on a regular basis. This can impact on regeneration efficiency and polisher flow. It is recommended that these valves be replaced.

Finding # 12: The acid and caustic strength meters are not working on #5 polishers. Inaccurate acid/caustic strength can impact on regeneration efficiency. Recommend replacing the old meters.

Finding #13: Most of the pneumatic control valves on the #5 condensate polishers are original, + 30 years old. These valves should be in an asset management plan for refurbishment or replacement .These types of valves have a history of diaphragm failure.

Finding #14: The average polisher throughputs before regenerations in 2009 & 2010 were 9.5 and 8.6 million US gallons. Normal throughputs should be 12-15 million US gallons. This 25 % loss in capacity can be attributed somewhat to condenser salt leak activity in #5 units, some equipment maintenance issues and deterioration of resin due to age. It is recommended that Trenton continue with plans to inspect the vessels, test and replace the #5-1 and #5-2 polisher resins by 2012.

Finding #15: The acid and caustic strength meters are not working on the #6 polishers and there is no level indication in the acid/caustic day tanks. It is recommended that new Acid/ caustic strength meters and level gauges be installed.

Boiler/Feed water Cycle Chemistry

The boiler water treatment program at Trenton is caustic treatment for unit #5 boiler, and AVT with caustic addition for unit #6 boiler.
Unit #5 has pH limits of 9-2-9.6, chloride limit of 500 ppb and sulfate at 200 ppb and sodium 2000 ppb with a conductivity range from 4-15 mmhos. Unit #6 is AVT treatment with a pH limit of 9.2-9.6 and chloride and sulfates limit of 200 ppb. The EPRI limit for chloride is 200 ppb for boilers treated with caustic at this pressure.
Unit #5 feed system is ammonia/hydrazine mixed metallurgy with pH limits of 8.8-9.2 and hydrazine limits of 40-80 ppb. Dissolved oxygen is limited to 5 ppb at the economizer inlet. Unit #6 is also ammonia/hydrazine treated but is all ferrous with a pH limit of 9.2-9.6 and hydrazine limit of 20-40 ppb. EPRI is recommending a pH limit of 9.0-9.3 for mixed metallurgy feedwater treatment. Iron and copper limits are < 5 ppb at the DA Inlet and 2 ppb at the Economizer inlet.
Trenton boiler and feedwater chemistry has generally been good with the exception of a few condenser leak excursions and some maintenance problems with LP dosing pumps.
There was also one incident with silica contamination. Contamination issues are controlled with condensate polishing and boiler blowdown. The unit #5 HP dose pump is > 40 years old and is having maintenance issues. The caustic skid has no containment or safety curtains.

Action Taken: The unit #6, LP dose pumps and tote tank are to be replaced in 2010.
The unit #5 LP system has new IC controls for auto chemical feed. The plant has plans to replace the unit #5 LP dose tank.

Finding # 16: Regular testing for copper and iron in the feedwater is not being done. This is recommended by EPRI to monitor feedwater quality.

Finding # 17: The LP dose pumps on unit #5 are >30 years old and it is recommended that they are put into an asset management plan for replacement.

Finding # 18: There are no online sodium analyzers for monitoring sodium in feedwater and steam samples. Sodium is a core parameter for EPRI. It is recommended that sodium analyzers be installed on all both Trenton units on the steam sample and extraction pump.

Finding #19: The unit #5 HP dosing system needs to be upgraded. The caustic pump is >40 years old and is having maintenance problems. The caustic day tank needs to be inspected. There is no containment or safety curtains around the skid. There may be an opportunity to use the unit #6 HP dose system with the addition of one new caustic pump.

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6.23 (a) General Service Cooling Water/Circulating Cooling Water

The closed cooling system is treated with a Molybdate based corrosion inhibitor in the range of 60-80 mg/l as Molybdate.
Weekly testing for Molybdate, pH and Fe is recommended. In 2008 the Trenton GSCW was tested for Molybdate 10 times for unit #5 and 8 times for unit #6. The average Molybdate for unit #5 was 64 mg/L as Mo and 88.4 mg/l for unit #6. In 2009 the GSCW was tested only three times for each system with the average molybdate 43.4 mg/l in unit #5 and 65.1 in unit #6. In 2010 the GSCW was tested eight times in unit #5 and twelve times in unit #6. The average molybdate concentration was 50.3 mg/L in unit #5 and 51.5 mg/L in unit #6. The molybdate was below the 60 mg/L limit, 75 % of the time in unit #5 and 58.3 % of the time in unit #6. Iron levels measured in both systems in 2010 exceeded 6 mg/L as Fe. Lack of treatment and testing in the GSCW closed systems can lead to corrosion in the storage tank systems and small bore piping to analytical panels, fans and other equipment.

Action Taken: Unit #5 GSCW storage tanks were inspected internally and thickness tested in 2010. The upper storage tank is lined.

Finding #19: The weekly testing program for GSCW chemical treatment with Molybdate is not been followed and the limits of 60-80 mg/l for molybdate are not always within spec. There were some tests for iron completed where the iron exceeded 6 mg/l in the GSCW. It is recommended that the weekly testing program for the unit #5 & #6 GSCW systems be reinstated for measuring pH, molybdate and iron content.

Finding #20: The unit #6 GSCW storage tanks were last inspected internally in 2001. It is recommended that the tanks be inspected internally and thickness tested. It is also recommended that small bore cooling water piping in units #5 & #6 be checked for corrosion and restricted flows.

6.04 (b) Circulating Cooling Water (Seawater) Ferrous Sulfate Treatment.

Trenton circulating cooling water is a mixture of seawater and brackish river water. The unit #6 condenser has Titanium tubes and is virtually condenser leak free. The unit #5 condenser is copper nickel alloy and is being replaced with Sea-cure stainless steel tubes in 2010 after a history of condenser leaks with the old tubes. Trenton had a hypochlorite disinfection treatment system in place for mussel control but this is no longer being used. Trenton also had planned to use a liquid Ferrous Sulfate treatment system for corrosion Control but it is not required with Sea-cure condenser tubes. Sea-cure is resistant to manganese and sulfide pitting and ammonia attack on the steam side of the condenser.

Action Taken: Trenton is replacing old copper nickel condenser tubes in unit #5 with Sea-cure stainless steel tubes that are resistant to pitting. The tube sheet is being coated with plastocor. Treatment with Ferrous Sulfate is not required since the Sea-cure is resistant to sulfide and manganese attack. This is being completed in 2010.

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6.24 Monitoring and Instrumentation

The analytical panel for unit #6 is in good shape with the following exceptions. There are no sodium analyzers on the steam or extraction pump samples. The cooling water is currently not adequate to cool the samples to 25 deg C. Elevated sample temperatures can affect the accuracy of sample testing and can cause damage to analytical sensors. There are problems with sample flows from the smaller sample lines coming into the panel.
Unit #5 does not have a standard analytical panel for housing boiler, steam and feedwater samples. Samples are exposed to high temperature environments and they do not have an adequate cooling water supply to meet the standard water sample temperature of 25 deg C. The dissolved oxygen meters on the 7th floor are in a hot environment and do not function properly. Unit #5 does not have any sodium analyzers on the steam or extraction pump samples. Sodium is one of the core sample parameters for EPRI.
There is currently no regular instrument check done for online analytical monitors.

Finding # 21: There is one new Rosemont dissolved oxygen meter on unit #5 but it is not currently working. It is recommended that this meter be included in any upgrade for unit #5 boiler & feedwater samples.

Finding #22: There is inadequate cooling of the water samples to the #6 analytical panel and the unit #5 water samples. Water sample should be cooled to 25 deg. C .It is recommended that cooling water lines to the panel be checked for corrosion buildup and chillers added or upgraded to meet the temperature standard for water samples.

Finding # 23: The unit #5 boiler, steam and feedwater samples are not housed in a standard analytical panel setting and sample temperatures do not meet the standard 25 deg C. Dissolved oxygen samples are also exposed to high temperature environments and do not function properly. This places the unit at risk with inaccurate data from sample tests and online instrumentation. It is recommended that the unit #5 boiler, steam and feedwater samples be upgraded to an analytical panel with adequate cooling and standard flow controls.

Finding # 24: There is no regular instrument check being done for online analytical monitors for cycle chemistry. This should be done at least monthly.

6.25 Procedures/Chemical Control Records/Tasks

Trenton has several procedures on the Trenton website for operation of the water treatment plant, polishing plant and chemical handling. They use the Operations Chemical Handbook version #3 for guidance on cycle chemistry controls. Trenton had the Infocalc database software available but had discontinued using the program for tracking of cycle chemistry data. There is some cycle chemistry and water usage data available in Microsoft Excel spreadsheets created by lab personnel. Generation Services is currently looking at a replacement software program for Infocalc to collect and monitor cycle chemistry data from all thermal plants. The new program will have automatic quality control features included.

The Trenton lab has created a task list in 2010 to evaluate the effectiveness of the current staffing level at the plant. The list is broken down into Regeneration, Environment and Fuel/Flyash rotations as well as a miscellaneous list of tasks to be completed. In 2010, the lab has added a new Chemical Supervisor and replaced a full time Chemical Technician with a Chemical Technician Apprentice. Also this year there has been additional ash and coal testing with the Mercury removal projects. Apprenticeship training has added additional time restraints on the lab staff who are already struggling with completion of tasks. One of the areas that have been impacted is the GSCW treatment.

Action Taken: Trenton has new Ion Chromatographs for both anion and cation analysis of water samples. Trenton also has a new portable Orbisphere dissolved oxygen meter for manually measuring feedwater dissolved oxygen.

Finding #25: Trenton lab is currently struggling with completion of required testing and monitoring with the additional ash and coal testing in 2010 and time required to train a new Chemical Technician Apprentice in 2010. In addition the Chemical Supervisor is new and developing in this position. It is recommended that an additional apprentice be placed in Trenton to train and assist with the work load until the current Chemical Technician Apprentice has completed the apprenticeship. The new apprentice could then be used to replace future vacancies in Chemical Technician succession plan.

Finding # 26: Although cycle chemistry data is being collected and stored in various areas, it is difficult to graph and trend as well as monitor the quality control of the data. It is recommended that the Trenton lab use Infocalc or other database to store data for ease of retrieval and quality control monitoring.

6.26 General Condition of Chemical Tanks and Piping.

This section of the report discusses the general condition of chemical assets, such as bulk tanks, day tanks, water tanks treated with chemicals, piping and chemical pumps.
The main acid bulk tank at Trenton has never been cleaned out and inspected internally. The bulk caustic tank in the WTP was last cleaned and inspected about ten years ago. Both these tanks are 25 years old and should be cleaned and internally inspected and thickness tested. The bulk caustic tank in the WWTP is a nineteen year old tank and has never been cleaned out and inspected internally.
The acid and caustic transfer pipelines have not been thickness tested. The pipelines should be tested as per TMP-30 to determine corrosion rates.
An asset management plan for inspection and testing of these systems should be set up in Directline.
There are several areas in the Trenton plant with original chemical pumps still in service. Some pumps are working while others are not. Here is a list of areas:

a) Unit #5 HP Dose pumps.
b) Caustic and acid pumps in the WTP.
c) #5 LP dose pumps.
d) Condensate polisher acid & caustic pumps.

These pumps should be evaluated for service and placed in an asset management plan for Replacement.

Trenton: > Summary and Recommendations

1/ Since 2003 Trenton has reduced raw water usage by 27 %, and WTP regenerations by more than 10 % since 2004 by taking advantage of the improved water treatment from the town water supply and better management of cooling water supply to the #5 lube oil coolers. Fouling of the ion exchange resins has been reduced as a result of these changes to the water treatment town water supply.
The ion exchange resins for both #5 and #6 demin trains are ten or more years old. The carbon filter vessels are > 40 years old and show signs of deterioration. Plans are in place to replace resin in #6 demin in 2010 with inspection, spark testing and upgrade of the screen socks.
Both the bulk acid and caustic tanks in the WTP have not been internally inspected for ten or more years. Thickness testing is also required as per TMP-30.
Trenton had a silica contamination excursion since the 2002 review and do not have any silica monitors in the WTP.
The clear well pump pressure to the demineralizers is only 60 psi. The design operating pressure for the WTP vessels is 80 psi. There may be an opportunity to increase flow capacity by increasing the pressure or bypassing the clear well using only town water pressure.

Recommendations: (a) Replace the aging and deteriorating carbon filter vessels.

(b) Continue with plans for resin replacement in #6 demin plant for 2010 including maintenance improvements.

(c) Complete thickness testing and internal inspection of bulk acid & caustic tanks in the WTP.

(d) Install silica monitors on both #5 and #6 demineralizers.

(e) Recommend testing of #5 ion exchange resins and the organic traps resin for capacity and fouling.

2/ Condensate polisher regenerations have been reduced in 2009 by 22 % on unit #6 and 15 % on unit #5 since the 2002 review. A new 5-3 polisher has been added to unit #5 in 2007. New resin was added in 2009. Polisher throughputs are lower than the historical 12-15 million USG for unit #5 and 25-30 million USG for unit #6 before regenerations. Condenser leakage, resin age and maintenance issues leading to poor regenerations have contributed to the lower numbers in unit #5 Degremont polishers. Resin losses and poor regenerations due to inaccurate acid/caustic strength monitoring may be contributing to the lower throughputs in the Gaco polishers. The #6 polisher resin was changed in 2004. Problems with pneumatic valves sticking may also contribute to lower throughputs.

Recommendations: (a) Replace the service inlet and outlet pneumatic valves on #5 condensate polishers.

(b) Most of the pneumatic valves on the #5 condensate polishers are +30 old. These valves have a history of diaphragm failures. These valves should be in an asset management plan for replacement to maintain reliability of the system.

(c) Replace the acid and caustic strength meters and add day tank. level gauges to #6 polishers.

(d) Have the 5-1 and 5-2 polisher resins tested and plan for replacement by 2012.

3/ The boiler water treatment program for Trenton is caustic treatment for unit #5 and AVT with caustic addition for unit #6. The feedwater treatment for unit #5 is mixed metallurgy AVT (R) ammonia with hydrazine as an oxygen scavenger. The feedwater system for unit #6 is all ferrous with ammonia and hydrazine for pH and oxygen scavenging. The chemistry treatment in both units has been good with a few excursions from condenser leak situations and silica from the WTP. There have been some issues with LP dose pump maintenance. The unit #6 LP dose pumps and dose tank are scheduled for replacement in 2010. Regular iron and copper in the feed system and online sodium monitoring is not being done on either unit. The EPRI standards for feedwater and caustic/phosphate treatment have changed since the 2002 review.
The HP dose system for unit #5 has some safety and reliability issues with the aging equipment and lack of containment and curtains.

Recommendations: (a) Start a program of regular testing for iron and copper in the feedwater. This is an EPRI recommendation.

(b) Install sodium analyzers on both units to measure sodium in steam and extraction pump samples. Sodium is an EPRI core parameter.

(c) EPRI is recommending that the pH for mixed metallurgy feed systems be changed from 8.8-9.2 to 9.0-9.3. This change is recommended for unit #5.

(d) The recommended chloride limit for boilers on caustic treatment is 200 ppb. Trenton #5 currently has a limit of 500 ppb. The 200 ppb limit for chlorides is recommended for unit #5.

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(e) Upgrade the unit #5 HP dose system to current safety standards and replace the 40 year old pump.

4/ The closed cooling water system (GSCW) for both units at Trenton has a program with addition of molybdate based corrosion inhibitor with limits of 60-80 mg/l as molybdate. The pH is controlled at 8.5-9.5. The recommended frequency of testing for pH, molybdate and iron are weekly as per the Chemical Handbook version #3. Data files from Trenton have shown in the last two to three years that the required frequency of weekly testing is not being met and a high percentage of the numbers are lower than the 60-80 mg/l molybdate limits. This can lead to corrosion of storage tanks and small bore piping restrictions. The unit #5 storage tanks were inspected internally in 2010. The upper tank is lined and looks okay.

Recommendation: (a) Inspect the unit #6 upper and lower GSCW storage tanks to see if there has been any corrosion impact from the low levels of Molybdate.

(b) Inspect small bore piping for evidence of corrosion and replace where required. This may have an impact on cooling to to the analytical panels or other equipment.

(c) Reinstate the weekly testing program for pH, molybdate and iron testing.

5/ Trenton have titanium tubes in the Unit #6 condenser and this is virtually leak free. No chemical treatment is required .The unit #5 condenser had copper-nickel tubes and had been experiencing a high percentage of condenser leakage in the past few years. Ferrous Sulfate treatment for corrosion control was attempted and hypochlorite for slime and mussel control. In 2010, Trenton replaced the #5 condenser tubes with Sea-cure stainless steel tubes that are resistant to pitting from sulfide and manganese pitting. The tubes are also resistant to ammonia attack on the steam side. The tube sheet has been protected with plastocor. No Ferrous Sulfate is required for corrosion control. The hypochlorite system has not been used for some time.

Recommendations: (a) Monitor new condenser for biological fouling over time. Stainless steel is less resistant than copper to biological fouling.

6/ The Trenton plant has access to online cycle chemistry data via the PI system and some boiler and feedwater parameters are fed into the control room. The lab produces a daily chemical and operating parameter sheet that is shared with operations. The unit #6 analytical panel is in good shape but the sample temperatures do not meet the required standard of 25 deg C. The small sample lines into the analytical panel have a history of flow problems. Unit #5 boiler, steam and feedwater samples are not in a standard analytical panel and are exposed to high temperature dusty environments. The samples

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also do not have adequate cooling water to meet the standard sample temperature of 25 deg. C. Analytical instruments , such as the dissolved oxygen monitors on the seventh floor, are not protected from the elements and do not function properly. There are no sodium analyzers on either unit. This is an EPRI core parameter for monitoring steam and feedwater.

Recommendations: (a) Water samples at the analytical panel cannot be cooled to the the 25 deg. C standard in summer months. It is recommended that the cooling water supply to the #6 panel be investigated for restricted flow and/or add additional chillers to the sample panel to achieve the proper sample temperatures.

(b) Create capital project for a new analytical panel for the unit #5 boiler, steam and feedwater samples that includes current sample valve standards and adequate cooling for samples. The panel should house all analytical monitors such as pH, conductivity, cation conductivity, dissolved oxygen and sodium analyzers.

(c) Replace small sample lines in the #6 analytical panel with Standard 3/8" OD stainless lines to prevent sample flow restrictions.

7/ Trenton have several procedures in place for operation of the WTP and for chemical handling condensate polisher operation. The lab uses the Chemical Handbook version #3 for guidance on chemical parameters. Daily cycle chemistry results are shared electronically with operations. The lab has a list of tasks developed to ensure core work is completed. The lab has two Dionex Ion Chromatographs for daily water analysis. The plant currently uses a combination of hard copy sheets, logbooks and electronic spreadsheets for data storage. The Infocalc database software is available but was not being use during this review.
With recent changes to lab staffing and additional ash and coal testing added in 2010, the lab is struggling with completion of routine tasks and quality control testing. Additional time is required by experienced Chemical Technicians to train the new apprentice and assist the new Chemical Supervisor in a developing role. Having an additional apprentice on staff would assist staff in completion of the required testing such as the GSCW weekly testing. The new apprentice could be use in future succession planning to replace any vacancies in the Power Production Chemical/Environmental group.

Recommendations: (a) Improve data storage and quality control by transferring cycle Chemistry data and water usage information into the Infocalc database or equivalent for ease of retrieval and quality control monitoring. Generation Services is currently looking at a a software package to replace the Infocalc program.

(b) Recommend the hiring of a new Chemical Technician Apprentice for Trenton lab to assist lab staff until the current Chemical Technician apprentice completes the apprenticeship. The new apprentice could then be used for future succession

8/ The most recent internal inspection to bulk acid and caustic tanks in Trenton was ten years ago. The two bulk caustic tanks and the main bulk acid tank are due for internal inspection and thickness testing as per TMP-30 to determine corrosion rates and general condition of the tanks.
Any carbon steel day tanks should also be included in the thickness testing to determine corrosion rates.
Acid and Caustic transfer piping has not been thickness tested to determine the corrosion rates and condition of the piping as per TMP-30.

Recommendations: (a) Create an asset management plan for cleaning, internal inspection and thickness testing of all bulk chemical tanks and day tanks in Directline, as per TMP-30 guidelines.

(b) Conduct UT testing of the acid and caustic transfer piping to determine corrosion rate as per TMP-30.

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7. 6.0 Plant Specific Findings

Pt. Aconi > **Gap Analysis Results**.

6.27 Water Treatment Plant

In 2008 the annual Raw Water consumption at Pt. Aconi peaked at 186,610 m^3 compared to an average annual consumption of 140,460 m^3 from 2004-2007. The increase was due to additional water for the FuelTech, TIFFI fuel ash treatment, in the boiler furnace. Initially the water used was 100% demin water from the Pt. Aconi Water Treatment plant. This created an increased demand on the Water Treatment plant with additional regenerations that also produced more demand on raw water. The plant was able to reduce the injection water supply to 50 % demin and 50 % raw water. This reduced the water usage in 2009 by 12 %.
The number of primary train regenerations ranged from a low of 99 in 2006 to a high of 154 in 2008. The number was reduced to 140 regenerations in 2009. The normal throughput for the demineralizer trains is 700,000 liters. The average throughput before regenerations in 2009 was 650,929 liters and in 2010 the average is 605,890 liters. During the 2002 chemical review the primary train was producing an average 700,000 liters between regenerations.
The WTP Train “A” cation resin was changed in 2003 and the anion in 2009. The WTP Train “B” resin was placed in service in 1993 and has not been changed.
The plant is currently having an issue with a white deposit on the Train “A’ cation resin. This may be contributing to the lower average throughputs in 2010.
In 2002, it was recommended that the effluent conductivity of the WTP demineralizers be added to the daily sheet to ensure that there was adequate flow through the cells. This is currently being done.
During the 2002 chemical review the plant was using a Nematron operating interface to operate the demineralizers. The program did not have any flexibility to allow the operator to skip steps to repeat a regeneration step. This forced the technician to manually isolate pumps and flows to prevent contamination in the system. The system did not have a reset button to return to the Home position

Actions Taken: The WTP Train “A” cation was replaced in 2003 and the Train “A” anion in 2009. A new PLC interface has been added to the WTP that allows flexibility in operating the Water Treatment Plant during regenerations. The system does not have a reset button but has a pause/hold step for better control of the operation. The WTP effluent conductivity is recorded on the daily sheet.

Finding #1: The WTP Train “A” cation resin has a white residue on the resin that may be contributing to lower average throughputs on this unit. It is recommended that the resin is tested for fouling and identification of the residue.

Finding #2: The WTP train “B” resin is seventeen years old and may be contributing to the lower average throughputs in the WTP. It is recommended that the resin be replaced.

WTP Maintenance and Equipment:

The bulk acid tank in the Pt. Aconi WTP was cleaned and inspected in 2006. Also the acid piping from the bulk tank to the acid transfer pumps was replaced with stainless steel piping. The "A" acid transfer pump is new and there is one original acid pump existing. The acid day tank is showing signs of corrosion at the top seam. There is one new acid metering pump. The acid transfer piping to the condensate polishers has been replaced.
The bulk caustic tank has never been cleaned and inspected internally. There have been some problems with blockage on the caustic tank vent and with the caustic day tank vent.
All the caustic pumps in the WTP are original. There has been some problems with the caustic blocking valve plugging and leaking.

Action Taken: Pt. Aconi has cleaned and inspected the bulk acid tank. There is four week PM's in place to inspect the bulk caustic tank vent and the day tank vents. Pt. Aconi also has PM's in place for annual inspection and oiling of chemical pumps. Acid transfer piping to the polishers was replaced.

Finding #3: The Bulk Caustic tank has not been inspected internally or thickness tested. See TMP-30 for details.

Finding #4: The WTP acid day tank is showing signs of corrosion on the top seam. The tank should be cleaned and thickness tested to assess the remaining life of the tank.

Finding #5: There has been a history of the caustic block valve plugging and leaking. This system should be replaced with new valves.

Finding #6: The caustic transfer line to the condensate polishers needs to be NDT thickness tested.

6.28 Condensate Polishers

Pt. Aconi currently operates with three Ecodyne condensate polishers in service. During the 2002 review, the throughputs were approximately 80 million liters between regenerations. In 2009 there were 47 regenerations with an average 75.8 million liters between regenerations and in 2010 there were 22 regenerations with an average 80.5 million liters between regenerations to date.
Polisher "A" resin was installed in 2000, "B" in 2002 and "C" in 1997. Resin has been purchased in 2010 for the "C" polisher. A new computer interface has been installed to replace the old Nematron. This program has a pause/hold feature to allow some manual adjustments during the regeneration steps.
The acid day tank at the polishers is original and has a history of overflowing the tank.
The caustic system still has original pumps and day tank. Neither of the tanks has been thickness testing.

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Actions Taken: New PLC interface added to replace old Nematron unit. Resin purchased for "C" polisher in 2010. Acid transfer line polishers replaced. Resin samples taken from all polishers for analysis in 2010.

Finding # 7: Resin in the "B" polisher is ten years old. Consider replacing the resin subject to resin testing analysis.

Finding #8: Both the polisher acid and caustic day tanks are over fifteen years old and have not been thickness tested. Recommend thickness testing to determine estimated remaining life of tanks.

Boiler/Feed water Cycle Chemistry

In 2002, Pt. Aconi had the only Ahlstrom Pryoflow fluidized bed unit in Nova Scotia Power operating at 12.8 kpa with a maximum load of 185 megawatts. Installation of a division wall to the furnace in 2004 has allowed an increased maximum capacity of 193 MW. The boiler and feedwater continues to be treated with All Volatile Treatment (AVT) with ammonia for pH control and hydrazine as a reducing agent for oxygen scavenging.(AVT) R. Rather than install an emergency caustic dosing system for the HP dosing system, the plant has chosen to shut down the unit in the event of a major excursion. There is no formal Boiler Gross Contamination procedure developed for the site. The LP dose is controlled with variable speed pumps on manual control. There are two pumps for each chemical in the feed system.
Pt. Aconi was completing daily and weekly analysis as required until the DX-100 Ion Chromatograph stopped functioning in 2010. Chemistry control has been good.
The current EPRI parameter guideline for boilers at this pressure and on AVT treatment is as follows:

Sodium	Max 700 ppb		
Cation Cond.	Max 4.0		
Chloride	Max 150 ppb		
Sulfate	Max 250 ppb.		
Silica	Max 0.45 mg/l		
pH	9.2-9.6	< 8.0	immediate shutdown.

Action Taken: A major design change with addition of a division wall in the furnace was completed in 2004 to increase maximum load to 193 MW. All three condensate polishers are in service to prevent differential pressure increase with higher MW load.

Finding # 9: The inline dissolved oxygen monitors are not working properly. It is recommended that these meters be replaced. EPRI recommends continuous monitoring of condensate and economizer inlet for dissolved oxygen.

Finding #10: There are no inline sodium analyzers for the condensate or steam. This is recommended by EPRI for continuous monitoring.

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Finding #11: The main lab DX-100 Ion Chromatograph is not working. This is essential analytical equipment for boiler and feedwater analysis. It is recommended that this unit be replaced with a new current Ion Chromatograph with an updated software package.

6.29 (a) General Service Cooling Water/Circulating Cooling Water

The closed cooling water system at Pt. Aconi uses demineralised water for makeup and a molybdate based corrosion inhibitor to minimize corrosion in the system.
The GSCW was generally being monitored weekly for Mo, Fe, pH and conductivity. This is not currently being done on a regular basis. The average Molybdate concentration for 2009 and 2010 is 64.5 mg/l as Mo. The Molybdate was below the recommended range of 60-80 mg/L for 33% of the results. The average iron from July 2008-October 2010 was 0.86 mg/l as Fe compared to <0.1 during the 2002 chemical review. The GSCW storage tanks have not been inspected in the last ten years. Makeup to the GSCW seems to be consistently low.

Finding #12: The Molybdate concentration was below the recommended 60-80 mg/l level for 33% of the tests completed in 2009 and 2010. The frequency of testing is also less than the recommended weekly schedule. Iron in the system has increased since the last review.

Finding #13: The GSCW storage tanks have never been inspected internally.
It is recommended that the GSCW storage tanks be internally inspected to see if there is any impact from lower Molybdate concentrations.

6.30 (b) Circulating Cooling Water (Seawater) & Wastewater system.

Pt. Aconi has Titanium tubes in the seawater cooled condenser. There is currently no treatment for corrosion control or biological disinfection. The condenser is operating virtually leak free.

The wastewater plant at Pt. Aconi has a 15 year old bulk caustic tank and ten years old bulk acid tank. Neither of the bulk tanks has been internally inspected or thickness tested. The chemical piping associated with these systems has not been thickness tested. There is a history of some pluggage in the caustic transfer lines to the basins. The acid system has one of two pumps working and there is no block/bleed system in the transfer lines. Some of the acid piping has threaded fittings. Online turbidity meters were replaced in 2009.

Finding #14: There is an existing acid tote tank in the WWTP that is not being used. This should be removed from the acid system.

Finding #15: The acid bulk tank and associated piping is ten years old and has not been thickness tested. The bulk tank has not been inspected internally. See TMP-30 for guidelines on inspection and testing.

Finding #16: The current acid transfer system in the WWTP does not have a block/bleed system and contains threaded fittings in some piping. It is recommended that this system be upgraded to the standard for material and safety features.

Finding #17: Only one of two acid metering pumps is available for Wastewater treatment. The defective pump should be repaired or replaced.

Finding #18: There is a history of pluggage in the caustic transfer lines to the WWTP basins. The current heat tracing should be checked and upgraded as necessary.

6.31 Monitoring and Instrumentation

Pt. Aconi has access to online cycle chemistry instruments via the PI system or DCMS .
The dissolved oxygen online meters are no longer reliable and should be replaced. This is an EPRI core parameter. The current manual YSI conductivity meter in the analytical panel room is not reliable and should be replaced with a modern unit. Two online conductivity meters on the analytical panel have been replaced with Honeywell meters. The analytical panel is in good shape but cooling water to the panel is not adequate in summer months to meet the standard sample temperature of 25 deg. C. The original chiller system for secondary cooling is currently not working and should be replaced. Inadequate cooling can produce inaccurate online cycle chemistry data or cause damage to expensive online instrumentation.
The analytical panel has no inline sodium analyzers on the steam or condensate. This is a recommended EPRI core parameter for online monitoring.
The current manual dissolved oxygen meter is not reliable for daily dissolved oxygen checks. The plant has ordered a new updated manual dissolved oxygen meter in 2010.

Action Taken: Two conductivity meters were replaced on the analytical panel. A new portable dissolved oxygen analyzer has been ordered.

Finding # 19: The old Dionex DX-100 Ion Chromatograph used for boiler and feedwater analysis is not working and should be replaced. The upgrade should include new current software for operating the instruments.

Finding #20: There is inadequate cooling of the water samples to the analytical panel in the summer months. Water sample should be cooled to 25 deg. C .It is recommended that the old secondary cooling system (chiller) be replaced with a new unit.

Finding # 21: The old YSI conductivity meter in the analytical room is not reliable. This should be replaced with a modern conductivity meter.

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6.32 Procedures/Chemical Control Records/Tasks

Pt. Aconi has procedures in place for operation of the WTP, condensate polishers and for cycle chemistry control. There is no procedure for in place for Gross Boiler Water Contamination. The current policy is immediate shutdown for any chemical excursions.
Cycle chemistry records are still being kept in logbooks and daily sheets. Some data is being stored electronically. The lab is not using any database for storage of cycle chemistry data. They were using the PI system for manual lab data from 2002 to 2005 but this has been discontinued. It is still highly recommended that a computer software program similar to Infocalc be used for cycle chemistry and water usage data. Generation Services is currently looking at a Lan/Web based software package for Power Production thermal stations.
The lab has an instrument check sheet for daily checks of online instruments with manual results. There is no list of tasks and responsibilities developed for the lab to adequately assess how the current staffing resources match up with work requirements.

Action Taken: The Pt. Aconi lab has a daily result sheet that is shared with operations and senior management to communicate cycle chemistry conditions.

Finding # 22: Although cycle chemistry data is being collected and stored in various areas, it is difficult to graph and trend as well as monitor the quality control of the data. It is recommended that the Pt. Aconi lab use Infocalc or other database to store data for ease of retrieval and quality control monitoring.

Finding # 23: There is no procedure in for Gross Boiler Contamination to instruct lab technicians and operations on the proper steps to follow in the event of a major chemical excursion.

Finding # 24: There is no list of tasks developed for the lab Chemical Technicians to assess the work load against the current staffing resources. It is recommended that this list be created for a staffing resource assessment.

6.33 General Condition of Chemical Tanks and Piping.

This section of the report discusses the general condition of chemical assets, such as bulk tanks, day tanks, water tanks treated with chemicals, piping and chemical pumps.
Pt. Aconi has four bulk chemical tanks. There is one acid tank and one caustic tank in the WTP and in the WWTP. The bulk acid tank in the water treatment plant was cleaned and inspected internally in 2006. The other three bulk tanks have not been cleaned or inspected internally. Also the acid day tanks are showing signs of corrosion at the top plates. These should be cleaned and inspected and thickness to assess corrosion and remaining life of the tanks. Some acid transfer piping has been replaced at the outlet of the bulk tank in the WTP and the transfer line to the polishers. The transfer line to the polishers has some valves included in the piping. TMP-30 states that “metal piping that holds concentrated sulfuric acid should not be “blocked in” nor have valves closed tightly without a properly designed pressure- relief device in the line”.

The acid transfer line at the WTTP does not meet the stipulations in TMP-30 and should be upgraded. Pt. Aconi has some PM's in place for piping and tank inspections. These should be increased to meet the requirements of TMP-30.
Caustic transfer lines in the WWTP have a history of pluggage. This should be investigated as to the cause, i.e., heat tracing etc.
Pt. Aconi should have a PM in place to have the Hydrogen system piping inspected and tested by a qualified inspector.

Pt. Aconi: > Summary and Recommendations

1/ Raw water usage at Pt. Aconi increased by 25 % after the installation of the TIFFI ash injection system in 2008 that initially used 100 % demin water. The water usage was decreased by 12 % in 2009 by changing the ash injection water to 50 % raw water and 50 % demin water. The number of WTP, primary train regenerations were at a low of 99 in 2006 to a high of 154 in 2008 and reduced to 140 in 2009. The average throughputs in 2002 were about 700,000 liters before regenerations. This has been reduced to an average of 650,929 in 2009 and 605,890 in 2010. Contributing factors are resin age and possible contamination of the "A" cation with a white residue. The train "B" resin is seventeen years old.
Some maintenance improvements in the WTP have included replacing the old Nematron PLC with a new more flexible PLC interface, replacements of acid transfer piping and a new replacement acid pump. The bulk acid tank was cleaned and inspected in 2006. Acid day tank is showing signs of corrosion.
The caustic bulk tank and piping are original as well as the caustic pumps. The bulk tank and piping have not been thickness tested. There is a history of pluggage and caustic leaks with the caustic block and bleed system.

Recommendations: (a) Investigate white residue on train "A' cation for impact on WTP throughputs. Look for source and identify product.

(b) Have the acid day tank cleaned and thickness tested to assess remaining life of the tank.

(c) Complete thickness testing and internal inspection of bulk caustic tank in the WTP.

(d) Replace the ion exchange resin in train "B".

(e) Replace caustic block and bleed valves to prevent leaks.

2/ Pt. Aconi currently operates with three condensate polishers in service since the furnace wall division modification in 2004 that increased the maximum load on the unit from 185 MW to 193 MW. Throughputs between regenerations have remained virtually unchanged form the 2002 average throughput of 80 million liters. The oldest polisher

resin is in the "C' polisher and it is 13 years old. Resin has been purchased in 2010 to replace the old resin. Resin samples have been collected from all three polishers in 2010.
The old Nematron PLC interface has been replaced with a new more flexible PLC interface. The new PLC has a pause/hold feature to allow manual adjustments during regenerations.
The polisher acid day tank has a history of overflowing the tank and is showing signs of corrosion. The acid transfer piping to the polishers has been replaced. Some valves inline on this piping do not conform to the TMP-30 standard. The caustic system has the original day tank and piping existing.

Recommendations: (a) The resin in "B" polisher is ten years old. Consider replacing the resin subject to resin analysis results.

(b) Both the acid and caustic day tanks are fifteen years old. Recommend cleaning and thickness testing of the two tanks.

3/ The boiler water treatment program at Pt. Aconi is All Volatile treatment with ammonia for pH control and Hydrazine as an oxygen scavenger in the feedwater system.
The treatment is called AVT (R), all volatile reducing environment. The feed system is all ferrous with Titanium tubes in the condenser. The cycle chemistry has been generally within the EPRI guidelines as stated in 2002. Hydrazine levels have been outside the 20-40 ppb levels on occasion. LP dose pumps are currently operated on manual control.
The plant currently does not have a Boiler Gross Contamination procedure in the event of a major chemical excursion to the boiler. EPRI also recommends inline sodium analyzers for steam and condensate samples.
EPRI has made some modifications to the AVT treatment program. These will be added to the Chemical Handbook when it is updated. The lab DX-100 Ion Chromatograph stopped functioning in 2010, so some of the regular testing is not getting done.

Recommendations: (a) Develop a new Boiler Gross Contamination procedure for Pt. Aconi as a guideline for operations and lab staff to follow in the event of a major chemical excursion to the boiler.

(b) Replace the old DX-100 Ion Chromatograph with a new modern analyzer complete with an updated software package.

4/ The closed cooling water system (GSCW) continues to be treated with a molybdate based corrosion inhibitor within the 60-80 mg/l guideline. Pt. Aconi uses demin water for makeup and the system has used minimum makeup. The concentration of molybdate for 2009 and 2010 has been 64.5 mg/l as Mo. The molybdate concentration was below the minimum specified range of 60-80 mg/l for 33 % of the time in 2009 and 2010. The average iron for this time period was 0.68 mg/l as Fe compared to <0.1 mg/l as Fe during the 2002 review. The GSCW storage tanks have not been inspected in the last ten years.

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Recommendation: (a) Inspect the upper and lower GSCW storage tanks to see if there has been any corrosion impact from the low levels of molybdate.

(b) Continue with weekly testing of the GSCW to monitor for pH, molybdate and iron. Try to improve performance on molybdate additions and iron levels.

5/ The Pt. Aconi condenser is seawater cooled and contains Titanium tubes with no treatment for biological or corrosion control. The condenser is virtually leak free. Polishers are operated at 100%.
The Pt. Aconi Wastewater plant has one fifteen year old bulk caustic tank and one ten year old bulk acid tank. Neither of the tanks have been cleaned or inspected internally.
The chemical piping has not been thickness tested. The acid transfer system has a tote tank that is not being used and the piping does not meet the requirements for TMP-30.
The caustic transfer piping to the basins has a history of pluggage.

Recommendation: (a) Remove the acid tote tank that is not being used and upgrade the acid transfer piping to the TMP-30 standard, i.e. no threaded fittings and upgrade with block & bleed system.

(b) Complete cleaning, inspection and thickness testing of bulk chemical tanks and piping in the WWTP.

(c) Investigate reason for pluggage in caustic transfer piping, i.e. heat tracing or faulty valves in the WWTP.

6/ Pt. Aconi have access to online cycle chemistry parameters via the PI system or the DCMS. Improvements have been made to the WTP and condensate controls by replacing the old Nematron PLC interface with two new PLC's with pause /hold features.
The analytical panel is in good shape with the following exceptions. Sample cooling to the analytical panel is not adequate and does not meet the temperature standard of 25 deg. C for water samples in the summer months. Pt. Aconi has an old secondary cooling system (chiller) that does not cool the samples adequately. The inline dissolved oxygen meters on the analytical panel are not working reliably and a new manual dissolved oxygen meter has been ordered in 2010 to monitor dissolved oxygen sample cooling problems in the summer months. Hot samples give inaccurate results and can also damage measuring devices. The analytical panel does not have inline sodium analyzers for steam and condensate. This is an EPRI core parameter for cycle chemistry monitoring.

Recommendations: (a) Water samples at the analytical panels cannot be cooled to the the 25 deg. C standard in summer months. It is recommended that the old chiller be replaced to restore temperature control.

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(b) Install sodium analyzers on the analytical panel to measure sodium in steam and extraction pump samples. Sodium is an EPRI core parameter.

(d) Replace the two inline dissolved oxygen analyzers on the analytical panel with new modern units.

(e) Replace the old manual YSI conductivity meter in the analytical room with a new reliable unit for daily inline monitor checks.

7/ Pt. Aconi have several procedures in place for operation of the WTP, condensate polishers and for chemical control situations. Daily cycle chemistry results are shared electronically with operations. The plant does not have a procedure for Boiler Gross Contamination. Cycle chemistry results are currently recorded in logbooks, sheets or electronic files. There is no database for storage of cycle chemistry data to allow for trending, trouble shooting and quality control. The lab does a daily manual check of online instruments. They do not have a lab task list developed. This list could be use to for tracking to ensure core work is being completed and to assess how current staffing levels match up with work requirements.

Recommendations: (a) Improve data storage and quality control by transferring cycle Chemistry data and water usage information into Infocalc database or equivalent for ease of retrieval and quality control monitoring. Generation Services is currently looking at an upgrade for the Infocalc program.

(b) Create lab task list for tracking core work and assessment of of staffing resources versus workload.

8/ Pt. Aconi has made several improvements to the sulfuric acid storage and transfer systems since the 2002 review. The main bulk acid tank in the WTP was cleaned and inspected internally in 2006. the old carbon steel discharge piping has been upgraded to stainless steel. The acid transfer piping to the condensate polishers has been replaced.
The acid day tanks are fifteen years old and have not been cleaned or thickness tested. Some deterioration of the tanks has occurred.
The caustic bulk tanks and day tanks in the WTP and WWTP and associated piping, and pumps are original equipment. The bulk tanks and day tanks need to be cleaned and inspected with thickness testing to determine corrosion rate and remaining life estimate.

Recommendations: (a) Clean and internally inspect the bulk caustic storage tanks.

(b) Conduct UT testing of caustic transfer piping to determine corrosion rate as per TMP-30.

(d) Create PM program in Directline to ensure future inspections and testing of Chemical Assets. as per TMP-30.

7.0 Laboratory Staffing & Apprenticeship.

A review of laboratory staffing levels was completed in 2010 as part of the succession planning program for Power Production. The following is a summary of current staffing in the Thermal plants.

Pt. Tupper has an Acting Chemical Supervisor in the lead role for the lab under the guidance of the Chemical Asset Specialist. Some changes in personnel have taken place in 2010, but they are adequately trained and staffed.

Trenton has a new Environmental Engineer /Chemical Supervisor in the lead role in the lab. They lost a full time Chemical Technician and replaced him with a Chemical Technician Apprentice. The new lab supervisor and apprentice are developing with the assistance of lab staff and the Chemical Asset Specialist. There has been a struggle with time management during this training and development period. The apprentice is developing with the updated Chemical Technician Apprentice training program.

Lingan lab had to replace their lead hand and two other Chemical Technicians in 2010 due to retirements and one Chemical Technician transferring to a new location. Two replacements were full time experienced Chemical Technicians so the transition and training period did not have a huge impact on the lab. The third replacement is a PPT1 from the labor pool who will require some development in this role. Lingan has one employee who is currently eligible to retire. The lab supervisor is a full time experienced supervisor with additional responsibility for the coal crew.

Pt. Aconi has a full time experienced Chemical Supervisor in the lead role in the lab. They replaced their lead hand who transferred to Lingan, with a full time experienced Chemical Technician. They have one more full time PPT1 Chemical Technician and one 50 % PPT11 Chemical Technician/Instrument Technician. The labor pool Chemical Technician who was assisting with the lab duties at Pt. Aconi was awarded one of the Chemical Technician Shift vacancies at Lingan. It is recommended that Pt. Aconi replace the term position lost with a new term employee unless the work load can be adjusted.

Tuft's Cove has a new Environmental Engineer/ Chemical Supervisor who is developing in this role. The lab has an experienced lead hand and one other full time experienced PPT1 Chemical Technician. The Chemical Technician Apprentice that was hired in 2009 just recently completed the In-House Chemical Technician Apprenticeship program. Tuft's Cove recently lost one full time Chemical Technician who was transferred to Pt. Tupper. This position will be filled with a new apprentice. The lab lead hand is currently eligible to retire. There will be some time constraints during this developmental and training period.

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8.0 Boiler Tube Sampling and Failure Mechanisms.

8.01 Introduction

Boiler tube failures due poor cycle chemistry programs, or chemical excursions, can be extremely costly from a replacement energy perspective or additional costs for multi-stage chemical cleaning of the boiler.
This section of the report will describe some common boiler tube failure mechanisms and their possible causes.
The report will also list a history of water chemistry related boiler tube failures for Power Production since the last chemical review in 2002. The history will also include any chemical cleaning that may have occurred as a result of the analysis.
It will also include a description of any boiler tube sample deposit analysis and recommendations for chemical cleaning.

Hydrogen Damage - Most commonly associated with excessive deposition on the ID tube surfaces, coupled with a boiler water low pH excursion. Under-deposit corrosion releases atomic hydrogen which migrates into the tube wall metal, reacts with the carbon in the steel (decarburization), and causes micro-fissures in the metal. Hydrogen Damage results in large window failures in the tubes. Water chemistry upsets condenser leakage and metal deposits from condenser and feed water can contribute to this problem. Copper in the deposits can accelerate the corrosion rate.

Caustic Gouging - This occurs when boiler water concentrates to high pH levels within tube deposits. Under these conditions the protective magnetite layer can be dissolved and rapid corrosion of tube material occurs. Only occurs in boilers using caustic .Caustic attack occurs when there is excessive deposition on the ID portion of the tube surfaces in combination with high pH water chemistry excursions. Produced localized wall loss on the inside diameter of the tube surface. In boilers with phosphate/caustic treatment the sodium to phosphate ration should be kept near 2.8 to prevent caustic corrosion.
Acid Phosphate Corrosion - is caused when phosphate salts present in the boiler water treatment concentrate under heavy deposits in the boiler tubing. The problem is almost always associated with mono sodium phosphate usage.

Oxygen Pitting – Aggressive localized corrosion and loss of tube wall, most prevalent near economizer feedwater inlet on operating boilers. Flooded or non-drainable surfaces are most susceptible during outage periods. It can occur during operation when the Deaerator is not functioning properly there is excessive air in-leakage from pumps and other pre-boiler equipment. Proper shutdown/lay-up procedures are critical in prevention of oxygen pitting.

Acid Attack – Corrosive attack of the internal tube metal surfaces, resulting in an irregular pitted or "swiss cheese" appearance of the tube ID. It is usually associated with poor control of process during boiler chemical cleanings and/ or inadequate post-cleaning passivation of residual acid.

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Corrosion Fatigue – is usually a result of cyclic loading. Corrosion fatigue crack initiation requires repeated disruption and repair of the protective oxide layer on the tube. The mechanism may present itself as aligned corrosion pits and then crack like pits. The water chemistry system greatly influences the growth of these cracks when contaminants in the water accelerate the corrosion. It is more likely to occur in units that have been cleaned using inorganic acids or operated with a low pH (< 8.0), in the boiler during start-up when dissolved oxygen levels may be elevated.

8.02 Boiler Tube Failure Risk Factors (Water side).

The following is a list of conditions that can increase the risk of boiler tube failures:

(a) High waterside boiler tube deposits.

(b) Low boiler, feed water pH conditions.

(c) Water treatment plant excursion or condenser leak excursion history.

(d) Age of boiler, frequency of failures, and time interval between boiler cleanings.

(e) External thinning of tubes from erosion or fireside corrosion.

(f) Tube deposit components. High copper in deposit accelerates corrosion rate. High chlorides, sulfates and dissolved oxygen contribute to breakdown of the protective magnetite layer.

(g) Internal deposits could initiate and or accelerate external corrosion/wastage by increasing the outside surface temperatures.

Babcox and Wilcox maximum recommended water side loading for a boiler operating in the 1000 to 2000 psig range is 12-20 grams per ft^2.

The tubes deposit quantity guidelines for Alstom Canada Inc. for 1800 psig and higher are as follows:

• Normal/clean surfaces	Less than 15	mg/cm^2
• Moderately Dirty Surfaces	15-40	mg/cm^2
• Very Dirty Surfaces	More than 40	mg/cm^2

The ASME Research Committee on Corrosion in Thermal Power Systems made the following observations:

"In all their tests, fouling of the heat transfer surfaces was necessary for the initiation of corrosion. when the heat transfer surfaces were free of deposits, no corrosion occurred even with aggressive low pH, boiler water chemistry. Once deposits were present, the same conditions caused accelerated corrosion."

Tube sampling to measure relative thickness of tubes and amounts of deposit build up is performed on a regular basis as well as analysis of deposit material to determine corrosion activity.

8.03 Plant Waterwall Tube Samples and Acid Clean History

Action Taken:

- ♦ Pt. Tupper has not been acid cleaned since commissioning in 1987.
- ♦ Tuft's Cove unit #1 was last acid cleaned in 1999.
- ♦ Tuft's Cove unit #2 was last acid cleaned in 2006. (Multi-stage cleaning).
- ♦ Tuft's Cove unit #3 acid cleaned in 2003
- ♦ Trenton unit #5 was acid cleaned in 2005.
- ♦ Lingan unit #1 acid cleaned in 2005.
- ♦ Lingan unit #2 acid cleaned in 2004.
- ♦ Lingan unit #4 acid cleaned in 2008.

- Tube samples were taken from Pt. Tupper unit #2 in 2010
- Lingan has an acid clean planned for unit # 3 in 2011.

See table below for tube sampling and failure mechanism history for chemistry related failures.

Table 3 NSPI Boiler Tube Samples & Failure Mechanisms. (Chemistry Related)

Plant/Unit	**Date Sample**	**Tube # Area**	**Deposit Weight**	**Other Risk Factors**	**Major Elements %**	**Acid Cleaning Recommended**
Lingan/ #2	Oct /2001 Alstom	Elev.388' Tube #51	60.9 mg/cm^2	External Wastage Wall Thinning	Fe 54 Cu 5	Yes, acid cleaned in 2004
Lingan/#1	Jan /2002 Alstom	East wall, Elev. 420, Tube #19	59.4 mg/cm^2	External Wastage Wall Thinning	No analysis done	Yes, acid cleaned in 2005
Lingan / #4	Jan 2006 Northland Consulting	NW Corner at Buckstay 2nd Flr.	58.85 & 33.37 mg/cm^2	High magnetite loading	Primarily Fe 0.5- Cu P04- 1.54	Yes, completed in 2008.
Lingan/#3	Oct /2001 Alstom	Elev.388' Tube #51	60.9 mg/cm^2	External Wastage Wall Thinning	Fe 54 Cu 5	Yes, planned for 2011
Tuft's Cove /#1	Dec 2007 Northland	T373 Rear wall #28	16.9 mg/cm^2	Tube sample analysis	Fe 88.5 Cu 2.88	No Normal

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	Consulting.	Elev. 145 ft.			Zn 5.27 Cr 1.97	
Tuft's Cove unit #2	Dec 2004 B & W.	Bull nose tube bottom section	712 mg/cm2	Internal deposit analysis	Fe – 41.68 Cu 70.12	Yes, 4-stage cleaning in 2006.
Tuft's Cove unit #2	Jan 2005	Waterwall	Failure	Internal deposit overheating		Yes-completed in 2006.
Tuft's Cove #2	Dec 2006	Waterwall	Failure	Hydrogen Damage		Post acid cleaning.
Tuft's Cove/#2	Dec 2007, Northland Consulting.	T374-rt side wall, North #34 elev. 104 ft.	7.6 mg/cm^2	Tube sample analysis.	Fe 89.6 Cu 3.01 Zn 4.12 Cr 1.00	No, Normal
Tuft's Cove #2	Oct 2009	Waterwall	Failure	Under deposit corrosion		Yes, evidence of Cu plating from acid Clean.
Tuft's Cove #3	Dec 2002	Waterwall	Failure	Overheating due to thick internal deposit		Yes, completed in 2003
Tuft's Cove/#3	Dec 2007, Northland Consulting	Left sidewall, #77 elev. 175 ft 5th flr.	15.3 mg/cm^2	Tube sample Analysis.	Fe 93.15 Cu 2.08 Zn 2.53 S = 2.39.	No Normal.
Tuft's Unit #2	Dec 2009	Front wall North, # 53 Elev. 151 ft. T464	10.85 mg/cm^2	Under deposit corrosion, Cu plating indicated.	Fe 91.9 Cu 11.0	Yes, evidence of copper plating and corrosion products.
Trenton #5 Failure	Sept 2003	South WW Tube #69	73.9 mg/cm^2	Fireside corrosion wall thinning internal pitting	Fe- 90.7 O – 7.3	Acid cleaning recommended & completed in 2005.
Pt. Tupper/#2	Feb 6, 2006 Alstom	NW corner Waterwall Elev. 107	13.5 mg/cm^2	Black, grey, red deposit	Fe - 70.84 O- 24.94 Cu - 0.52	No

Conclusions:

The history of cycle chemistry related boiler tube failures in the last seven or eight years has indicated a low boiler tube failure rate for the thermal plant boilers with the exception of Tuft's Cove unit #2. A program of planned chemical cleaning of the boilers has been executed in Lingan, Trenton and Tuft's Cove. Tuft's Cove unit #2 had a multi-stage acid

clean completed in 2006 due to the extremely high tube deposits. This unit has been two-shifted for several years and this has contributed to the high deposit loadings on the boiler tubes. There is still evidence of some copper plating on the Tuft's Cove unit #2 tube samples that were recently collected. High copper in the deposits indicates that the deposit originates from the low pressure feed system. Deposit loadings from 2007 are normal since the chemical cleanings were completed on all three Tuft's Cove units.
Lingan has acid cleaned all units except unit #3, and this unit is to be cleaned in 2011.
Pt. Tupper boiler tube sample deposits were normal. Samples were collected from Pt. Tupper unit #2 in 2010 for additional deposit weight analysis.
TMP-029 was created in 2002 as a guideline for collecting boiler tube samples. This TMP
recommends annual boiler tube sampling for units experiencing water wall failures and minimum five years for all other boiler tube samples.

7.0 Report Summary

(a) The Power Production Chemical Handbook needs to be updated to include recent guidelines and recommendations from EPRI for fossil fueled boiler cycle chemistry and Heat Recovery Steam Boilers.

(b) All laboratory test records should be kept in a computer database to improve retrieval of data and for ease of reporting statistics and trends. Currently, some data records are kept in logbooks and sheets and retrieval for reporting is very time consuming. It is recommended that all plants use a software package to store cycle chemistry data.

(c) The In-house Chemical Technician Apprenticeship program is being updated in 2010 to be used as a tool for training and evaluation of new Chemical Technician Apprentices. The program is being monitored by the Chemical Asset Specialist, Generation Services. All new PPTI Chemical Technician Apprentices must participate in the In-House Apprenticeship program.

(d) Improvements to online monitoring of cycle chemistry should include upgrades to analytical panels where required and improvements to cooling water supplies to the panels when the water sample temperature standard is not being met. Inadequate cooling of water samples is a common problem in all Thermal Stations. This directly affects the reliability of online analytical equipment and can lead to asset damage due to inaccurate cycle chemistry data.

(e) A review of chemical assets for the individual Thermal Stations is included in this report. This includes an update from the 2002 Gap Analysis. Actions taken and current findings are included in the report.

(f) There is inconsistency in how the Thermal Plants complete inspections of chemical assets such as chemical storage tanks, day tanks and chemical piping. Not all plants are following TMP-30.

(g) Several of the Thermal Plants may require condensate polisher resin in the next two to five years. There may be an opportunity to save on the cost of resin by purchasing all the required resin from a single supplier via a capital program.

(h) Current staffing levels and succession planning programs were included in this review. Recommendations are included for each individual plant.

(i) A review of the recent history of cycle chemistry related boiler tube failures and boiler tube deposit sampling is included in this report. This includes recommendations for chemical cleaning and a record of those that were completed.

References:

"NSPI, Chemical Handbook, Power Production Division, published 1984, Peter Whitehouse, Revision 3, 2003, by Mike McCarthy.

Cycle Chemistry Guidelines for Combined Cycle/Heat Recovery Steam Generators (HRSG's). TR-1010438 March 2006.

/ Cycle Chemistry Guidelines for Fossil Plants: Phosphate Continuum & Caustic Treatment. TR-1004188, Jan 2004.

NSPI Generating Facility Water/Chemistry Cycle Practices Gap Analysis Report-2002 Generation Services, by Mike McCarthy

Cycle Chemistry Guidelines for Fossil Plants: All Volatile Treatment, Revision 1, TR-1004187, Nov. 2002.
Integrated Boiler Tube Failure Reduction/Cycle Chemistry Improvement Program. TR-1013098 May 2006.

Selection and Optimization of Boiler Water & Feedwater Treatments for Fossil Plants. TR-105040, March 1997.

Trenton Chemistry Review Action Plan
Updated October 18, 2012
J. McKiel

A chemical asset review was completed in 2010 by Generation Services for the Trenton Generating Station. A number of recommendations were made as a result of this study. This document includes the actions to be taken as a result of these recommendations.

1) Replace the aging and deteriorating carbon filter vessels.

   The carbon filters were initially in the capital plan for 2013. These were repaired in 2012 due to the passing of activated carbon. Life expectancy has been extended by possibly 5 years. Annual PM will be added to inspect carbon filter vessels. PM in place for first annual inspection in 2013.

2) Continue with plans for resin replacement in Trenton 6 demin plant for 2010 including maintenance improvements.

   The resin for the Trenton 6 demin plant has been purchased and is scheduled to be replaced in 2013.

3) Complete thickness testing and internal inspection of bulk acid & caustic tanks in the WTP.

   This work is scheduled to be completed in 2012, pending labour disruption.

4) Recommend testing of Trenton 5 ion exchange resins and the organic traps resin for capacity and fouling.

   The Trenton 5 demin resin and organic trap resin is scheduled to be replaced in 2013.

5) Replace the service inlet and outlet pneumatic valves on Trenton 5 condensate polishers.

   This will be scoped in 2013 and possibly included in the 2014 capital plan.

6) Most of the pneumatic valves on the Trenton 5 condensate polishers are more than 30 years old. These valves have a history of diaphragm failures. These valves should be in an asset management plan for replacement to maintain reliability of the system.

   This will be scoped in 2013 and possibly included in the 2014 capital plan.

7) Replace the acid and caustic strength meters and add day tank level gauges to Trenton 6 polishers.

   This will be scoped in 2013 and possibly included in the 2014 capital plan.

8) Have the 5-1 and 5-2 polisher resins tested and plan for replacement by 2012.

   This replacement is scheduled for 2014. Resin has been purchased for 5-1, 5-2, and 5-3 polishers as a result of the 2012 Trenton 5 forced outage.
   The resin in these vessels will be tested in 2012 to determine if the original replacement schedule is still valid.

9) Start a program of regular testing for iron and copper in the feedwater. This is an EPRI recommendation.

   Iron and copper is tested in the feedwater by the chem lab on a weekly basis. – Complete.

10) Install sodium analyzers on both units to measure sodium in steam and extraction pump samples. Sodium is an EPRI core parameter.

    The addition of sodium analyzers for Trenton 5 and Trenton 6 will be scoped in 2013 and possibly added to the 2014 capital plan.

11) EPRI is recommending that the pH for mixed metallurgy feed systems be changed from 8.8-9.2 to 9.0-9.3. This change is recommended for Trenton 5.

    The pH range for Trenton 5 has been changed to 9.0 – 9.3 as per EPRI guidelines.- Complete.

12) The recommended chloride limit for boilers on caustic treatment is 200 ppb. Trenton 5 currently has a limit of 500 ppb. The 200 ppb limit for chlorides is recommended for Trenton 5.

    EPRI now recommends the chloride limit to be 400 ppb. This change has been made for Trenton 5. – Complete.

13) Upgrade the Trenton 5 HP dose system to current safety standards and replace the 40 year old pump.

    This has been included in the 2013 capital plan.

14) Inspect the Trenton 6 upper and lower GSCW storage tanks to see if there has been any corrosion impact from the low levels of Molybdate.

This will be scoped in 2013 and possibly added to the 2014 capital plan.

15) Inspect small bore piping for evidence of corrosion and replace where required. This may have an impact on cooling to the analytical panels or other equipment.

    This will be scoped in 2013 and possibly added to the 2014 capital plan.

16) Reinstate the weekly testing program for pH, molybdate and iron testing.

    Molybdate, iron, and pH testing is completed on the GSCW system. – Complete.

17) Monitor new condenser for biological fouling over time. Stainless steel is less resistant than copper to biological fouling.

    The condenser for Trenton 5 is inspected during planned outages. Last inspected during 2012 outage. No evidence of increased biological fouling.

18) Water samples at the analytical panel cannot be cooled to the 25 deg. C standard in summer months. It is recommended that the cooling water supply to the Trenton 6 panel be investigated for restricted flow and/or add additional chillers to the sample panel to achieve the proper sample temperatures.

    This will be scoped in 2013 and possibly added to the 2014 capital plan.

19) Create capital project for a new analytical panel for the Trenton 5 boiler, steam and feedwater samples that includes current sample valve standards and adequate cooling for samples. The panel should house all analytical monitors such as pH, conductivity, cation conductivity, dissolved oxygen and sodium analyzers.

    This project has been included in the 2013 capital plan.

20) Replace small sample lines in the Trenton 6 analytical panel with Standard 3/8" OD stainless lines to prevent sample flow restrictions.

    This will be scoped and possibly completed in 2013 or added to the 2014 capital plan.

21) Improve data storage and quality control by transferring cycle chemistry data and water usage information into the Infocalc database or equivalent for ease of retrieval and quality control monitoring. Generation Services is currently looking at a software package to replace the Infocalc program.

    A new software package "Truesense" was purchased as a replacement to "Infocalc". The Trenton lab department is currently using this program. - Complete

22) Recommend the hiring of a new Chemical Technician Apprentice for Trenton lab to assist lab staff until the current Chemical Technician apprentice completes the apprenticeship. The new apprentice could then be used for future succession.

    A justification was completed and submitted in 2011, but not approved for business reasons. Apprentice at the time has now successfully completed the apprenticeship program. - Complete

23) Create an asset management plan for cleaning, internal inspection and thickness testing of all bulk chemical tanks and day tanks in Directline, as per TMP-030 guidelines.

    A preventative maintenance program will be set up in Directline, as per TMP-030 guidelines and implemented in 2012.

24) Conduct UT testing of the acid and caustic transfer piping to determine corrosion rate as per TMP-030.

    This will be completed in 2012 as part of the bulk tank inspections.

CI Number: 43041

Title: **POT – Air Heater Steam Coil Replacement**

Start Date: 2013/05
Final Cost Date: 2013/12
Function: Generation
Forecast Amount: $331,766

DESCRIPTION:

This project is for the replacement of Unit 2 steam coil air heaters. There are two banks of heaters in each of the North and South Forced Draft (FD) Fan ducts. The steam coil air heaters prevent corrosion caused by acid condensation in the downstream ductwork and stack when the unit's back end temperature from combustion is below the acid dew point (approximately 300^{o} F). At lower and variable loads, the steam coils are needed to keep the temperature high.

Summary of Related CIs +/- 2 years:
No other projects in 2011, 2012, 2013, 2014 and 2015

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

Without these coils, the ductwork and stack may degrade quickly from acid condensation, resulting in flue gas leaks and possible unit outages. The top banks in both ducts have deteriorated and have been out of service for some time. The bottom coils now deteriorated to the point that they require replacement. Both the top and bottom coils require replacement.

Why do this project now?

The outage in 2013 will provide the opportunity to replace the existing steam coils and return the unit to original design. Without these coils, the ductwork and stack may corrode very quickly causing flue gas leaks and possible unit outages. While the bottom bank alone has been able to maintain a suitable back end temperature in recent operation, the unit is expected to see more low and variable load operation, resulting in lower back end temperatures and higher risk of acid formation.

Why do this project this way?

As this is specialized boiler equipment, and part of the overall boiler design, replacing the coils in-kind would not require any additional modifications to the ducting and pipework to install the coils. Repair is no longer an option for these coils.

CI Number : 43041 - POT - Air heater steam coils replacement **Project Number**

Parent CI Number : -

Cost Centre : 351 - 351-Pt.Tupper Admin./Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		3,194	0	3,194
095		095-Thermal Regular Labour AO		[redacted]	0	[redacted]
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	2,160	0	2,160
002	013	002 - THERMAL Overtime Labour	013 - SGP - Boiler	0	0	0
004	013	004 - THERMAL Term Labour	013 - SGP - Boiler	0	0	0
012	013	012 - Materials	013 - SGP - Boiler	[redacted]	0	[redacted]
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	[redacted]	0	[redacted]
011	085	011 - Travel Expense	085 Design	500	0	500
028	085	028 - Consulting	085 Design	2,000	0	2,000
041	085	041 - Meals & Entertainment	085 Design	500	0	500
			Total Cost:	331,766	0	331,766
			Original Cost:	196,539		

Air Heater Steam Coils Replacement
Summary of Alternatives

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Point Tupper Generating Station	**CI Number:**	43041
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Steam Coils	6.48%	10,281,102	1	39.33%	9.8 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

It is recommended that the steam coils be replaced based on favorable economic analysis.

Notes/Comments :

Replace Steam Coils

The steam coil air heaters provide heat in the back end of the boiler to prevent acid condensation and accelerated corrosion of the equipment downstream, including the ductwork, two induced draft fans, and the stack liner when flue gas temperature is reduced at lower loads. Without the steam coils, and with low and variable load operation increasing, the corrosion will cause unplanned failures until a long-term outage results from failure of back-end equipment.

Test 2

Test 3

Test 4

Air Heater Steam Coils Replacement
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Point Tupper Generating Station	CI Number:	43041
Originator :		Project No. :	

Replace Steam Coils

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$32,000	$34,242		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	5%	10%	5%	10%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	150	150				
Duration (Hours)	36	36				
Totals	$410	$1,274	$1,600	$3,424	$2,010	$4,698
Total Capital Cost of Alternative						$331,766

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

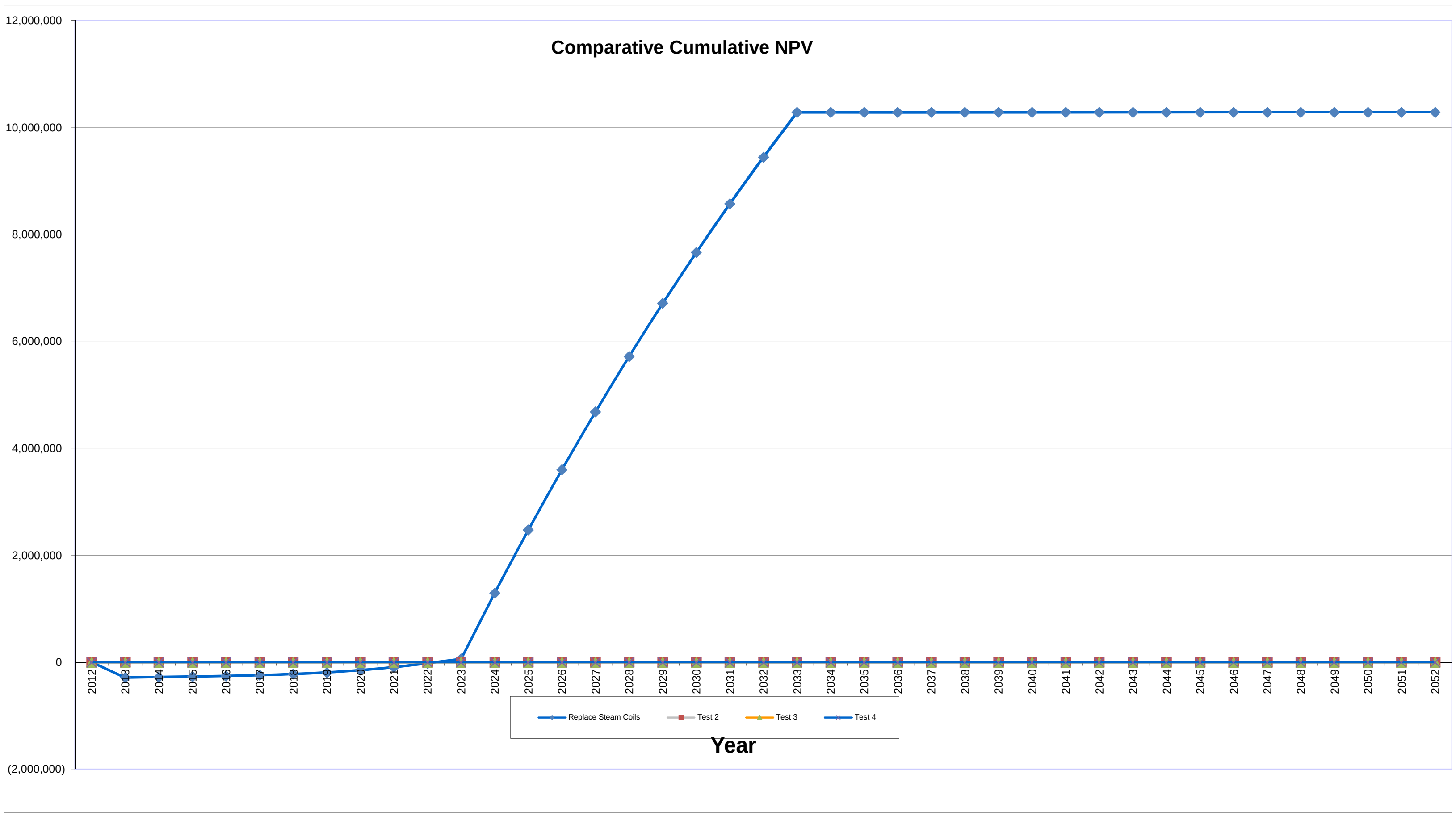
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Air Heater Steam Coils Replacement
Replace Steam Coils

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	2,009.5	(311,055.0)	12,652.4	303,657.6	(309,045.5)	3,299.3	(305,746.2)	(287,139.534)	0.9	(287,139.5)
2014	-	4,698.3	-	24,292.6	279,365.0	4,698.3	6,074.2	10,772.5	9,501.259	0.9	(277,638.3)
2015	-	7,445.5	-	22,349.2	257,015.8	7,445.5	4,620.1	12,065.6	9,994.163	0.8	(267,644.1)
2016	-	10,492.7	-	20,561.3	236,454.5	10,492.7	3,121.2	13,614.0	10,590.420	0.8	(257,053.7)
2017	-	19,416.6	-	18,916.4	217,538.2	19,416.6	(155.1)	19,261.5	14,071.806	0.7	(242,981.9)
2018	-	35,211.5	-	17,403.1	200,135.1	35,211.5	(5,520.6)	29,690.9	20,371.106	0.7	(222,610.8)
2019	-	62,107.1	-	16,010.8	184,124.3	62,107.1	(14,289.8)	47,817.2	30,811.164	0.6	(191,799.6)
2020	-	98,631.4	-	14,729.9	169,394.4	98,631.4	(26,009.4)	72,621.9	43,946.410	0.6	(147,853.2)
2021	-	139,285.7	-	13,551.5	155,842.8	139,285.7	(38,977.6)	100,308.1	57,006.418	0.6	(90,846.8)
2022	-	184,473.9	-	12,467.4	143,375.4	184,473.9	(53,322.0)	131,151.9	69,999.379	0.5	(20,847.4)
2023	-	234,636.5	-	11,470.0	131,905.4	234,636.5	(69,181.6)	165,454.9	82,933.709	0.5	62,086.3
2024	-	3,783,442.6	-	10,552.4	121,352.9	3,783,442.6	(1,169,595.9)	2,613,846.6	1,230,448.930	0.5	1,292,535.2
2025	-	3,859,328.3	-	9,708.2	111,644.7	3,859,328.3	(1,193,382.2)	2,665,946.1	1,178,601.026	0.4	2,471,136.3
2026	-	3,936,747.2	-	8,931.6	102,713.1	3,936,747.2	(1,217,622.9)	2,719,124.4	1,128,954.603	0.4	3,600,090.9
2027	-	4,015,731.0	-	8,217.0	94,496.1	4,015,731.0	(1,242,329.3)	2,773,401.7	1,081,414.366	0.4	4,681,505.2
2028	-	4,096,312.1	-	7,559.7	86,936.4	4,096,312.1	(1,267,513.2)	2,828,798.8	1,035,889.390	0.4	5,717,394.6
2029	-	4,178,523.7	-	6,954.9	79,981.5	4,178,523.7	(1,293,186.3)	2,885,337.4	992,292.892	0.3	6,709,687.5
2030	-	4,262,399.8	-	6,398.5	73,583.0	4,262,399.8	(1,319,360.4)	2,943,039.4	950,542.011	0.3	7,660,229.5
2031	-	4,347,975.2	-	5,886.6	67,696.3	4,347,975.2	(1,346,047.5)	3,001,927.7	910,557.607	0.3	8,570,787.1
2032	-	4,435,285.3	-	5,415.7	62,280.6	4,435,285.3	(1,373,259.6)	3,062,025.7	872,264.073	0.3	9,443,051.2
2033	-	4,524,366.5	-	4,982.4	57,298.2	4,524,366.5	(1,401,009.1)	3,123,357.4	835,589.157	0.3	10,278,640.4
2034	-	-	-	4,583.9	52,714.3	-	1,421.0	1,421.0	357.022	0.3	10,278,997.4
2035	-	-	-	4,217.1	48,497.2	-	1,307.3	1,307.3	308.472	0.2	10,279,305.8
2036	-	-	-	3,879.8	44,617.4	-	1,202.7	1,202.7	266.523	0.2	10,279,572.4
2037	-	-	-	3,569.4	41,048.0	-	1,106.5	1,106.5	230.279	0.2	10,279,802.7
2038	-	-	-	3,283.8	37,764.2	-	1,018.0	1,018.0	198.964	0.2	10,280,001.6
2039	-	-	-	3,021.1	34,743.0	-	936.6	936.6	171.907	0.2	10,280,173.5
2040	-	-	-	2,779.4	31,963.6	-	861.6	861.6	148.530	0.2	10,280,322.1
2041	-	-	-	2,557.1	29,406.5	-	792.7	792.7	128.332	0.2	10,280,450.4
2042	-	-	-	2,352.5	27,054.0	-	729.3	729.3	110.880	0.2	10,280,561.3
2043	-	-	-	2,164.3	24,889.7	-	670.9	670.9	95.802	0.1	10,280,657.1
2044	-	-	-	1,991.2	22,898.5	-	617.3	617.3	82.774	0.1	10,280,739.8
2045	-	-	-	1,831.9	21,066.6	-	567.9	567.9	71.518	0.1	10,280,811.4
2046	-	-	-	1,685.3	19,381.3	-	522.5	522.5	61.792	0.1	10,280,873.2
2047	-	-	-	1,550.5	17,830.8	-	480.7	480.7	53.389	0.1	10,280,926.5
2048	-	-	-	1,426.5	16,404.3	-	442.2	442.2	46.129	0.1	10,280,972.7
2049	-	-	-	1,312.3	15,092.0	-	406.8	406.8	39.856	0.1	10,281,012.5
2050	-	-	-	1,207.4	13,884.6	-	374.3	374.3	34.436	0.1	10,281,047.0
2051	-	-	-	1,110.8	12,773.8	-	344.3	344.3	29.753	0.1	10,281,076.7
2052	-	-	-	1,021.9	11,751.9	-	316.8	316.8	25.707	0.1	10,281,102.4
Total	-	42,238,520.4	(311,055.0)	304,558.1	3,660,572.7	41,927,465.4	(12,999,528.3)	28,927,937.1	10,281,102.4		


Comparative Cumulative NPV
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Replace Steam Coils
Test 2
Test 3
Test 4
Year

Location: Point Tupper Generating Station
CI# / FP#: 43041
Title: POT - Air Heater Steam Coils Replacement
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.7	Utility & Unskilled	hr	[redacted]		$ 2,160.00		
1.1							
				Sub-Total	$ 2,160.00		
2	**012 Materials**						
2.1	Air heater steam coils	lot	2	[redacted]		Cost Support 1	
2.2					$ -		
2.3					$ -		
				Sub-Total	[redacted]		
3	**013 Power Production Contracts**						
3.1	Boilermakers	lot	1	[redacted]		Cost Support 2	
3.2					$ -		
3.3					$ -		
				Sub-Total	[redacted]		
4	**028 Consulting**						
4.1	Consulting	lot	1	$ 2,000.00	$ 2,000.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 2,000.00		
5	**011 Travel Expenses**						
5.1	Travel	lot	1	$ 500.00	$ 500.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 500.00		
6	**041 Meals and Entertainment**						
6.1	Meals and expenses	lot	1	$ 500.00	$ 500.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 500.00		
8	**094 Interest Capitalized**						
8.1	AFUDC	lot	1	$ 3,194.01	$ 3,194.01		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 3,194.01		
9	**095 Administrative Overhead**						
9.1	Contracts AO	lot	1	[redacted]			
9.2	Regular Labour AO	lot	1				
9.3					$ -		
				Sub-Total	[redacted]		
Cost Estimate				**Total**	$ 331,765.67		
10	**Original Cost**						
10.1					$ 196,538.73		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 & 2

Removed due to confidentiality

CI Number: 43097

Title: **LIN 3,4 Replace Boiler Feed Pump (BFP) Check Valve**

Start Date: 2013/03
Final Cost Date: 2014/02
Function: Generation
Forecast Amount: $331,572

DESCRIPTION:

The purpose of this project is to replace the existing discharge check valves on Unit 3 boiler feed pump (BFP) 3B, and one on Unit 4 BFP 4B at the Lingan Generating Station. Replacement of these valves will improve the reliability and performance of the BFP discharge check valve isolation.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015.

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

The existing BFP discharge check valves are approximately 25 years old and have reached the end of their useful life. It is becoming increasingly difficult to source replacement parts and maintain the valves in acceptable working condition. The existing valves also contain an automatic recirculation feature which is no longer used. There are several parts associated with this automatic recirculation feature that cannot be removed from the valves. These parts have begun to cause performance and maintenance issues. Hot feedwater leaking past a discharge check valve from the unit's common BFP discharge line promotes uneven thermal flow within the standby pump, and significant by-pass can cause the pump to run backward and create damage to the standby pump. This uneven flow distorts critical tolerances and clearances. This also increases the risk of damaging the pump when it is started.

Why do this project now?

The check valves have reached end of life condition and may affect the reliability of the boiler feed pump standby system. Replacement parts are difficult to source, which increases the risk of outages of the standby and main boiler feed pump systems.

Why do this project this way?

The existing valves have reached the end of their useful life. Replacement with new valves is recommended to increase the reliability of the system and reduce the risk of unplanned outages. Modification of the existing valves is not feasible.

CI Number : 43097 - LIN 3,4 Replace BFP Check Valve **Project Number**

Parent CI Number : -

Cost Centre : 305 - 305-Lingan 3&4 Prod.Unit **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		9,505	0	9,505
095		095-Thermal Regular Labour AO		2,639	0	2,639
095		095-Thermal & Hydro Contracts AO		25,775	0	25,775
001	016	001 - THERMAL Regular Labour	016 - SGP - Feed Water Sys.	9,920	0	9,920
002	016	002 - THERMAL Overtime Labour	016 - SGP - Feed Water Sys.	0	0	0
004	016	004 - THERMAL Term Labour	016 - SGP - Feed Water Sys.	0	0	0
012	016	012 - Materials	016 - SGP - Feed Water Sys.	81,733	0	81,733
013	016	013 - POWER PRODUCTION Contracts	016 - SGP - Feed Water Sys.	202,000	0	202,000
			Total Cost:	331,572	0	331,572
			Original Cost:	82,500		

LIN 3,4 BFP Discharge Chk Valve Replacement
Summary of Alternatives

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Lingan	**CI Number:**	43079
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Valves	6.48%	933,868	1	34.58%	4.9 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

Replace the BFP Discharge Check Valves to reduce risk of Standby Boiler feed pump damage

Notes/Comments :

Replace Valves

Each unit has two boiler feed pumps, one running and one in standby. The boiler feedpump check valve provides isolation between the standby pump and the common boiler feed water high pressure discharge line. If the valve fails, hot, high-pressure water is allowed to pass into the discharge of the standby pump creating thermal stresses and potential for the standby pump to run backwards and damage components. The failure scenario assumes damage to the standby pump, but no incremental replacement energy required.

Test 2

Test 3

Test 4

LIN 3,4 BFP Discharge Chk Valve Replacement
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Lingan	CI Number:	43079
Originator :		Project No. :	

Replace Valves

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$308,650	$314,823		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	15%	20%	15%	20%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$46,298	$62,965	$46,298	$62,965
Total Capital Cost of Alternative						$331,572

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

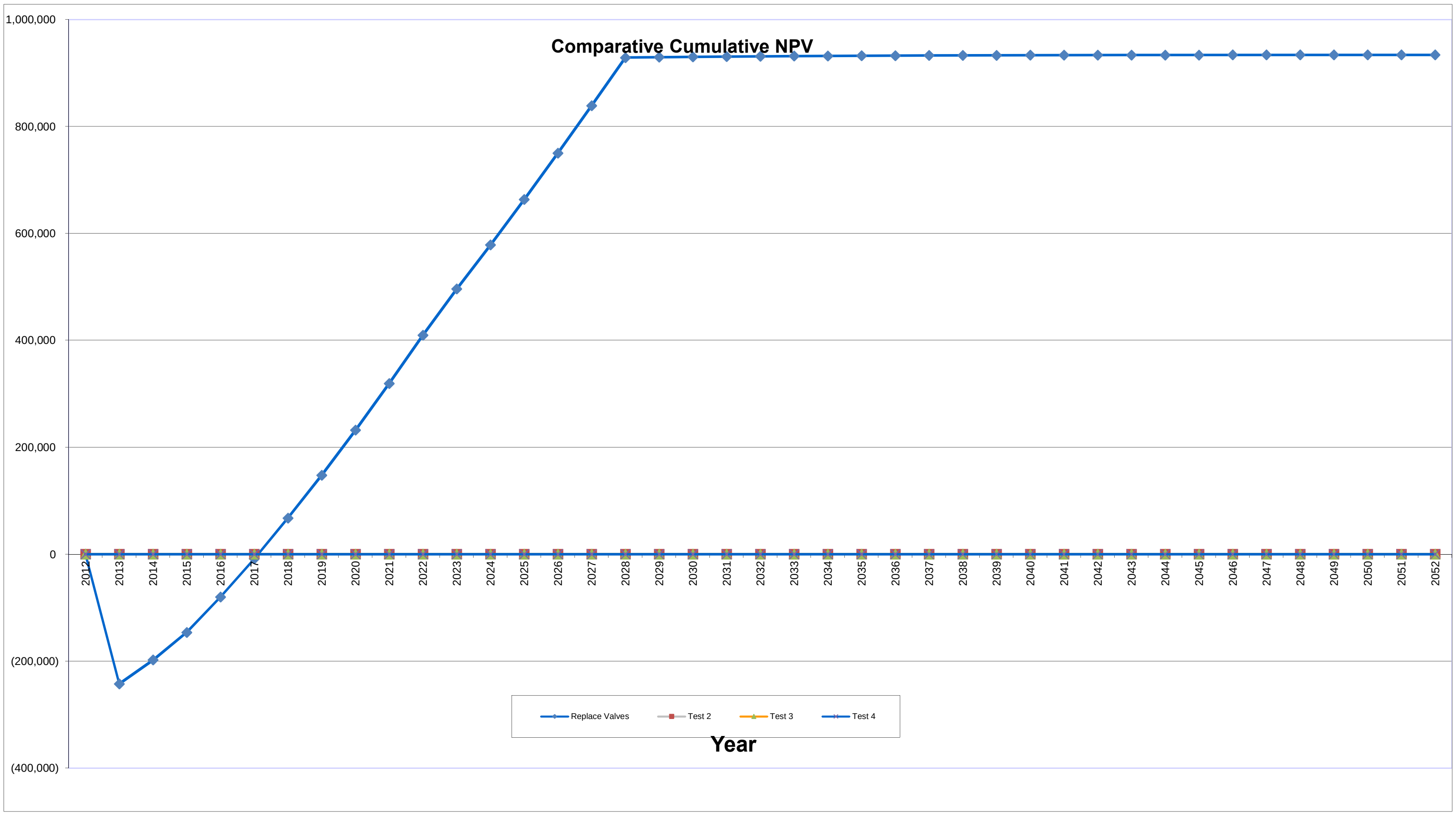
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

LIN 3,4 BFP Discharge Chk Valve Replacement
Replace Valves

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	46,297.5	(293,653.0)	12,087.1	290,090.1	(247,355.5)	(10,605.2)	(257,960.7)	(242,262.141)	0.9	(242,262.1)
2014	-	62,964.6	-	23,207.2	266,882.9	62,964.6	(12,324.8)	50,639.8	44,663.831	0.9	(197,598.3)
2015	-	80,279.9	-	21,350.6	245,532.3	80,279.9	(18,268.1)	62,011.8	51,365.347	0.8	(146,233.0)
2016	-	114,639.6	-	19,642.6	225,889.7	114,639.6	(29,449.1)	85,190.6	66,270.353	0.8	(79,962.6)
2017	-	133,637.1	-	18,071.2	207,818.5	133,637.1	(35,825.4)	97,811.6	71,457.917	0.7	(8,504.7)
2018	-	153,348.5	-	16,625.5	191,193.0	153,348.5	(42,384.1)	110,964.4	76,133.429	0.7	67,628.7
2019	-	173,795.0	-	15,295.4	175,897.6	173,795.0	(49,134.9)	124,660.1	80,325.112	0.6	147,953.8
2020	-	194,998.0	-	14,071.8	161,825.8	194,998.0	(56,087.1)	138,910.9	84,060.494	0.6	232,014.3
2021	-	216,979.6	-	12,946.1	148,879.7	216,979.6	(63,250.4)	153,729.2	87,366.310	0.6	319,380.7
2022	-	239,762.5	-	11,910.4	136,969.3	239,762.5	(70,634.1)	169,128.3	90,268.431	0.5	409,649.1
2023	-	244,557.7	-	10,957.5	126,011.8	244,557.7	(72,416.1)	172,141.7	86,285.439	0.5	495,934.5
2024	-	249,448.9	-	10,080.9	115,930.8	249,448.9	(74,204.1)	175,244.8	82,495.194	0.5	578,429.7
2025	-	274,010.0	-	9,274.5	106,656.4	274,010.0	(82,068.0)	191,942.0	84,856.556	0.4	663,286.3
2026	-	299,453.8	-	8,532.5	98,123.9	299,453.8	(90,185.6)	209,268.2	86,886.158	0.4	750,172.4
2027	-	325,805.7	-	7,849.9	90,274.0	325,805.7	(98,566.3)	227,239.4	88,605.973	0.4	838,778.4
2028	-	353,091.9	-	7,221.9	83,052.0	353,091.9	(107,219.7)	245,872.2	90,036.952	0.4	928,815.4
2029	-	-	-	6,644.2	76,407.9	-	2,059.7	2,059.7	708.346	0.3	929,523.7
2030	-	-	-	6,112.6	70,295.2	-	1,894.9	1,894.9	612.019	0.3	930,135.7
2031	-	-	-	5,623.6	64,671.6	-	1,743.3	1,743.3	528.792	0.3	930,664.5
2032	-	-	-	5,173.7	59,497.9	-	1,603.9	1,603.9	456.883	0.3	931,121.4
2033	-	-	-	4,759.8	54,738.1	-	1,475.5	1,475.5	394.752	0.3	931,516.1
2034	-	-	-	4,379.0	50,359.0	-	1,357.5	1,357.5	341.071	0.3	931,857.2
2035	-	-	-	4,028.7	46,330.3	-	1,248.9	1,248.9	294.689	0.2	932,151.9
2036	-	-	-	3,706.4	42,623.9	-	1,149.0	1,149.0	254.615	0.2	932,406.5
2037	-	-	-	3,409.9	39,214.0	-	1,057.1	1,057.1	219.990	0.2	932,626.5
2038	-	-	-	3,137.1	36,076.8	-	972.5	972.5	190.074	0.2	932,816.6
2039	-	-	-	2,886.1	33,190.7	-	894.7	894.7	164.226	0.2	932,980.8
2040	-	-	-	2,655.3	30,535.4	-	823.1	823.1	141.894	0.2	933,122.7
2041	-	-	-	2,442.8	28,092.6	-	757.3	757.3	122.598	0.2	933,245.3
2042	-	-	-	2,247.4	25,845.2	-	696.7	696.7	105.926	0.2	933,351.2
2043	-	-	-	2,067.6	23,777.6	-	641.0	641.0	91.521	0.1	933,442.8
2044	-	-	-	1,902.2	21,875.4	-	589.7	589.7	79.076	0.1	933,521.8
2045	-	-	-	1,750.0	20,125.3	-	542.5	542.5	68.322	0.1	933,590.1
2046	-	-	-	1,610.0	18,515.3	-	499.1	499.1	59.031	0.1	933,649.2
2047	-	-	-	1,481.2	17,034.1	-	459.2	459.2	51.004	0.1	933,700.2
2048	-	-	-	1,362.7	15,671.4	-	422.4	422.4	44.068	0.1	933,744.3
2049	-	-	-	1,253.7	14,417.7	-	388.6	388.6	38.075	0.1	933,782.3
2050	-	-	-	1,153.4	13,264.2	-	357.6	357.6	32.897	0.1	933,815.2
2051	-	-	-	1,061.1	12,203.1	-	329.0	329.0	28.424	0.1	933,843.6
2052	-	-	-	976.2	11,226.9	-	302.6	302.6	24.558	0.1	933,868.2
Total	-	3,163,070.2	(293,653.0)	290,950.3	3,497,017.3	2,869,417.2	(890,357.2)	1,979,060.1	933,868.2		



Comparative Cumulative NPV
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Replace Valves
Test 2
Test 3
Test 4
Year

Location: Lingan
CI# / FP#: 43097
Title: LIN4 3,4 Replace BFP Discharge Check Valves
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Engineering (P.Eng)	hr	[redacted]		$ 2,240.00		
1.2	Power Engineer	hr			$ 5,520.00		
1.3	Utility & Unskilled	hr			$ 2,160.00		
1.4		hr		$ -	$ -		
				Sub-Total	$ 9,920.00		40222
2	**012 Materials**						
2.1	10 Inch check valve	each	2	[redacted]		Cost Support 1	
2.2	Contigency for purchase of Valves	%					40222
2.3	Fittings (Flange, Red, Caps)	each	2				
				Sub-Total	$ 81,733.20		
3	**013 Power Production Contracts**						
3.1	Valve Installation (HP Weld)	each	2	[redacted]			
3.2	Weld Inspection	each	2				
3.3	Freight	lot	1				
3.4	Stress Relieve Service	each	2				
3.5					$ -		
				Sub-Total	$ 202,000.00		40222
4	**094 Interest Capitalized**						
4.1	Interest Capitalized	lot	1	$ 9,505.27	$ 9,505.27		
4.2							
				Sub-Total	$ 9,505.27		
5	**095 Administrative Overhead**						
5.1	Thermal & Hydro Contracts	lot	1	$ 12,665.40	$ 25,775.20		
5.2	Thermal Regular Labour	lot	1	$ 2,255.33	$ 2,638.72		
5.3							
				Sub-Total	$ 28,413.92		
Cost Estimate				**Total**	$ 331,572.39		
6	**Original Cost**						
6.1					$ 82,500.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

CI Number: 41159

Title: **LIN Reclaim Feeders Replacement**

Start Date: 2013/05
Final Cost Date: 2013/12
Function: Generation
Forecast Amount: $314,078

DESCRIPTION:

The Lingan live storage coal operation has six reclaim locations (A to F) with two parallel reclaim feeders at each location. These vibratory feeders are located in a conveyer tunnel below the coal pile base. The vibratory feeders draw coal from the pile and deliver it to a conveyer which transports the coal to the plant conveyance systems. Numerous feeders are active at any given time to ensure sufficient coal supply to the plant, and to allow blending of up to six different coal types.

This project is for replacement of the vibratory feeder and support structure at the Lingan live coal storage reclaim A1 and A2 locations. An engineering assessment indicates the feeder and related support structures at the A reclaim are degraded, and replacement is recommended. The scope of work involves removing the grizzly and chutes from above, and then removing the feeder assembly and supports. New equipment that will fit in the existing location will be specified and installed to match the existing belt and related power and controls.

Summary of Related CIs +/- 2 yrs:
No other projects 2011, 2012, 2013, 2014 or 2015.

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

Feeder and related support structures are degraded and replacement is recommended to avoid the risk of structural failure. Availability of all six reclaims is necessary for Lingan operations to achieve fuel blending requirements. A significant failure in one feeder can affect short term fuel blending capability and require re-positioning of coal inventory as a work-around.

Why do this project now?

Allowing the feeder and support structure to continue to degrade past 2013 increases the risk of a structural failure. Planning the replacement in 2013 provides time for necessary design and sourcing so that materials and services are available in the summer of 2013. Doing the extraction and replacement in the low-load, dry months of summer is preferable.

Why do this project this way?

The feeder structure and support mechanism have had numerous repairs and metal replacements over time. Further repairs are not deemed feasible as they cannot be made structurally sound. Removing and replacing isolated components in situ may be possible but would present worker risk due to the constrained work area and coal dust concerns. The A belt would also have to be out of service at all times that work was underway. It is preferable to remove the grizzly and chutes and extract the complete assembly by crane. The new assembly will be replaced from above, limiting work in the tunnel and belt down-time.

The extracted feeder and support structure will be examined and further determination made as to refurbishment / re-engineering options for use as a swap with remaining feeders prior to commencing any further replacement work.

CI Number : 41159 - LIN Reclaim Feeders Replacement **Project Number**

Parent CI Number : -

Cost Centre : 301 - 301-Lingan Admin./Common Capital **Budget Version** 2012 08/04 Forecast

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		3,671	0	3,671
095		095-Thermal & Hydro Contracts AO		18,247	0	18,247
095		095-Thermal Regular Labour AO		2,660	0	2,660
001	018	001 - THERMAL Regular Labour	018 - SGP - Fuel Hndlg.Coal	10,000	0	10,000
004	018	004 - THERMAL Term Labour	018 - SGP - Fuel Hndlg.Coal	0	0	0
012	018	012 - Materials	018 - SGP - Fuel Hndlg.Coal	136,500	0	136,500
013	018	013 - POWER PRODUCTION Contracts	018 - SGP - Fuel Hndlg.Coal	143,000	0	143,000
			Total Cost:	314,078	0	314,078
			Original Cost:	100,100		

LIN Coal Reclaim Feeder Replacement
Summary of Alternatives

Division :	Power Production		**Date :**	**31-Oct-12**
Department :	Lingan		**CI Number:**	41159
Originator :			**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Feeders	6.48%	275,764	1	18.46%	7.5 years
B	Repair Feeders	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

Replace Reclaim A feeders to ensure reliability of the system to blend coal as required, and to avoid unplanned outages in the coal system.

Notes/Comments :

Replace Feeders

A failed feeder will require stoppage of the reclaim belts to complete necessary repairs. This would affect the coal supply to the plant. Due to workaround options, an unplanned outage would not be expected and is not assumed in this evaluation.

Repair Feeders

Repairs are no longer feasible. No other viable option has been identified.

Test 3

Test 4

LIN Coal Reclaim Feeder Replacement
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Lingan	CI Number:	41159
Originator :		Project No. :	

Replace Feeders

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	0.00	0.00				
Repair Cost ($)			$80,640	$83,874		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	35%	40%	35%	40%		
Capacity Factor (%)	0%	0%				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$28,224	$33,550	$28,224	$33,550
Total Capital Cost of Alternative						$314,078

Repair Feeders

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	0.00	0.00				
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	0%	0%				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

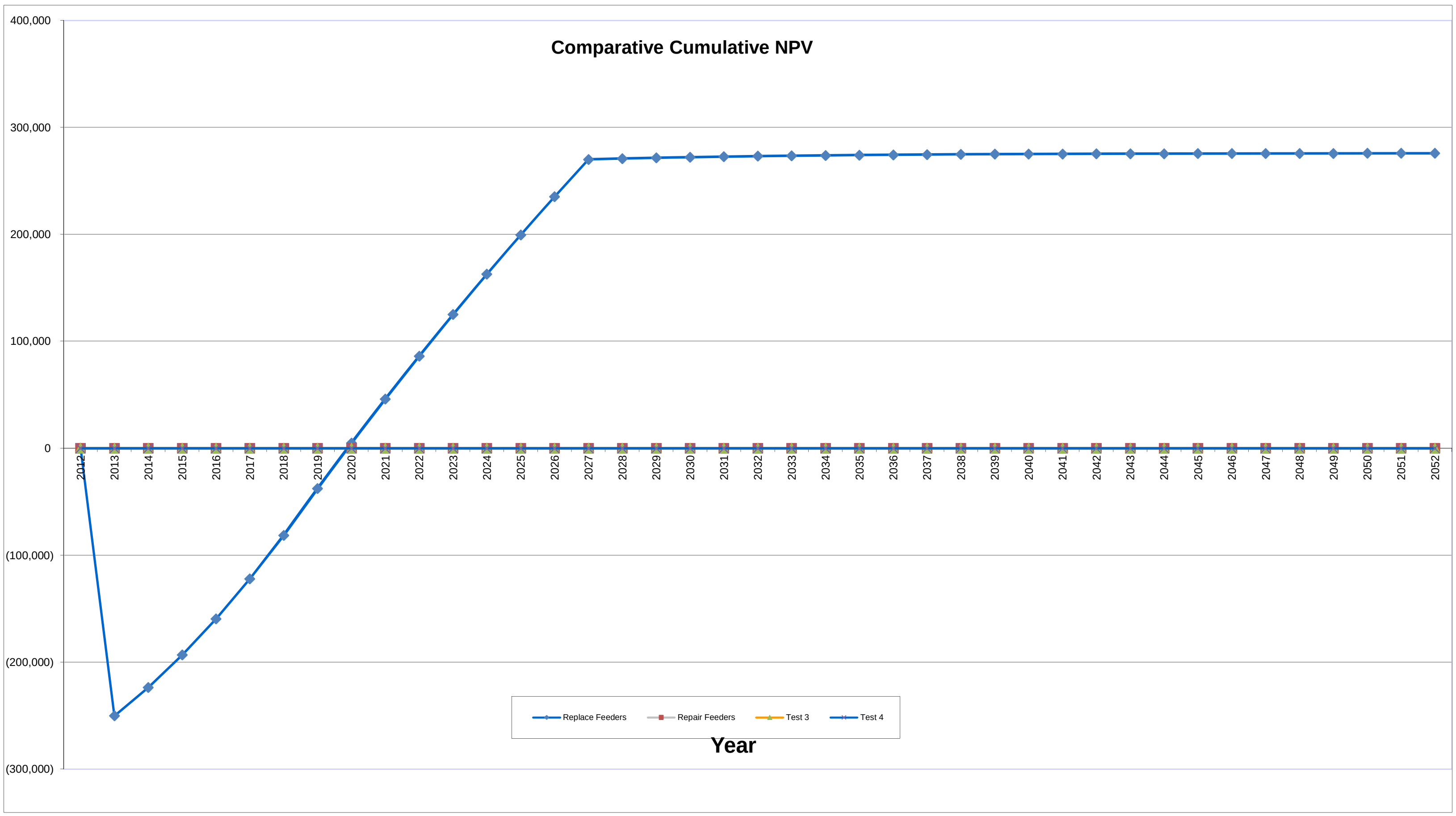
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	0.00	0.00				
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	0%	0%				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	0.00	0.00				
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	0%	0%				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

LIN Coal Reclaim Feeder Replacement
Replace Feeders

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	28,224.0	(289,500.0)	11,830.9	283,941.2	(261,276.0)	(5,081.9)	(266,357.9)	(250,148.259)	0.9	(250,148.3)
2014	-	33,549.5	-	22,715.3	261,225.9	33,549.5	(3,358.6)	30,190.9	26,628.109	0.9	(223,520.1)
2015	-	43,618.7	-	20,898.1	240,327.8	43,618.7	(7,043.4)	36,575.3	30,295.897	0.8	(193,224.3)
2016	-	54,441.5	-	19,226.2	221,101.6	54,441.5	(10,916.7)	43,524.8	33,858.230	0.8	(159,366.0)
2017	-	66,062.2	-	17,688.1	203,413.4	66,062.2	(14,996.0)	51,066.2	37,307.282	0.7	(122,058.7)
2018	-	78,527.4	-	16,273.1	187,140.4	78,527.4	(19,298.8)	59,228.5	40,637.108	0.7	(81,421.6)
2019	-	91,886.1	-	14,971.2	172,169.1	91,886.1	(23,843.6)	68,042.5	43,843.361	0.6	(37,578.3)
2020	-	95,571.0	-	13,773.5	158,395.6	95,571.0	(25,357.2)	70,213.8	42,489.131	0.6	4,910.9
2021	-	99,403.6	-	12,671.6	145,724.0	99,403.6	(26,886.9)	72,516.7	41,212.182	0.6	46,123.0
2022	-	103,389.9	-	11,657.9	134,066.0	103,389.9	(28,436.9)	74,953.0	40,004.484	0.5	86,127.5
2023	-	107,536.2	-	10,725.3	123,340.8	107,536.2	(30,011.4)	77,524.8	38,859.041	0.5	124,986.6
2024	-	111,848.6	-	9,867.3	113,473.5	111,848.6	(31,614.2)	80,234.4	37,769.754	0.5	162,756.3
2025	-	116,334.1	-	9,077.9	104,395.6	116,334.1	(33,249.4)	83,084.7	36,731.296	0.4	199,487.6
2026	-	120,999.4	-	8,351.6	96,044.0	120,999.4	(34,920.8)	86,078.6	35,739.011	0.4	235,226.6
2027	-	125,851.8	-	7,683.5	88,360.5	125,851.8	(36,632.2)	89,219.6	34,788.826	0.4	270,015.5
2028	-	-	-	7,068.8	81,291.6	-	2,191.3	2,191.3	802.455	0.4	270,817.9
2029	-	-	-	6,503.3	74,788.3	-	2,016.0	2,016.0	693.331	0.3	271,511.2
2030	-	-	-	5,983.1	68,805.2	-	1,854.7	1,854.7	599.046	0.3	272,110.3
2031	-	-	-	5,504.4	63,300.8	-	1,706.4	1,706.4	517.583	0.3	272,627.9
2032	-	-	-	5,064.1	58,236.7	-	1,569.9	1,569.9	447.198	0.3	273,075.1
2033	-	-	-	4,658.9	53,577.8	-	1,444.3	1,444.3	386.385	0.3	273,461.5
2034	-	-	-	4,286.2	49,291.6	-	1,328.7	1,328.7	333.841	0.3	273,795.3
2035	-	-	-	3,943.3	45,348.3	-	1,222.4	1,222.4	288.443	0.2	274,083.7
2036	-	-	-	3,627.9	41,720.4	-	1,124.6	1,124.6	249.218	0.2	274,333.0
2037	-	-	-	3,337.6	38,382.8	-	1,034.7	1,034.7	215.327	0.2	274,548.3
2038	-	-	-	3,070.6	35,312.1	-	951.9	951.9	186.045	0.2	274,734.3
2039	-	-	-	2,825.0	32,487.2	-	875.7	875.7	160.745	0.2	274,895.1
2040	-	-	-	2,599.0	29,888.2	-	805.7	805.7	138.886	0.2	275,034.0
2041	-	-	-	2,391.1	27,497.1	-	741.2	741.2	119.999	0.2	275,154.0
2042	-	-	-	2,199.8	25,297.4	-	681.9	681.9	103.681	0.2	275,257.6
2043	-	-	-	2,023.8	23,273.6	-	627.4	627.4	89.581	0.1	275,347.2
2044	-	-	-	1,861.9	21,411.7	-	577.2	577.2	77.399	0.1	275,424.6
2045	-	-	-	1,712.9	19,698.8	-	531.0	531.0	66.874	0.1	275,491.5
2046	-	-	-	1,575.9	18,122.9	-	488.5	488.5	57.780	0.1	275,549.3
2047	-	-	-	1,449.8	16,673.0	-	449.4	449.4	49.923	0.1	275,599.2
2048	-	-	-	1,333.8	15,339.2	-	413.5	413.5	43.134	0.1	275,642.3
2049	-	-	-	1,227.1	14,112.1	-	380.4	380.4	37.268	0.1	275,679.6
2050	-	-	-	1,129.0	12,983.1	-	350.0	350.0	32.200	0.1	275,711.8
2051	-	-	-	1,038.6	11,944.4	-	322.0	322.0	27.821	0.1	275,739.6
2052	-	-	-	955.6	10,988.9	-	296.2	296.2	24.038	0.1	275,763.7
Total	-	1,277,243.9	(289,500.0)	284,783.2	3,422,892.3	987,743.9	(307,662.8)	680,081.1	275,763.7		


Comparative Cumulative NPV
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300,000
200,000
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Replace Feeders
Repair Feeders
Test 3
Test 4
Year

Location: Lingan
CI# / FP#: 41159
Title: LIN Reclaim Feeders Replacement
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	hr	[redacted]		$ 3,280.00		
1.2	Engineering (P.Eng)	hr			$ 1,120.00		
1.3	Maintenance Trades	hr			$ 3,440.00		
1.4	Utility & Unskilled	hr			$ 2,160.00		
1.5							
				Sub-Total	$ 10,000.00		
2	**012 Materials**						
2.1	Vibratory feeder	each	2	[redacted]		Cost Support 1. Exchange is assumed to be 1.0.	
2.2	Misc Materials - Fasteners , plate, etc	each	2	$ 14,700.00	$ 29,400.00		
2.3					$ -		
				Sub-Total	$ 136,500.00		
3	**013 Power Production Contracts**						
3.1	Demolition and installation contract cw lifts	each	2	[redacted]			
3.2	Sub Frame Fabrication	each	2				
3.3	Reverse Engineer Sub Frame & Drwgs	lot	1				
3.4	Project development and const management	lot	1				
				Sub-Total	$ 143,000.00		
4	**094 Interest Capitalized**						
4.1	Interest Capitalized	lot	1	$ 3,670.80	$ 3,670.80		
4.2					$ -		
				Sub-Total	$ 3,670.80		
5	**095 Administrative Overhead**						
5.1	Thermal & Hydro Contracts	lot	1	$ 18,246.80	$ 18,246.80		
5.2	Thermal Regular Labour	lot	1	$ 2,660.00	$ 2,660.00		
5.3					$ -		
				Sub-Total	$ 20,906.80		
Cost Estimate				**Total**	$ 314,077.60		
6	**Original Cost**						
6.1					$ 100,100.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

Submitted to:
Ron McNeil
Engineering Manager
Lingan

Submitted by:
Steve Butler P Eng.
Butler Associates

July 27 2012

SUBJECT: RECLAIM FEEDER 1A Evaluation:

The vibrating feeder used on the Coal Reclaim 1A was supplied by Stephens-Adamson, and is the oldest feeder, in the coal reclaim system. It has been repaired and replanted numerous times, with patches literally being put on patches. The following pictures illustrate the poor condition.

A new crack has developed along the side of the main pan

and has been temporarily sealed with caulking (above photo).

Most of the structural X-bracing and framing has deteriorated, (see below)

And the underlying support frame has been patched, welded and re-welded.
(see in the following photo the structural support leg has deteriorated from an original thickness of 5 mm to about 2 mm)

The following shows more metal deterioration.

REPLACEMENT:

Replacement cost for the feeder would include a new feeder – Stephens Adamson no longer will supply, a new supplier will be required. In addition to the vibrating feeder, the support structure will need to be replaced. Removal of the overhead chute and grizzly would be required. This would be lifted by a crane from the reclaim tunnel up to ground level. Any work in the reclaim tunnel (some will be required to repair and upgrade the discharge chute and support stand), will require a hot work procedure in a hazardous location. The feeder will be out of operation for one to two weeks. Once removed, coal could be lifted via the other feeders.

PRELIMINARY COST ESTIMATES

FEEDER (same principle as existing)………………… 60 k
REMOVAL OF FEEDER AND INSTALL NEW …… 40 k
FABRICATE NEW SUB FRAME ……………………. 5 k
MICELLANEOUS PLATE AND CHUTE REPAIR …..10 k

NOTE: This amount is preliminary only, and includes only one of the two feeders included in this work order application.

The total replacement cost estimate is: $115,000.00

The alternative to doing a change out would be to do a major in situ repair. This would take several weeks and would require a stop in operating of the “A” belt for almost the entire upgrade. Work in this area would also be hazardous, with coal dust and possible methane gas being present. A hot work permit and detailed hazard assessment/rescue plan would be required. The area is quite confined and does not allow access to heavy equipment to move steel plates or provide overhead access.

This feeder is one of twelve in the system. Several of the other ones are in similar condition (although the main pans don’t show any evidence of cracking) and will require a similar replacement. The feeder which is being removed could be evaluated ofr reconditioning at a repair shop and possible be rebuilt “as new” and reused in another location.

Regards
Steve Butler

CI Number: 41664

Title: **TRE5 Electrostatic Precipitator (ESP) Refurbishment**

Start Date: 2013/05
Final Cost Date: 2014/01
Function: Generation
Forecast Amount: $306,057

DESCRIPTION:

The electrostatic precipitator (ESP or Precip) on Unit 5 has been in service for more than 20 years. During an inspection in 2010 by the Original Equipment Manufacturer (OEM), it was found that the structural support for a number of the field plates was starting to fail, causing the fields to start leaning into each other or into one of the external walls. A follow-up inspection in 2012 confirmed that the structural support has degraded further. If the fields make contact with each other or with the external walls, it will cause the fields to short out, thus disabling a portion or possibly the entire precipitator.

The precipitator and the baghouse work in series with each other to remove flyash from the boiler exhaust gas stream. Degradation or loss of the precipitator will impact the ability to remove the flyash, which will impact the operation of Unit 5. Limited or no operation of the Precip may impact fuel flexibility, cause flyash release to the environment outside the limit of NS Power's operating permit, and result in the loss of partial or full generation from the unit.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015.

JUSTIFICATION:

Justification Criteria: Environment

Sub Criteria: Maintenance

Why do this project?

The structural support for a number of the field plates is failing. If this structural support is allowed to fail, the field plates will fall into adjacent field plates or into the outer walls of the precipitator, causing the fields to short out electrically thus disabling a section of the precipitator. This reduces the ability to remove fly ash from the boiler exhaust gas.

Why do this project now?

It is recommended from the OEM that these repairs are completed as soon as possible as degradation of the structural support has increased since the 2010 inspection. The 2013 shutdown on Unit 5 will be the next available opportunity of sufficient duration to complete these repairs.

Why do this project this way?

The OEM has recommended repairs to be completed in this manner, consistent with their recommendations for other precipitators of similar build and vintage through North America. Making these repairs to the existing structural support rather than installing new structure is more economical and efficient. It is expected that repairs to the structural support will last the projected life span of Unit 5.

CI Number : 41664 - TRE5 Precip Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 340 - 340-Trenton Unit 5 Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		4,291	0	4,291
095		095-Thermal Regular Labour AO		3,575	0	3,575
095		095-Thermal & Hydro Contracts AO		26,451	0	26,451
001	017	001 - THERMAL Regular Labour	017 - SGP - Draft Equip./Stacks	0	0	0
002	017	002 - THERMAL Overtime Labour	017 - SGP - Draft Equip./Stacks	0	0	0
011	017	011 - Travel Expense	017 - SGP - Draft Equip./Stacks	500	0	500
012	017	012 - Materials	017 - SGP - Draft Equip./Stacks	50,000	0	50,000
013	017	013 - POWER PRODUCTION Contracts	017 - SGP - Draft Equip./Stacks	207,300	0	207,300
021	017	021 - Telephones	017 - SGP - Draft Equip./Stacks	250	0	250
041	017	041 - Meals & Entertainment	017 - SGP - Draft Equip./Stacks	250	0	250
001	085	001 - THERMAL Regular Labour	085 Design	4,480	0	4,480
001	087	001 - THERMAL Regular Labour	087 Field Super.& Ops.	8,960	0	8,960
			Total Cost:	306,057	0	306,057
			Original Cost:	51,000		

Location: Trenton Generating Station
CI# / FP#: 41664
Title: TRE5 Precip Refurbishment
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Supervision	hr	[redacted]		$ 8,960.00		
1.2	Internal Engineering	hr			$ 4,480.00		
1.3					$ -		
1.4					$ -		
				Sub-Total	$ 13,440.00		
4	**012 Materials**						
4.1	1st and 2nd field collector	lot	1	[redacted]			
4.2	Miscellaneous materials	lot	1				
4.3					$ -		
4.4					$ -		
				Sub-Total	$ 50,000.00		
5	**013 Power Production Contracts**						
5.1	Technical Support	lot	[redacted]				
5.2	Boilermakers - Field 1 and 2 collector supports	hr					
5.3	Boilermakers - 3rd field collector rings, corona rings, and leaking seal boots	hr					
5.4	Boilermakers - Repair air leakage , hatches and inlet nozzle	hr					
5.5	Boilermakers - Repair insulation 2nd field east side	hr					
5.6	Boilermaker Overtime	hr					
5.7							
				Sub-Total	$ 207,300.00		
6	**011 Travel**						
6.1	Travel	lot	1	$ 500.00	$ 500.00		
				Sub-Total	$ 500.00		
7	**021 Telephones**						
7.1	Telephones	lot	1	$ 250.00	$ 250.00		
				Sub-Total	$ 250.00		
8	**041 Meals and Entertainment**						
8.1	Meals	lot	1	$ 250.00	$ 250.00		
				Sub-Total	$ 250.00		
9	**094 Interest Capitalized**						
9.1	Interest Capitalized	lot	1	$ 4,290.67	$ 4,290.67		
				Sub-Total	$ 4,290.67		
10	**095 Administrative Overhead**						
10.1	Thermal Regular Labour AO	lot	1	$ 3,575.04	$ 3,575.04		
10.2	Thermal & Hydro Contracts AO	lot	1	$ 26,451.48	$ 26,451.48		
10.3					$ -		
				Sub-Total	$ 30,026.52		
Cost Estimate				Total	$ 306,057.19		
11	**Original Cost**						
11.2	Retirement				$ 51,000.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project.

Lodge Cottrell

Nova Scotia Power

Trenton Unit #5 Precipitator

Mechanical Inspection & Repair Report

Contract UI00240

Lodge Cottrell Inc.

June 2012

Bernard Brandon

Contents

1.0 Introduction

The following preliminary report presents the findings of the mechanical inspection for Nova Scotia Power, Trenton Unit #5. The inspection was conducted at the request of Nova Scotia Power by Lodge Cottrell service department during June 2012.

Prior to the outage Nova Scotia Power had reported no major operating problems
The purpose of the inspection was to identify and address any immediate internal problems that would inhibit the performance of the precipitator and identify any developing problems that could affect future performance
Following this inspection and discussion with the plant a punch list of repairs was produced and items of concern prioritized. Most items are to be deferred until the 2013 outage and will not significantly affect the performance of the precipitator and are shown on the itemized summary below.

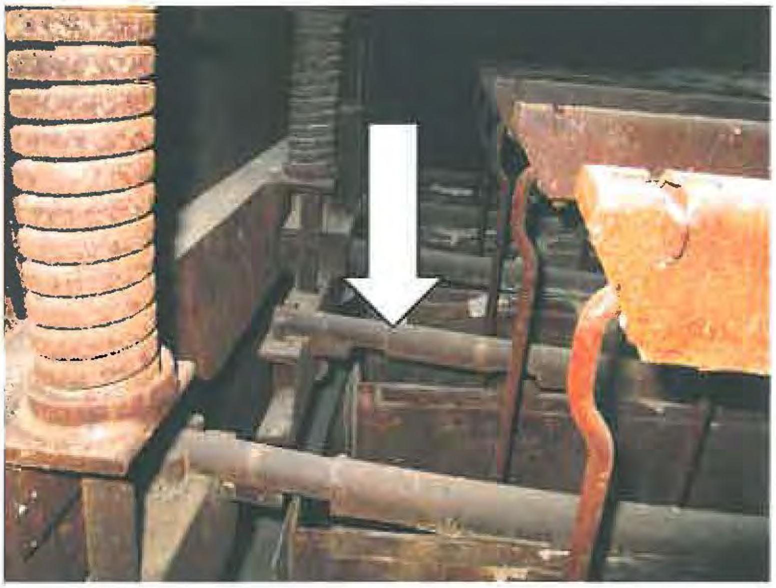
Equipment

The original precipitator consisted of 2 fields UOP design. Collector plates are 30ft x9ft deep in the direction of gas flow (32 gas passages) on 9 inch centers. Weighted wire discharge electrodes are suspended and centered in the gas passages. The 3rd field has been added/rebuilt by Joy Western with strip plates approximately 31ft x 12ft in the direction of gas flow mounted on 12inch centers, (24 gas passages). The discharge electrodes in this section are rigid mast,

2.0 Summary

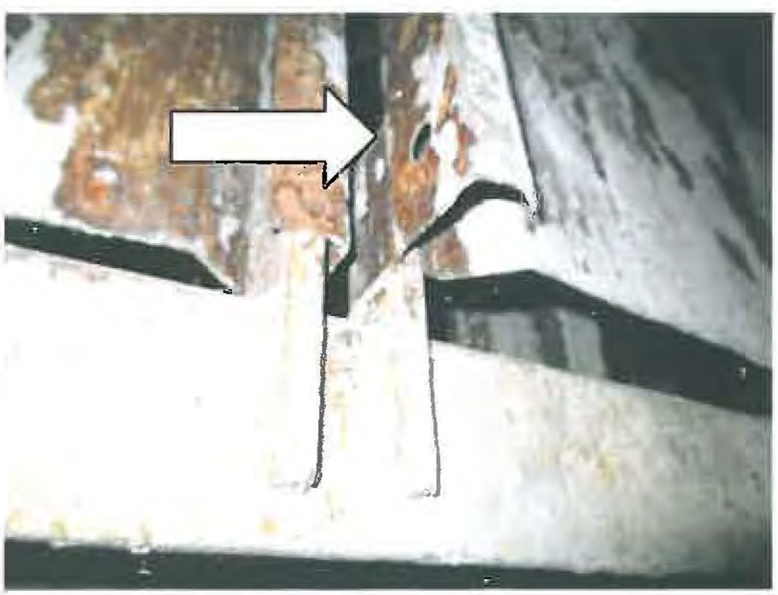
The precipitator was inspected at the upper level penthouse, below the hot roof and at the lower interbank walkway level and also included hoppers, inlet & outlet ducting. Associated layout sheets are attached showing the location and nature of items of concern. The findings can be summarized as follows:

Item 1	**Quantity**
Photo1 Badly worn collector Support sleeve. Located below hot roof 1st & 2nd fields Location shown figures 1-4	110



Item 2 is priority 1 to be repaired this outage badly worn collector channel (out of guide) 3rd field east side plate number 21 from side see figure 8
Access hatch

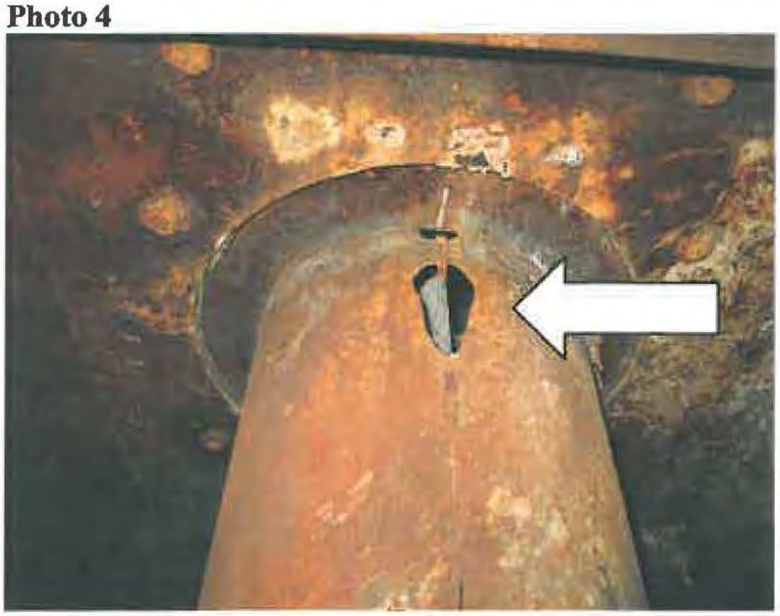
Photo 2



Item 3 Badly worn Corroded area approximately 16ft long 1
Located below hot roof 2nd field southeast Corner
Photo 3

Item 4 (3) Worn corona ring
Located in field 3 east side
Location shown figure 5

Photo 4



Item 5 Holes in inlet nozzle floor & sidewall total of 6 east side, 3 west sides
Locations shown on figure 6

Photo 5

Item 6 Distorted inlet perforated plates 2
East & West Sides location shown figure 6
Photo 6

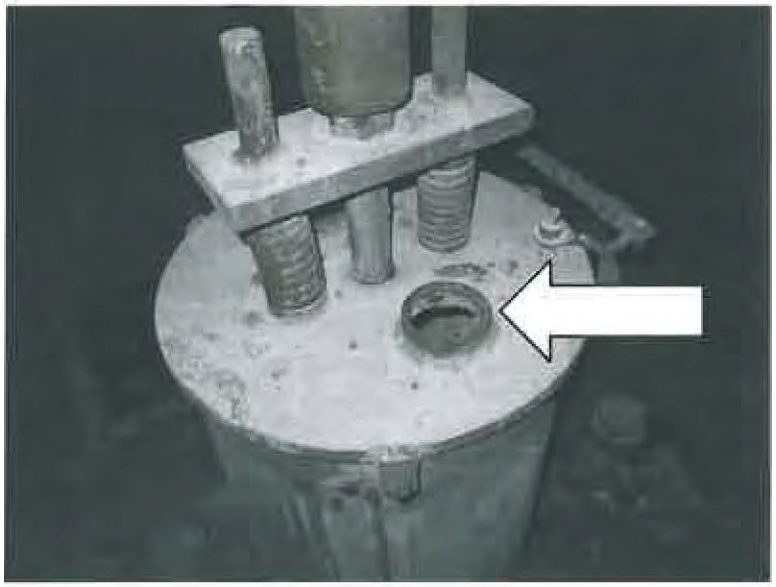
Item 7 Missing section perforated plate east side
Location shown figure 6

Photo 7

Item 8 Hole /Leaking Collector rapper seal tube
East side 2nd field leading edge

Photo 8

Item 9 Missing support insulator cover plug 2nd field east side (replaced by LC)
Photo 9



Item 10, 5 each Leaking /torn/missing seal boots
Location shown figure 9

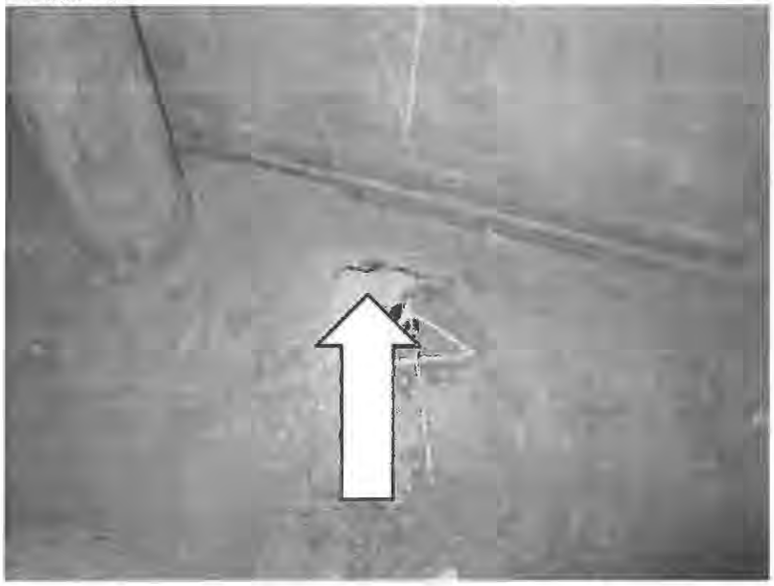
Photo 10

Item 11. Contaminated insulators
All insulator compartments 3rd field **insulator compartments should be vacuumed out and insulators cleaned this outage**

Photo 11

Item 12, (3) each Corroded hatch pans see figure 7
Photo 12
Typical example outlet nozzle west side

Item 13
Hole precipitator hot roof 2^{nd} field east side
To be repaired this outage
Photo 13



3.0 Inspection Comments.

Alignment

The location and nature of items of concern are shown in attached layout sheets . With respect to the precipitator internals, historically the collector plates in fields 1&2 (old UOP) are badly distorted and consequently greater focus was given to these fields. It was noted that several electrical clearances are reduced slightly by approximately ½ to ¾ inch when compared to previously issued layout maps dated 2007 quantifying the distortion. This would indicate the collector plates have distorted somewhat from 2009 and is probably associated with item 1 badly damaged collector support shown in photo 1 a total of 110 was found. This item has been documented in the past and trial parts had been installed shown below photo 14. Note the quantity of repairs required has significantly increased since 2009. The failure is predominately found at the leading edge of the 1^{st} field however the failure is now increasing at all location, as can be seen in figures 1-4.Lodge Cottrell strongly recommends all collector plates should be repaired in 2013.

Photo 14
Example of collector repair

Air in leakage

Several areas of air in leakage and subsequent corrosion were found within the inlet nozzle, outlet side access hatch, between the 2nd & 3rd field upper southwest corner and several minor areas below the roof and penthouse roof and sidewalls,
Final repair of the areas between the 2nd & 3rd field is to be deferred until the 2013 outage could possibly require removal of external lagging & cladding. With respect to the inlet, the present condition of the inlet nozzle sloping floor area has been well documented in the past and several repairs completed. Once again several major areas of air ingress were found.in both the inlet nozzles As noted in the past the inlet nozzle floor is very thin and in need of major repair and or replacement.
Also several areas of penthouse sidewalls, floor and roof now have minor leaks

Weighted wires

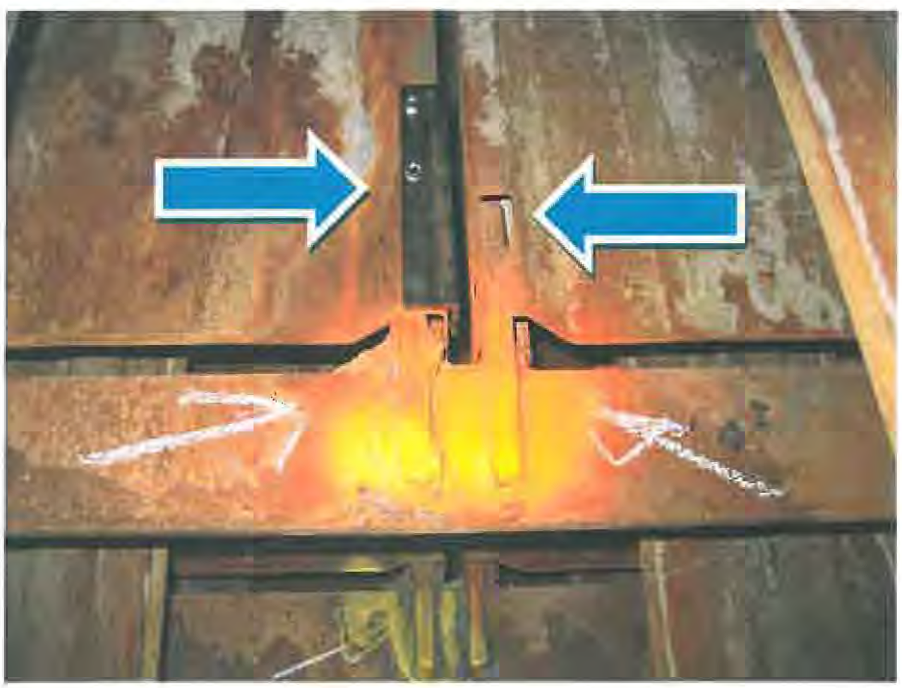
A question has been posed by the plant in regards to the life expectancy of the 1srt & 2nd field wires. Specifically when they should be replaced. The answer to this can depend on several conditions such as loss of wires, wear on wires and or changes in alignment. Presently there appears to no cause for concern. LC has monitored wire failure over the past several years and can report only 7 or 8 are missing; sheets. Consequently failure rate is not a problem. LC will measure wire wear during the next outage; typically the

loss of ¼ of the original diameter would be cause for concern. However, any shift in alignment associated with the upper badly damage collector
Connection failure could result in further reduction in electrical clearances and result in increased sparking/arcing .Consequently as electrical readings of the 1st & 2nd fields should be closely monitored following the startup of unit 5.

Collector plates 3rd field east & west
The collector plates in the 3rd field as previously mentioned are different Joy Western strip plate design and are fairly straight; previous inspection in 2006 had identified a developing problem. On approximately 130 strip collector panels equal to (15%) the lower sections had become badly worn in bottom guide as shown in photo 2.At that time approximately 200 were repaired. The typical repair is shown in photo 15 below.

It was anticipated approximately 60% will need to be reinforced within the next ten years. During this 2012 inspection (1) newly developed failure had occurred and subsequently repaired. However it was noted that approximately 50-75 collectors will need to be repaired in 2013. The repair is fairly easy to install. Once scaffolding is in place, the plate repair should be completed in 2 days. With proper maintenance plates, will last ten years. Lodge Cottrell will advise parts that will be required.

Photo 15
Typical collector repair badly worn



4.0 Recommendations 2012

1. Insulator compartments 3rd field insulator compartments should be vacuumed out and insulators cleaned this outage

2. Repair badly worn collector channel (out of guide)
3rd field east side plate number 21 from side
Access hatch

3. Bad air leak, hole in the precipitator hot roof 2nd field East side
To be repaired this outage

4. Clean out hoppers

4. Verify all rapping is operational.

5. Megger frames to ensure all grounds are cleared.

5.0 Recommendation 2013/Work Scope

To assist Nova Scotia power with man power resources to perform the repairs Lodge Cottrell has included an Estimate of manpower (hole watch is included) and time please remember this is only an estimate

1. **Inspect and repair all collector upper supports 1st and 2nd field**
   Presently 110 need repair item 1 on the summary. Lodge Cottrell would recommend that all collector plates are repaired/reinforce in fields 1&2 at both the leading and trailing edges for a total of 264.

   Estimated resources 3 men 4 weeks. to reduce time frame
   There are four areas that could be worked simultaneously utilizing labor as follows: 9 men 1 week (this includes hole watch)
   Lodge will advise regarding the parts

2. **Inspect & repair (reinforce) badly worn Lower 3rd field collector plates**
   Item 2 on the summary
   Estimated resources 3 men 2-3 days
   Lodge will advise regarding the parts

3. **Repair (3) Worn corona ring item 4 on the summary**
   Estimated resources, 2 men 2days

4. **Replace all leaking seal boots**
   2 men 1 day

5. **Repair all Air leakage/ penthouse/below hot roof/hatches/inlet nozzle/hatches**
   6 men 8 days

6. **Replace missing /damaged insulation 2nd field east side see photo 16 below**
   2 men 1day

In regards to the distorted /missing section perforated gas distribution screen presently these are not a priority item and can be deferred until all of the above item are addressed.

If you have any questions regarding this report please feel free to call Bernard Brandon with Lodge Cottrell Inc.

Office 281-292-3972
Cell 832-588-8727
Email bernardbrandon@lodgecottrell.us

6.0 Inspection Layout Sheets

Figure 1

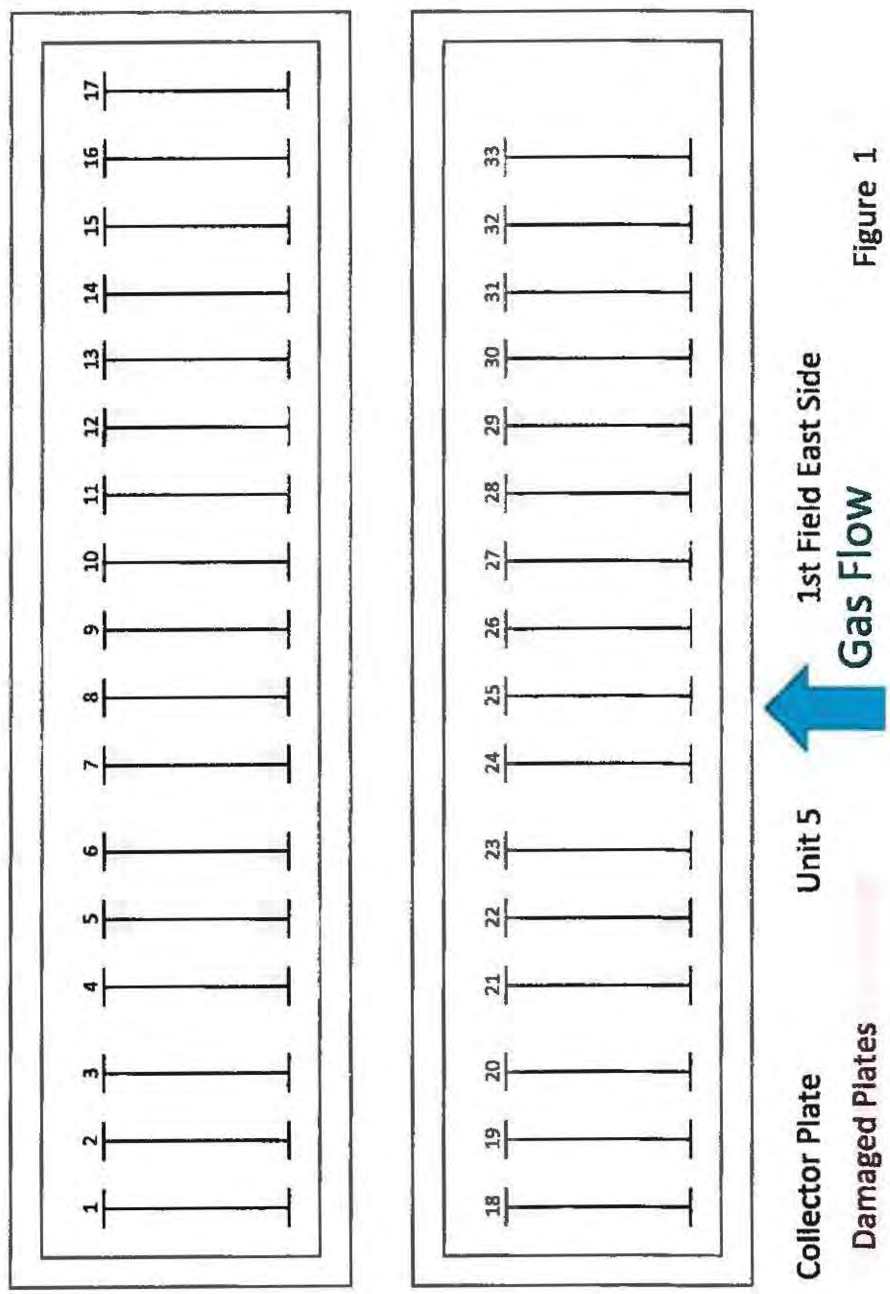
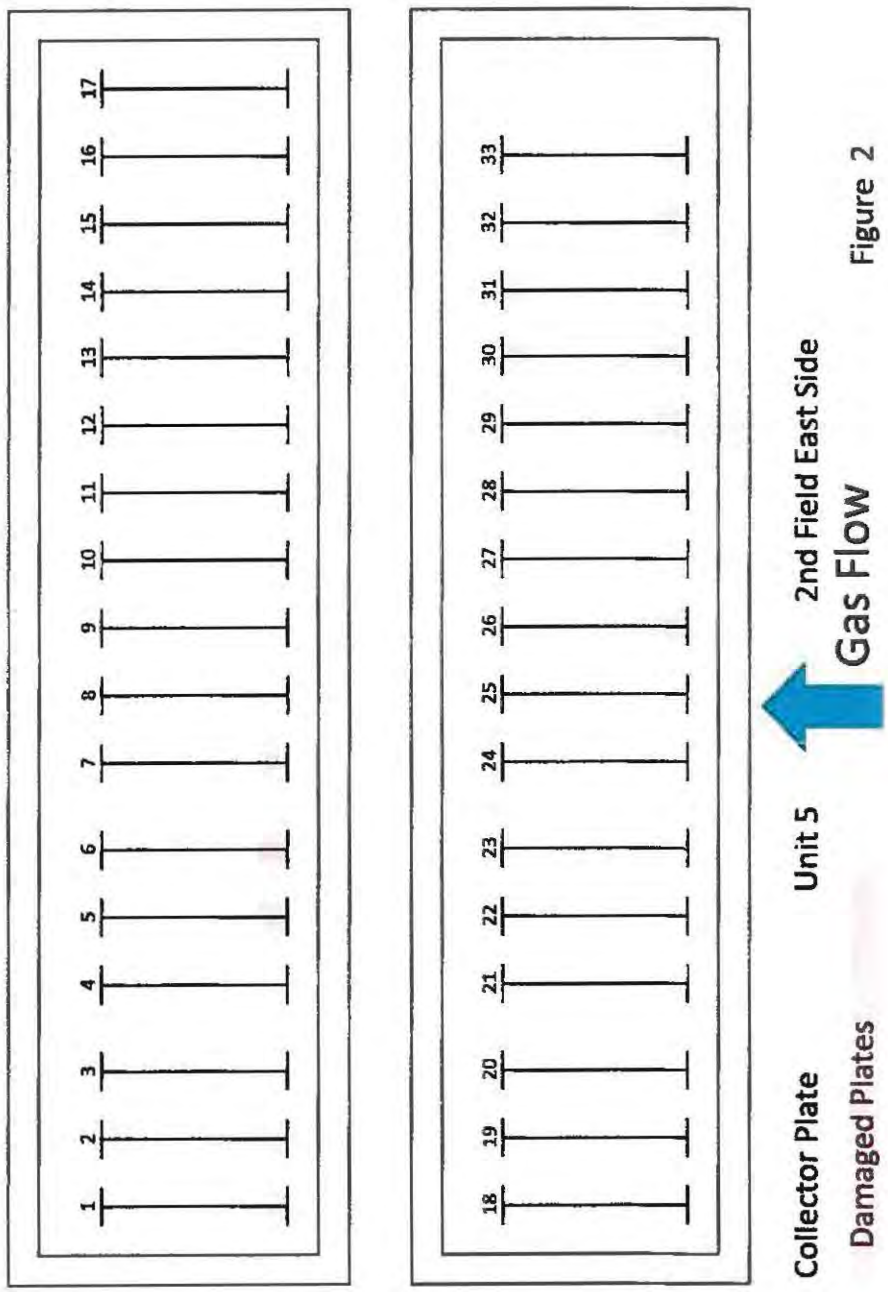


Figure 2



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
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19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
Collector Plate
Damaged Plates
Unit 5
2nd Field East Side
Gas Flow
Figure 2

Figure 3

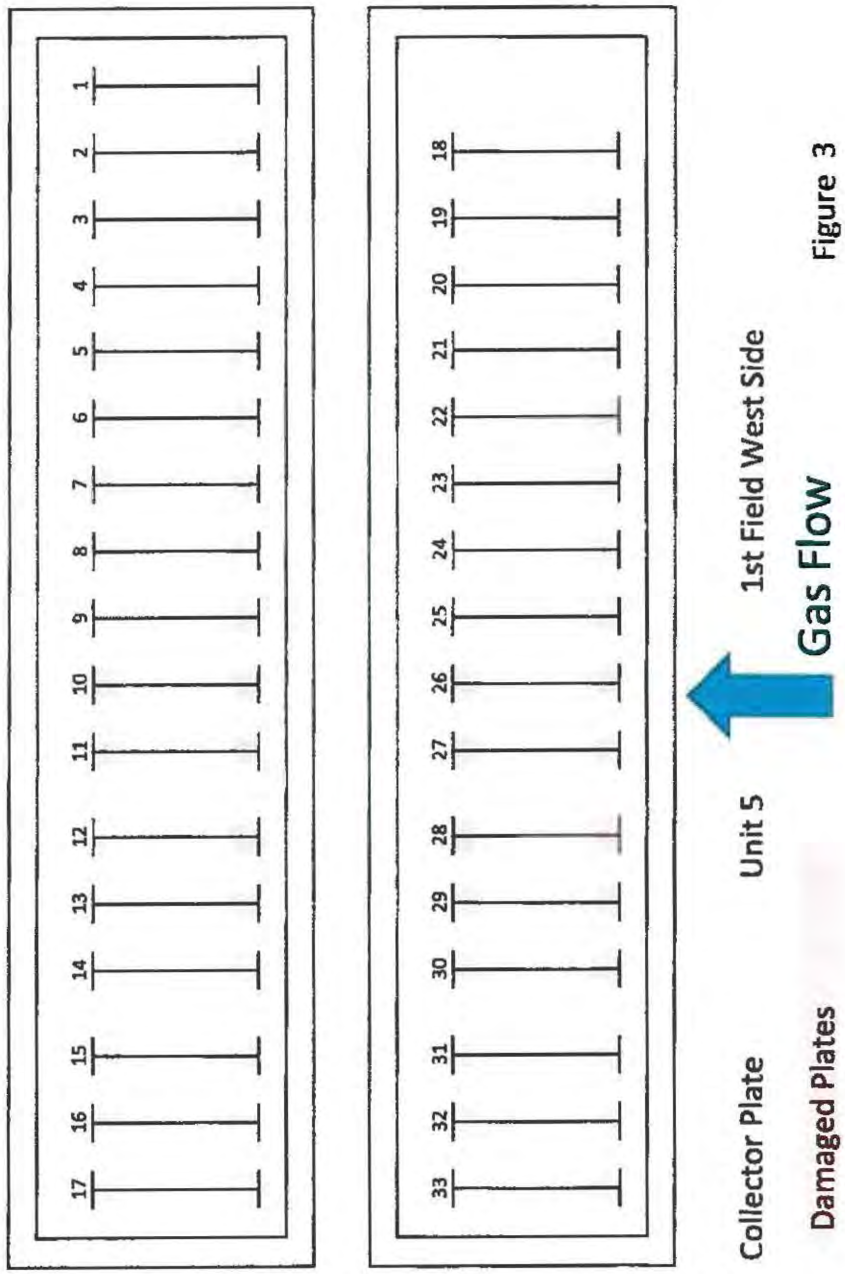
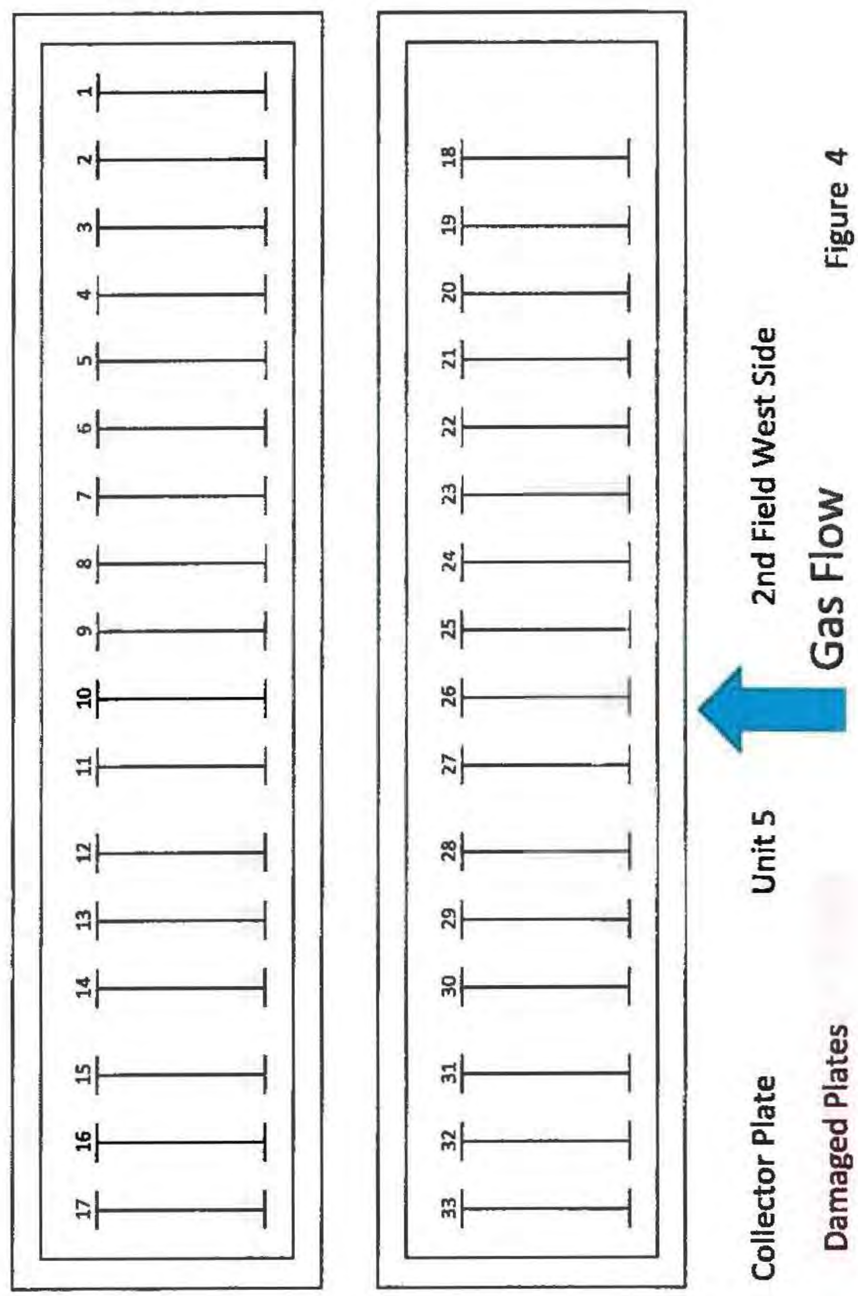


Figure 3
1st Field West Side
Gas Flow
Unit 5
Collector Plate
Damaged Plates
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33

Figure 4


1
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16
17
18
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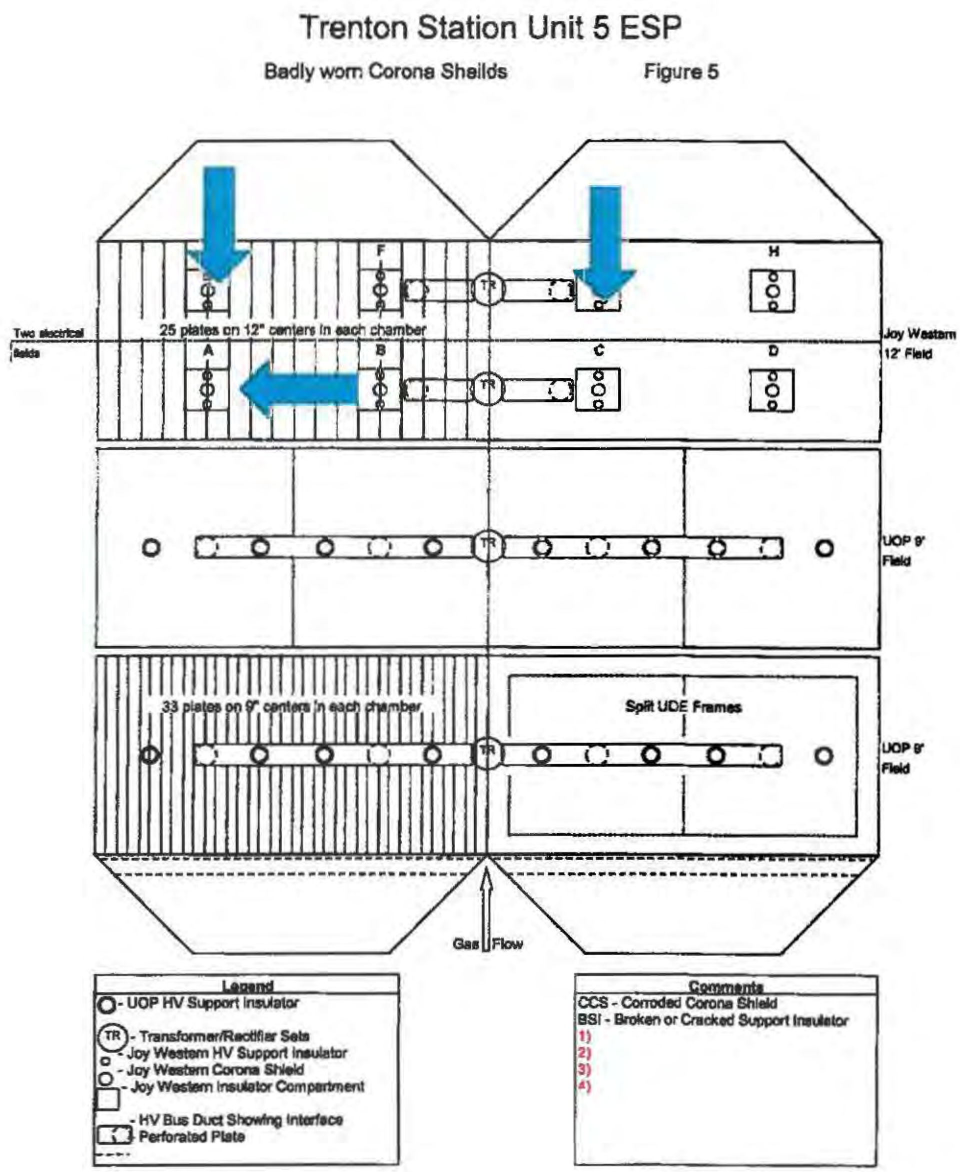
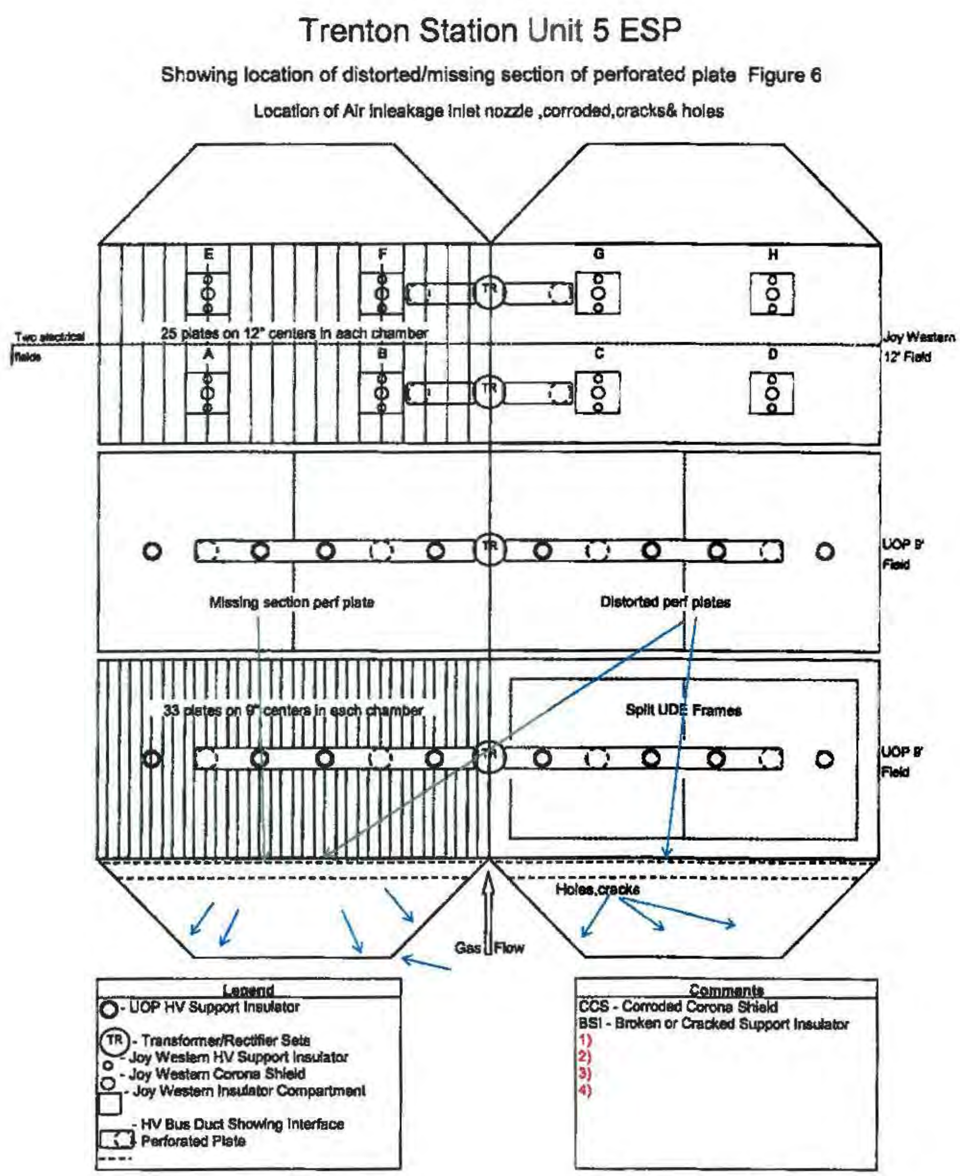
20
21
22
23
24
25
26
27
28
29
30
31
32
33
Collector Plate
Unit 5
2nd Field West Side
Damaged Plates
Gas Flow
Figure 4

Figure 5



Trenton Station Unit 5 ESP
Badly worn Corona Sheilds
Figure 5
F
H
TR
25 plates on 12" centers in each chamber
Two electrical fields
Joy Western 12' Field
A
B
C
D
UOP 9' Field
33 plates on 9" centers in each chamber
Split UDE Frames
UOP 9' Field
Gas Flow
Legend
- UOP HV Support Insulator
TR - Transformer/Rectifier Sets
- Joy Western HV Support Insulator
- Joy Western Corona Shield
- Joy Western Insulator Compartment
- HV Bus Duct Showing Interface
- Perforated Plate
Comments
CCS - Corroded Corona Shield
BSI - Broken or Cracked Support Insulator
1)
2)
3)
4)

Figure 6



Trenton Station Unit 5 ESP
Showing location of distorted/missing section of perforated plate Figure 6
Location of Air inleakage inlet nozzle ,corroded,cracks& holes
E
F
G
H
TR
Two electrical fields
25 plates on 12" centers in each chamber
Joy Western 12' Field
A
B
C
D
UOP 9' Field
Missing section perf plate
Distorted perf plates
33 plates on 9" centers in each chamber
Split UDE Frames
Holes,cracks
Gas Flow
Legend
- UOP HV Support Insulator
- Transformer/Rectifier Sets
- Joy Western HV Support Insulator
- Joy Western Corona Shield
- Joy Western Insulator Compartment
- HV Bus Duct Showing Interface
Perforated Plate
Comments
CCS - Corroded Corona Shield
BSI - Broken or Cracked Support Insulator
1)
2)
3)
4)

Figure 7

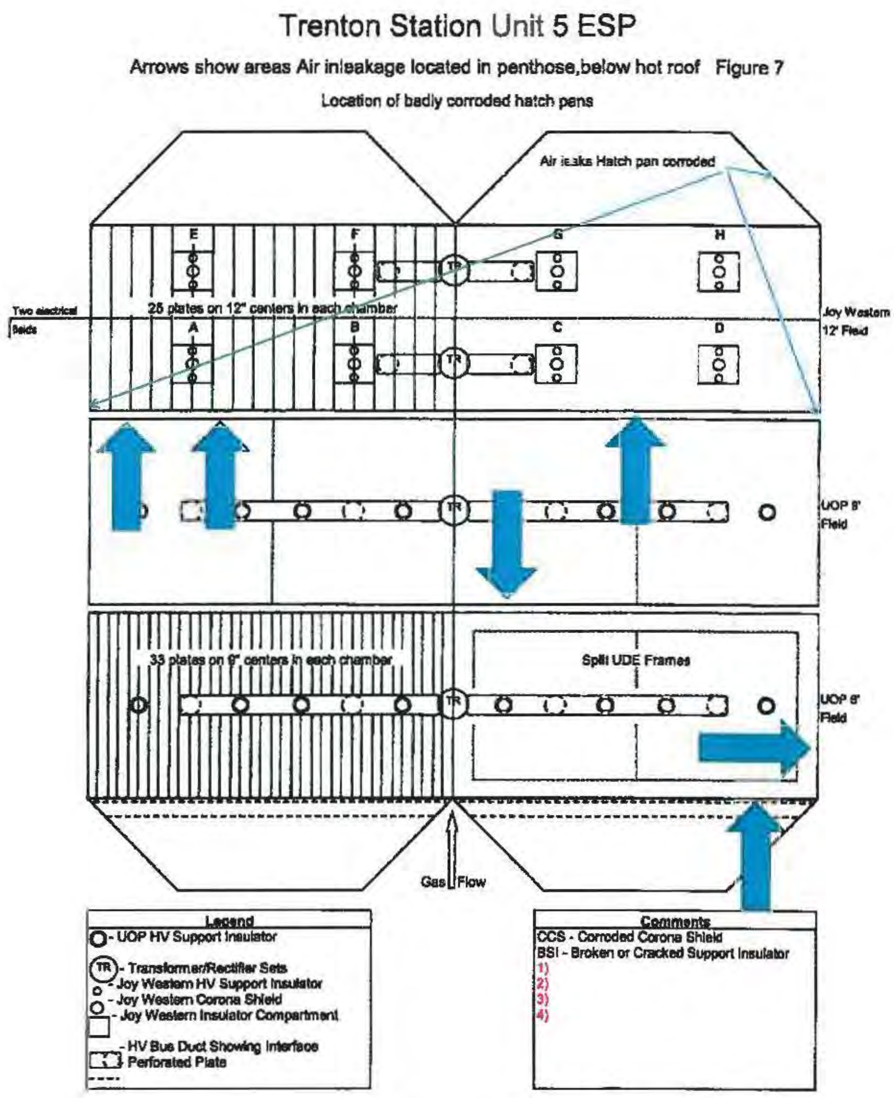
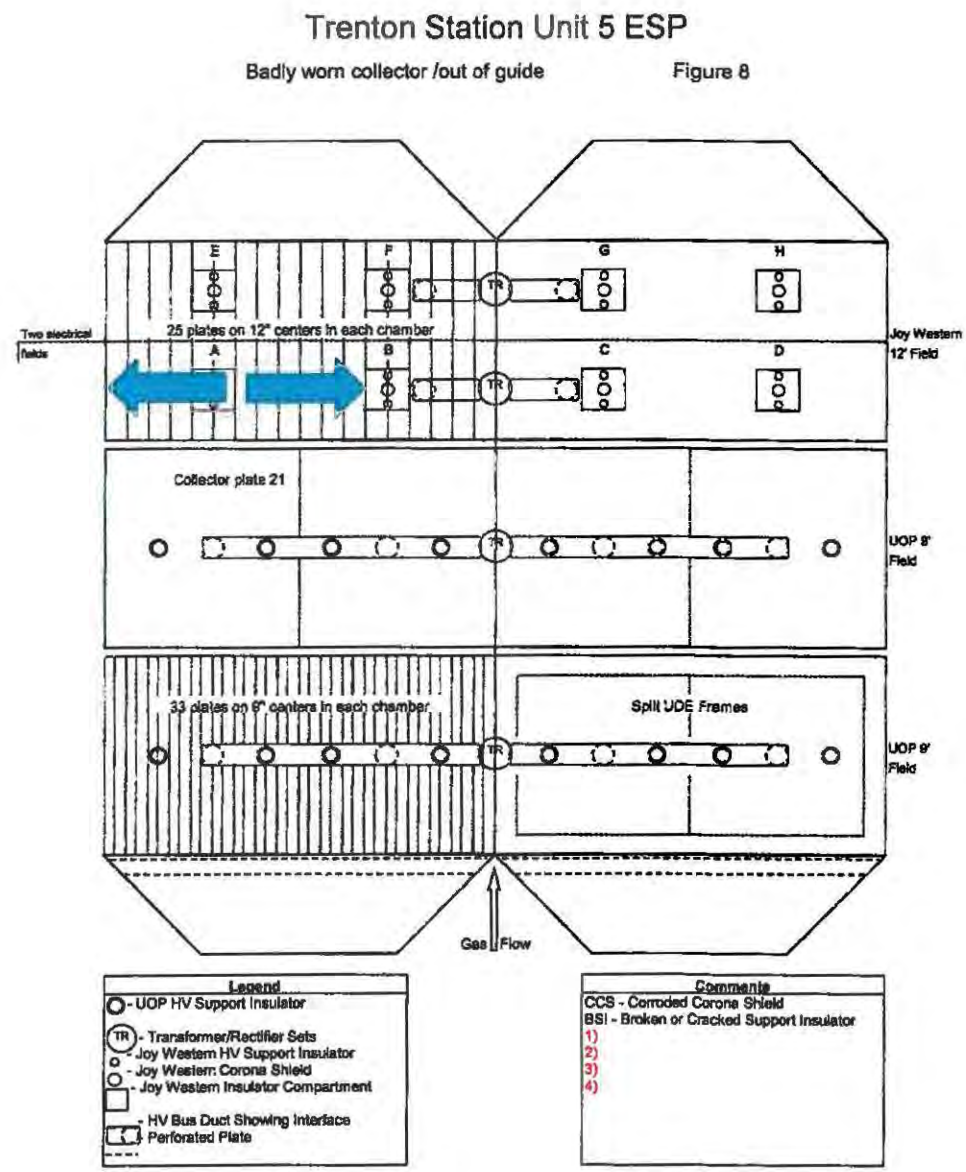
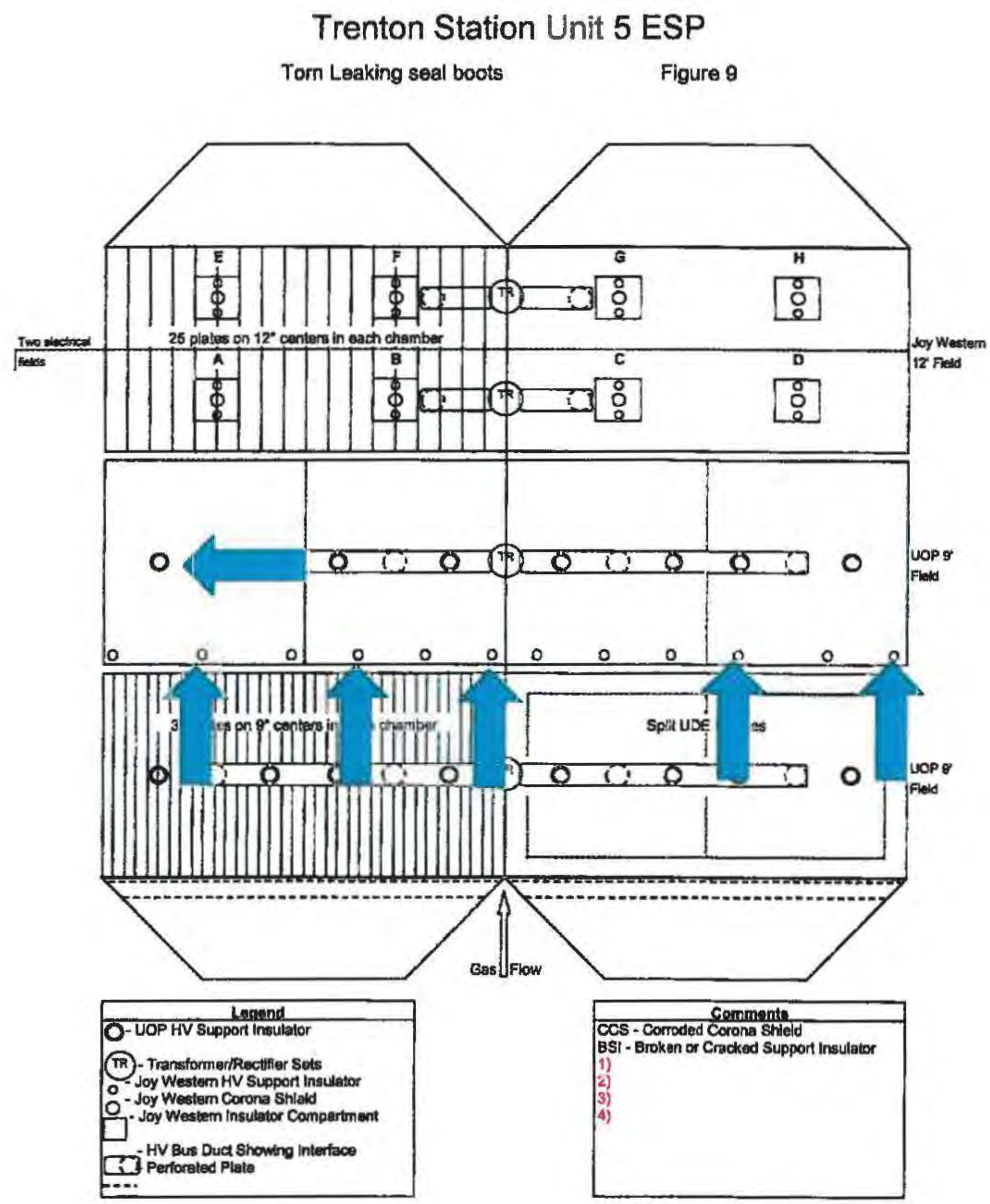

Trenton Station Unit 5 ESP
Arrows show areas Air inleakage located in penthose,below hot roof Figure 7
Location of badly corroded hatch pens
Air leaks Hatch pan corroded
E
F
G
H
A
B
C
D
TR
Two electrical fields
25 plates on 12" centers in each chamber
Joy Western 12' Field
UOP 9' Field
33 plates on 9" centers in each chamber
Split UDE Frames
UOP 8' Field
Gas Flow
Legend
- UOP HV Support Insulator
- Transformer/Rectifier Sets
- Joy Western HV Support Insulator
- Joy Western Corona Shield
- Joy Western Insulator Compartment
- HV Bus Duct Showing Interface
Perforated Plate
Comments
CCS - Corroded Corona Shield
BSI - Broken or Cracked Support Insulator
1)
2)
3)
4)

Figure 8



Trenton Station Unit 5 ESP
Badly worn collector /out of guide
Figure 8
E
F
G
H
Two electrical fields
25 plates on 12" centers in each chamber
Joy Western 12' Field
A
B
C
D
TR
Collector plate 21
UOP 8' Field
33 plates on 9" centers in each chamber
Split UOE Frames
UOP 9' Field
Gas Flow
Legend
- UOP HV Support Insulator
- Transformer/Rectifier Sets
- Joy Western HV Support Insulator
- Joy Western Corona Shield
- Joy Western Insulator Compartment
- HV Bus Duct Showing Interface
Perforated Plate
Comments
CCS - Corroded Corona Shield
BSI - Broken or Cracked Support Insulator
1)
2)
3)
4)

Figure 9



Trenton Station Unit 5 ESP
Torn Leaking seal boots
Figure 9
E
F
G
H
TR
Two electrical fields
25 plates on 12" centers in each chamber
Joy Western 12' Field
A
B
C
D
UOP 9' Field
Split UDE
UOP 9' Field
Gas Flow
Legend
- UOP HV Support Insulator
TR - Transformer/Rectifier Sets
- Joy Western HV Support Insulator
- Joy Western Corona Shield
- Joy Western Insulator Compartment
- HV Bus Duct Showing Interface
Perforated Plate
Comments
CCS - Corroded Corona Shield
BSI - Broken or Cracked Support Insulator
1)
2)
3)
4)

CI Number: 43008

Title: **TRE5 Turbine-Generator Fire Protection**

Start Date: 2013/05
Final Cost Date: 2013/12
Function: Generation
Forecast Amount: $305,402

DESCRIPTION:

This project includes the addition of a fixed fire protection system for the Unit 5 steam turbine and generator at the Trenton Generating Station. At the time of original construction, the fire protection infrastructure was adequate, but a recent risk analysis identified that existing fire protection around the turbine generator no longer meets current industry standards. Construction will be similar to work recently undertaken in the Lingan Generating Station, Tufts Cove Generating Station, and Unit 6 at the Trenton Generating Station.

Summary of Related CIs +/- 2 years:
2011 CI 40583 TRE5 U&U Burner Front Fire Protection - $46k
2013 CI 43407 TRE5 Cable Rooms Fire Protection - $239k

JUSTIFICATION:

Justification Criteria: Health & Safety

Why do this project?

Existing fire protection around the turbine generator does not meet current industry standards. In the recent assessment of fire protection systems at all NS Power thermal plants, the highest risk areas identified are associated with the turbine generator area of the plants. This risk is best mitigated by applying a fixed fire protection system around the equipment in this area as well as drainage for hydraulic oils and lubricants. A system of similar design was successfully installed at LIN Unit 4 in 2009, LIN Unit 1 in 2010, and LIN Units 2 and 3 in 2011, TRE Unit 5 and TUC Unit 3 in 2012. The design and construction of these systems will serve as a model for applying a similar solution for this project.

Why do this project now?

As a result of recent inspections, NS Power's insurance providers have recommended the need to introduce additional fire system risk-control measures. NS Power believes these modifications are important now as the plants age and a staged installation with one unit at a time is appropriate to reduce risk in the long term. Unit 5 is scheduled for a maintenance outage in 2013 which will facilitate installation of fire suppression equipment. This project is part of NS Power’s 5-year fire protection upgrade plan.

Why do this project this way?

The benchmark study used for assessing loss control practices was predicated on fire protection practices, NFPA 850 and FM DS7-101. Although they are recommended practices, they have become industry guidelines, widely used by insurers in risk assessments for power generation facilities. The new fire protection system will be integrated into the current system that exists at the plant.

CI Number : 43008 - TRE5 Turbine-Generator Fire Protection **Project Number**

Parent CI Number : -

Cost Centre : 340 - 340-Trenton Unit 5 Capital **Budget Version** 2012 08/04 Forecast

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		3,571	0	3,571
095		095-Thermal & Hydro Contracts AO		15,771	0	15,771
095		095-Thermal Regular Labour AO		12,614	0	12,614
095		095-Thermal Overtime Labour AO		458	0	458
001	003	001 - THERMAL Regular Labour	003 - SGP - Bldg.,Struct.Grnd.	25,480	0	25,480
002	003	002 - THERMAL Overtime Labour	003 - SGP - Bldg.,Struct.Grnd.	3,440	0	3,440
004	003	004 - THERMAL Term Labour	003 - SGP - Bldg.,Struct.Grnd.	0	0	0
011	003	011 - Travel Expense	003 - SGP - Bldg.,Struct.Grnd.	2,000	0	2,000
012	003	012 - Materials	003 - SGP - Bldg.,Struct.Grnd.	95,232	0	95,232
013	003	013 - POWER PRODUCTION Contracts	003 - SGP - Bldg.,Struct.Grnd.	123,597	0	123,597
001	085	001 - THERMAL Regular Labour	085 Design	660	0	660
001	087	001 - THERMAL Regular Labour	087 Field Super.& Ops.	21,280	0	21,280
021	087	021 - Telephones	087 Field Super.& Ops.	300	0	300
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	1,000	0	1,000
			Total Cost:	305,402	0	305,402
			Original Cost:			

Location: Trenton Generating Station
CI# / FP#: 43008
Title: TRE5 Turbine-Generator Fire Protection
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Generation Services Project Management	hr	[redacted]		$ 7,840.00		
1.2	CADD Operator	hr	[redacted]		$ 660.00		
1.3	Elec/Mech Engineering/Supervision	hr	[redacted]		$ 13,440.00		
1.4	Reg Mech	hr	[redacted]		$ 18,920.00		
1.5	Reg Elec	hr	[redacted]		$ 6,560.00		
1.6					$ -		
				Sub-Total	$ 47,420.00		
2	**002 Overtime Labour**						
2.1	OT Mech	hr	[redacted]		$ 3,440.00		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 3,440.00		
3	**004 Term Labour**						
3.1					$ -		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ -		
4	**012 Materials**						
4.1	Panels, Sensors, Cable	lot	1	$ 20,000.00	$ 20,000.00		
4.2	Fire Protection System Materials	lot	1	[redacted]		Cost Support 1 (assumes 40% materials)	41508
4.3	Escalation on Fire Protection Materials	%	[redacted]				
4.4	Miscellaneous Materials	lot	1	$ 5,000.00	$ 5,000.00		
4.5	Contingency on Materials	%	[redacted]				
4.6					$ -		
				Sub-Total	$ 95,231.55		
5	**013 Power Production Contracts**						
5.1	Fire Protection System Labour	lot	1	[redacted]		Cost Support 1 (assumes 60% labour)	41508
5.2	Escalation on Fire Protection Contractor	%	[redacted]				
5.2	Fire Alarm Contractor	lot	1	[redacted]			
5.3	Scaffolding	lot	1	[redacted]			
5.4	Contingency on Contracts	%	[redacted]				
5.5					$ -		
				Sub-Total	$ 123,597.32		
6	**028 Consulting**						
6.1					$ -		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ -		
7	**011 Travel**						
7.1	Travel	lot	1	$ 2,000.00	$ 2,000.00		
				Sub-Total	$ 2,000.00		
8	**021 Telephones**						
8.1	Telephones	lot	1	$ 300.00	$ 300.00		
				Sub-Total	$ 300.00		
9	**041 Meals and Entertainment**						
9.1	Meals	lot	1	$ 1,000.00	$ 1,000.00		
				Sub-Total	$ 1,000.00		
10	**094 Interest Capitalized**						
10.1	AFUDC	lot	1	$ 3,570.79	$ 3,570.79		
				Sub-Total	$ 3,570.79		
11	**095 Administrative Overhead**						
11.1	Thermal Regular Labour AO	lot	1	$ 12,613.72	$ 12,613.72		
11.2	Thermal Overtime Labour AO	lot	1	$ 457.52	$ 457.52		
11.3	Thermal & Hydro Contracts AO	lot	1	$ 15,771.02	$ 15,771.02		
11.4					$ -		
				Sub-Total	$ 28,842.26		
Cost Estimate				Total	$ 305,401.92		
12	**Original Cost**						
12.1	Retirement				N/A		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project.

Attachments 1 & 2

Removed due to confidentiality

CI Number: 43567

Title: **TUC3 - CW Travelling Screens Refurbishment**

Start Date: 2013/07
Final Cost Date: 2014/03
Function: Generation
Forecast Amount: $293,903

DESCRIPTION:

This project is to address the deficiencies of circulating water (CW) traveling screens at TUC Unit 3. The two screens, North and South, are original equipment from the commissioning of Unit 3 in 1976, and are reaching the end of their service life due to salt water corrosion and wear. This project will rebuild the boot and intermediate sections, and refurbish the top section of the traveling screens. The traveling screens have already been refurbished on Unit 1 (CI 41796) and Unit 2 (CI 41946).

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015.

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Maintenance

Why do this project?

The CW traveling screens are a critical component of the circulating water supply system for power generating unit. The main purpose of the screen system is to filter out the foreign materials such as seaweed and debris from sea water as it is being extracted from the harbour. Failure of the screen system would allow foreign materials into the CW system and result in increased downstream fouling. Increased fouling often results in (a) poor performance of condenser and coolers, (b) component failures of CW pumps due to high mechanical loading, and (c) blockage of the CW piping system. Each of these issues could lead to a unit de-rating, or a forced outage.

Why do this project now?

The Unit 3 CW traveling screens are original equipment from the commissioning of Unit 3 in 1976, and are reaching the end of their useful life. Without refurbishing these screens, there remains the risk of de-rating or a forced outage of the unit due to their failure.

Why do this project this way?

Due to the effects of salt water corrosion, the main components of the traveling screens are severely deteriorated. The most cost effective solution is to rebuild the boot and intermediate sections, and refurbish the head sections of the traveling screens.

CI Number : 43567 - TUC3 - CW travelling screens refurbishment

Project Number

Parent CI Number : -

Cost Centre : 319 - 319-TC Unit 3 Capital

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		3,042	0	3,042
095		095-Thermal & Hydro Contracts AO		18,519	0	18,519
095		095-Thermal Regular Labour AO		12,635	0	12,635
095		095-Thermal Overtime Labour AO		4,118	0	4,118
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	47,500	0	47,500
002	014	002 - THERMAL Overtime Labour	014 - SGP - Circ.Water Sys.	30,960	0	30,960
012	014	012 - Materials	014 - SGP - Circ.Water Sys.	32,000	0	32,000
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	145,130	0	145,130
			Total Cost:	293,903	0	293,903
			Original Cost:	71,122		

43567 - TUC3 CW Travelling Screens Structural Refurbishmen
Summary of Alternatives

Division :	Power Production	**Date :**	**10-Sep-12**
Department :	Tufts Cove Generating Station	**CI Number:**	43567
Originator :			

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish TUC3 CW Screens	6.48%	3,062,653	1	63.45%	2.9 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

It is recommended to proceed with the refurbishment.

Notes/Comments :

Refurbish TUC3 CW Screens

Without properly functioning screen system, it is very likely that severe fouling will be developed in CW system and thus lead to unit de-rating or forced outage.

Test 2

Test 3

Test 4

43567 - TUC3 CW Travelling Screens Structural Refurbishment
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Tufts Cove Generating Station	CI Number:	43567
Originator :		Project No. :	

Refurbish TUC3 CW Screens

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$141,280	$106,386		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	25%	27%	25%	27%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	150	150				
Duration (Hours)	336	336				
Totals	$84,029	$92,227	$35,320	$28,724	$119,349	$120,951
Total Capital Cost of Alternative						$293,903

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

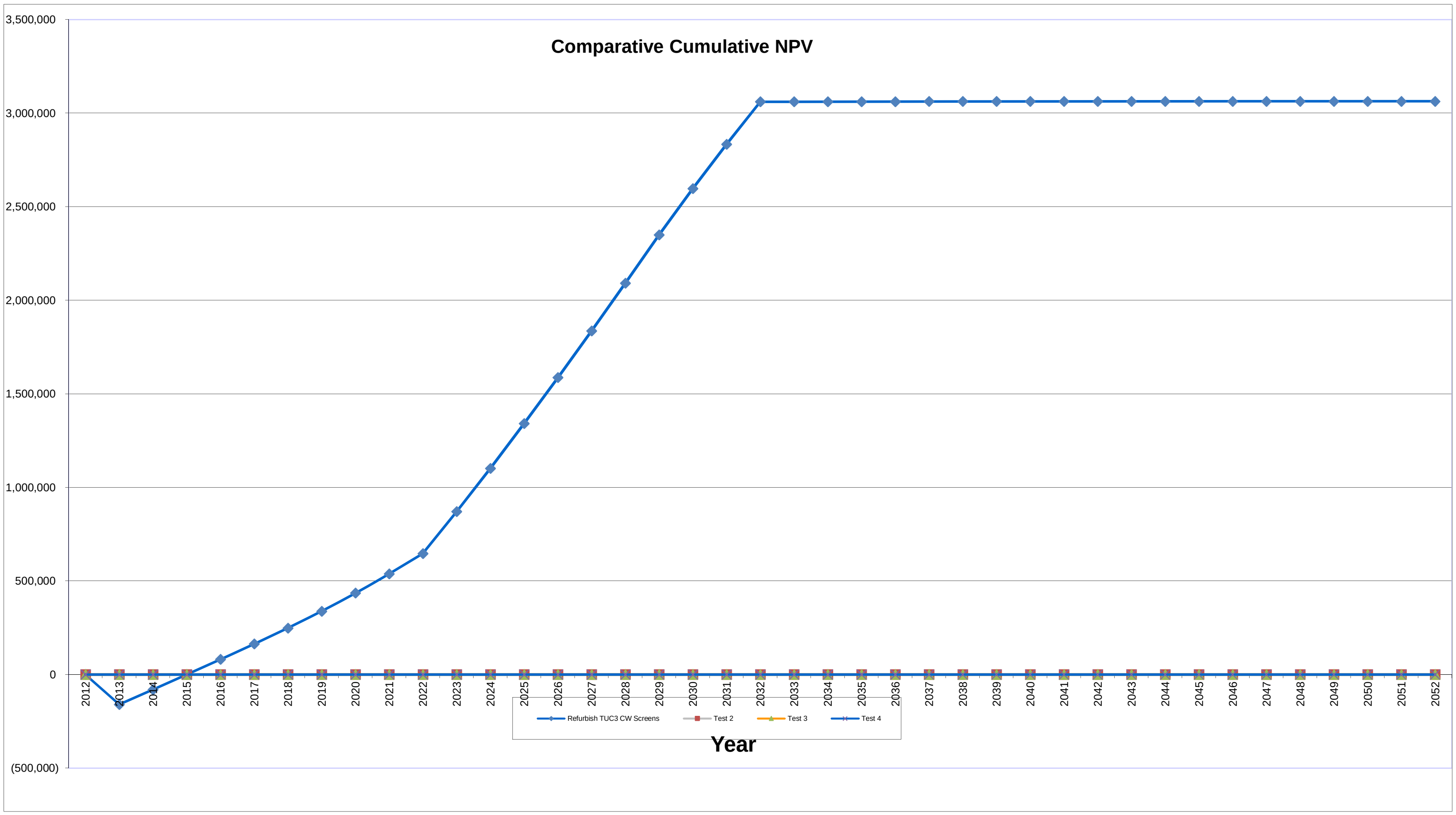
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

43567 - TUC3 CW Travelling Screens Structural Refurbishment
Refurbish TUC3 CW Screens

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	119,349.4	(255,590.0)	10,646.9	255,524.5	(136,240.6)	(33,697.8)	(169,938.4)	(159,596.534)	0.9	(159,596.5)
2014	-	120,951.1	-	20,442.0	235,082.6	120,951.1	(31,157.8)	89,793.3	79,196.797	0.9	(80,399.7)
2015	-	132,508.6	-	18,806.6	216,276.0	132,508.6	(35,247.6)	97,261.0	80,562.810	0.8	163.1
2016	-	144,480.1	-	17,302.1	198,973.9	144,480.1	(39,425.2)	105,054.9	81,722.978	0.8	81,886.1
2017	-	156,877.4	-	15,917.9	183,056.0	156,877.4	(43,697.4)	113,180.0	82,685.503	0.7	164,571.6
2018	-	169,712.8	-	14,644.5	168,411.5	169,712.8	(48,071.2)	121,641.7	83,459.168	0.7	248,030.7
2019	-	197,836.7	-	13,472.9	154,938.6	197,836.7	(57,152.8)	140,683.9	90,650.074	0.6	338,680.8
2020	-	227,017.6	-	12,395.1	142,543.5	227,017.6	(66,533.0)	160,484.6	97,115.618	0.6	435,796.4
2021	-	257,286.6	-	11,403.5	131,140.0	257,286.6	(76,223.8)	181,062.8	102,900.373	0.6	538,696.8
2022	-	288,675.6	-	10,491.2	120,648.8	288,675.6	(86,237.2)	202,438.4	108,046.952	0.5	646,743.7
2023	-	642,434.4	-	9,651.9	110,996.9	642,434.4	(196,162.6)	446,271.8	223,692.277	0.5	870,436.0
2024	-	709,890.0	-	8,879.8	102,117.2	709,890.0	(217,313.2)	492,576.8	231,876.886	0.5	1,102,312.9
2025	-	779,786.9	-	8,169.4	93,947.8	779,786.9	(239,201.4)	540,585.4	238,990.032	0.4	1,341,302.9
2026	-	852,195.6	-	7,515.8	86,432.0	852,195.6	(261,850.7)	590,344.9	245,105.589	0.4	1,586,408.5
2027	-	927,188.8	-	6,914.6	79,517.4	927,188.8	(285,285.0)	641,903.8	250,293.356	0.4	1,836,701.9
2028	-	1,004,840.9	-	6,361.4	73,156.0	1,004,840.9	(309,528.7)	695,312.3	254,619.235	0.4	2,091,321.1
2029	-	1,085,228.2	-	5,852.5	67,303.5	1,085,228.2	(334,606.5)	750,621.7	258,145.408	0.3	2,349,466.5
2030	-	1,106,932.8	-	5,384.3	61,919.2	1,106,932.8	(341,480.0)	765,452.7	247,225.697	0.3	2,596,692.2
2031	-	1,129,071.4	-	4,953.5	56,965.7	1,129,071.4	(348,476.5)	780,594.9	236,773.386	0.3	2,833,465.6
2032	-	1,151,652.8	-	4,557.3	52,408.4	1,151,652.8	(355,599.6)	796,053.2	226,767.726	0.3	3,060,233.3
2033	-	-	-	4,192.7	48,215.8	-	1,299.7	1,299.7	347.716	0.3	3,060,581.0
2034	-	-	-	3,857.3	44,358.5	-	1,195.8	1,195.8	300.430	0.3	3,060,881.5
2035	-	-	-	3,548.7	40,809.8	-	1,100.1	1,100.1	259.575	0.2	3,061,141.1
2036	-	-	-	3,264.8	37,545.0	-	1,012.1	1,012.1	224.276	0.2	3,061,365.3
2037	-	-	-	3,003.6	34,541.4	-	931.1	931.1	193.777	0.2	3,061,559.1
2038	-	-	-	2,763.3	31,778.1	-	856.6	856.6	167.426	0.2	3,061,726.5
2039	-	-	-	2,542.3	29,235.9	-	788.1	788.1	144.658	0.2	3,061,871.2
2040	-	-	-	2,338.9	26,897.0	-	725.0	725.0	124.986	0.2	3,061,996.2
2041	-	-	-	2,151.8	24,745.2	-	667.0	667.0	107.990	0.2	3,062,104.2
2042	-	-	-	1,979.6	22,765.6	-	613.7	613.7	93.304	0.2	3,062,197.5
2043	-	-	-	1,821.3	20,944.4	-	564.6	564.6	80.616	0.1	3,062,278.1
2044	-	-	-	1,675.6	19,268.8	-	519.4	519.4	69.653	0.1	3,062,347.7
2045	-	-	-	1,541.5	17,727.3	-	477.9	477.9	60.181	0.1	3,062,407.9
2046	-	-	-	1,418.2	16,309.1	-	439.6	439.6	51.997	0.1	3,062,459.9
2047	-	-	-	1,304.7	15,004.4	-	404.5	404.5	44.926	0.1	3,062,504.8
2048	-	-	-	1,200.4	13,804.1	-	372.1	372.1	38.817	0.1	3,062,543.7
2049	-	-	-	1,104.3	12,699.7	-	342.3	342.3	33.538	0.1	3,062,577.2
2050	-	-	-	1,016.0	11,683.7	-	315.0	315.0	28.977	0.1	3,062,606.2
2051	-	-	-	934.7	10,749.0	-	289.8	289.8	25.037	0.1	3,062,631.2
2052	-	-	-	859.9	9,889.1	-	266.6	266.6	21.632	0.1	3,062,652.8
Total	-	11,203,917.7	(255,590.0)	256,282.3	3,080,331.6	10,948,327.7	(3,393,767.0)	7,554,560.7	3,062,652.8		


Comparative Cumulative NPV
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
(500,000)
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052
Refurbish TUC3 CW Screens
Test 2
Test 3
Test 4
Year

Location: Tufts Cove Generating Station
CI# / FP#: 43567
Title: TUC3 - CW travelling screens structural refurbishment
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	hr	[redacted]		$ 820.00		
1.2	Maintenance Trades	hr			$ 41,280.00		
1.3	Utility & Unskilled	hr			$ 5,400.00		
1.4		hr		$ -	$ -		
				Sub-Total	$ 47,500.00		41796, 41946
2	**012 Materials**						
2.1	New bearing or bushings (for head section)	lot	1	[redacted]			
2.2	Screen trays	lot	1				
2.3	Misc. materials	lot	1	$ 10,000.00	$ 10,000.00		
2.4					$ -		
				Sub-Total	$ 32,000.00		41796, 41946
3	**013 Power Production Contracts**						
3.1	Rebuild the boot and intermidiate sections	lot	1	[redacted]			
3.2	Segment for driven sprocket	lot	1				
3.3	Sand blast and painting	lot	1				
3.4	Lighting	lot	1				
3.5	Crane / Boom truck rental service	lot	1				
3.6	Installing stop log	lot	1				
3.7	Staging	lot	1				
3.8	CW sump cleaning	lot	1				
3.9	Contingency	%					
3.10							
				Sub-Total	$ 145,130.00		41796, 41946
4	**002 Thermal Overtime labour**						
4.1	Maintenance trade	hr	[redacted]		$ 30,960.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 30,960.00		
5	**094 Interest Capitalized**						
5.1	Interest Capitalized	lot	1	$ 3,042.17	$ 3,042.17		
5.2							
5.3							
				Sub-Total	$ 3,042.17		
6	**095 Administrative Overhead**						
6.1	Contracts AO	lot	1	$ 18,518.59	$ 18,518.59		
6.2	Regular Labour AO	lot	1	$ 12,635.00	$ 12,635.00		
6.3	Overtime Labour AO	lot	1	$ 4,117.68	$ 4,117.68		
				Sub-Total	$ 35,271.27		
Project Cost Estimate				**Total**	$ 293,903.44		
7	**Original Cost**						
7.1					$ 71,121.79		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 41516

Title: **TRE6 - Stack Breaching Inlet Ductwork Refurbishment**

Start Date: 2013/04
Final Cost Date: 2013/12
Function: Generation
Forecast Amount: $289,375

DESCRIPTION:

As pulverized solid fuel is burned in the boiler, the products of combustion are exhausted by the Induced Draft (ID) fans through the exhaust stack. The ductwork from the discharge of the ID fans to the liner of the exhaust stack is fabricated from carbon steel plate and covered with insulation and exterior cladding. As the duct enters the concrete exterior of the stack, there is an expansion joint that allows the duct to move relative to the stack. This movement is caused by thermal expansion and the natural tendency for the stack liner to shift. There have recently been increased levels of sulphur dioxide gas in the space between the liner and the outer stack due to leaks from the expansion joint and the ductwork.

During remediation efforts in 2011 to replace external duct cladding in areas adjacent to the stack, the ductwork was found to have several holes and was thinner than expected in a number of areas. It was not possible to repair the holes in all cases, as the thickness of the duct is no longer sufficient in some of the areas that needed to be repaired. The expansion joint fabric and the adaptor affixing the joint to the ductwork are both failing and need to be replaced. The retaining system holding the external cladding to the duct has also reached the end of its useful life in some areas and must be replaced.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015

JUSTIFICATION:

Justification Criteria: Environment

Sub Criteria: Maintenance

Why do this project?

This project must be completed to avoid further deterioration and failure of the stack breaching expansion joint and ductwork. Failure of the expansion joint or ductwork contributes to unit inefficiencies due to the increased volume of gas being released through the stack. Ongoing leaks have resulted in delays in environmental testing required for compliance with the plant's mercury abatement approval and plant operating approval. As a temporary measure, fans have been installed in an attempt to force gases out of the annulus. A major failure of these components would result in an unplanned outage.

Why do this project now?

Completing this project now is required to avoid non-compliance to environmental regulatory testing and emissions control. In addition, a failure of the ductwork and expansion joint would result in unit downtime and resultant replacement energy costs. The next available opportunity to complete this work in a planned manner is the Unit outage scheduled for 2014. Waiting to complete this work in 2014 would expose the Unit to increased risk of environmental non-compliance and unplanned outages.

Why do this project this way?

Replacing the deteriorated ductwork and expansion joint in 2013 will avoid more costly repairs in the future and eliminate issues that may affect the plant's ability to remain in compliance with its operating permit. This is the only option as repair is no longer an option due to the condition of the components.

CI Number : 41516 - TRE6 - Stack Breaching Inlet Ductwork Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 345 - 345-Trenton unit 6 Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		642	0	642
095		095-Thermal & Hydro Contracts AO		21,826	0	21,826
095		095-Thermal Regular Labour AO		5,118	0	5,118
001	017	001 - THERMAL Regular Labour	017 - SGP - Draft Equip./Stacks	10,280	0	10,280
012	017	012 - Materials	017 - SGP - Draft Equip./Stacks	[redacted]	0	[redacted]
013	017	013 - POWER PRODUCTION Contracts	017 - SGP - Draft Equip./Stacks	171,050	0	171,050
001	087	001 - THERMAL Regular Labour	087 Field Super.& Ops.	8,960	0	8,960
011	087	011 - Travel Expense	087 Field Super.& Ops.	[redacted]	0	[redacted]
021	087	021 - Telephones	087 Field Super.& Ops.	150	0	150
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	250	0	250
			Total Cost:	289,376	0	289,376
			Original Cost:	185,000		

Location: Trenton Generating Station
CI# / FP#: 41516
Title: TRE6 Stack Breaching Inlet Ductwork Refurbishments
Execution Year: 2013

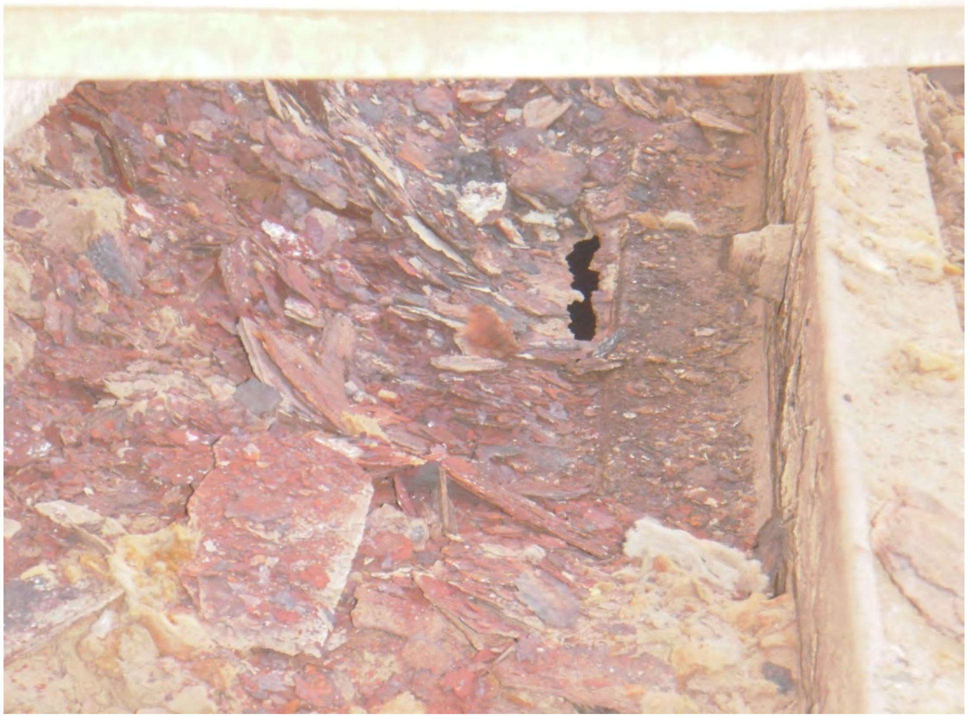
Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Supervision/Management	hr	[redacted]		$ 8,960.00		
1.2	Reg Utility (Ash removal, confined space, air supply)	hr			$ 8,640.00		
1.3	Reg Electrician (Power supply)	hr			$ 1,640.00		
1.4					$ -		
1.5					$ -		
1.6					$ -		
1.7					$ -		
1.8					$ -		
				Sub-Total	$ 19,240.00		
4	**012 Materials**						
4.1	Ductwork Refurbishments (assume 30% materials)	lot	1	[redacted]		Cost Support 1	
4.2	Contingency on Materials	%	[redacted]				
4.3					$ -		
4.4					$ -		
4.5					$ -		
				Sub-Total	[redacted]		
5	**013 Power Production Contracts**						
5.1	Ductwork Refurbishments (assume 70% labour)	lot	1	[redacted]		Cost Support 1	
5.2	Contractor Trailer Rental	lot	1				
5.3	NDT of Welds	lot	1				
5.4	Contingency on Contracts	%					
5.5					$ -		
5.6					$ -		
				Sub-Total	$ 171,050.00		
7	**011 Travel**						
7.1	Travel	lot	1	[redacted]			
				Sub-Total	$ 150.00		
8	**021 Telephones**						
8.1	Telephones	lot	1	$ 150.00	$ 150.00		
				Sub-Total	$ 150.00		
9	**041 Meals and Entertainment**						
9.1	Meals	lot	1	$ 250.00	$ 250.00		
				Sub-Total	$ 250.00		
10	**094 Interest Capitalized**						
10.1	Interest Capitalized	lot	1	$ 641.88	$ 641.88		
				Sub-Total	$ 641.88		
11	**095 Administrative Overhead**						
11.1	Thermal Regular Labour AO	lot	1	$ 5,117.84	$ 5,117.84		
11.2	Thermal Overtime Labour AO	lot	1		$ -		
11.3	Thermal & Hydro Contracts AO	lot	1	$ 21,825.98	$ 21,825.98		
11.4					$ -		
				Sub-Total	$ 26,943.82		
Cost Estimate				Total	$ 289,375.70		
12	**Original Cost**						
12.1	Retirement				$ 185,000.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project.

Attachment 1

Removed due to confidentiality

EXTERNAL PICTURES FROM MARCH 2011



CI Number: **41506**

Title: **TRE6 - 6B Cooling Water (CW) Pump Refurbishment**

Start Date: 2013/01
Final Cost Date: 2013/09
Function: Generation
Forecast Amount: $286,027

DESCRIPTION:

The Trenton Unit 6 circulating water (CW) system supplies cooling water to the steam condenser. Cooling water is drawn from a shoreline intake through a pair of traveling screens by two vertical single stage pumps. The water is then pumped through the CW piping and into the steam condenser inlet. These pumps also supply cooling water to the turbine lube oil coolers, general service cooling water coolers, hydrogen coolers and vacuum pump heat exchangers.

The 6B CW pump is a salt water service, single stage, vertical mixed-flow pump rated at approximately 61,000 USGpm, with a 950hP motor. Completing a pump overhaul and refurbishment will reduce the risk of an unexpected pump failure and associated replacement energy costs, resulting from a forced unit de-rating.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015.

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Maintenance

Why do this project?

The overhaul and refurbishment of the 6B cooling water pump is required in 2013 based on the plant's Life Cycle Management Program. Based on the duration the pump has been in operation since the last inspection, it is expected that the shafts, shaft sleeves, and inlet casing will require refurbishment or replacement. In addition, the impeller is scheduled for replacement based on recent inspection and vibration levels during operation.

During certain times of the year (typically April to October), the Trenton Generating Station must operate both CW pumps to achieve full load. If one CW pump is forced out of service, the average output drops by 48 MW due to loss of vacuum.

Why do this project now?

Not completing this pump overhaul could reduce the availability of cooling water to Trenton Unit 6. An unplanned outage in the spring, summer or fall would reduce the volume of cooling water to Unit 6 such that it could not operate at full load. This would decrease generation output and could result in the purchase of replacement energy. Completing internal inspection and overhaul now will ensure a more costly in-service failure does not occur.

Based on experience and condenser design data, the pump can be shut down when river water temperatures drop to 4 degrees Celsius without having to reduce generation. With these cooler water temperatures, the 6A CW pump can provide cooling water demand while the 6B CW pump is refurbished. Historical data indicates that the best timeframe to complete this work is between November and March.

Why do this project this way?

The most cost-effective option is to refurbish the CW pump during a planned outage. The option to replace the pump with a new pump was evaluated and is not the most cost-effective option. The individual components that require replacement or refurbishment will be confirmed when the pump is shut down and inspected.

CI Number : 41506 - TRE6 - 6B Cooling Water (CW) Pump Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 345 - 345-Trenton unit 6 Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		1,816	0	1,816
095		095-Thermal Term Labour AO		6,187	0	6,187
095		095-Thermal & Hydro Contracts AO		7,656	0	7,656
095		095-Thermal Regular Labour AO		10,938	0	10,938
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	27,680	0	27,680
004	014	004 - THERMAL Term Labour	014 - SGP - Circ.Water Sys.	23,260	0	23,260
012	014	012 - Materials	014 - SGP - Circ.Water Sys.	133,800	0	133,800
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	60,000	0	60,000
001	085	001 - THERMAL Regular Labour	085 Design	2,240	0	2,240
001	087	001 - THERMAL Regular Labour	087 Field Super.& Ops.	11,200	0	11,200
011	087	011 - Travel Expense	087 Field Super.& Ops.	500	0	500
021	087	021 - Telephones	087 Field Super.& Ops.	250	0	250
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	500	0	500
			Total Cost:	286,027	0	286,027
			Original Cost:	190,000		

TRE6 6B CW Pump Refurbishment
Summary of Alternatives

Division :	Power Production		**Date :**	**31-Oct-12**
Department :	Trenton Generating Station		**CI Number:**	41506
Originator :			**Project No. :**	

	Alternative	**After Tax WACC**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Pump Refurbishment	6.48%	1,626,013	1	59.66%	2.5 years
B	Pump Replacement	6.48%	1,129,237	2	20.25%	7.1 years
C	Test 3	6.48%	0	3	#NUM!	0.0 years
D	Test 4	6.48%	0	3	#NUM!	0.0 years

Recommendation :

It is recommended to approve this project to perform the 6B CW pump refurbishments. This project is backed by favorable economic analysis.

Notes/Comments :

Pump Refurbishment

This option assumes that If the pump is not refurbished, there is an escalating annual probability of the pump failing, causing an average one week duration de-rating due to a pump being offline. The derating is estimated on average to be 48MW.

Pump Replacement

This option makes the same assumptions as refurbishment, except the capital investment is for the purchase and installation of a new CW pump.

Test 3

Test 4

TRE6 6B CW Pump Refurbishment
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Trenton Generating Station	CI Number:	41506
Originator :		Project No. :	

Pump Refurbishment

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]	[redacted]				
Repair Cost ($)			$186,000	$189,720		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	30%	40%	30%	40%		
Capacity Factor (%)	[redacted]	[redacted]				
Energy Replaced (MW)	48	48				
Duration (Hours)	144	144				
Totals	$27,164	$34,615	$55,800	$75,888	$82,964	$110,503
Total Capital Cost of Alternative						$286,027

Pump Replacement

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]	[redacted]				
Repair Cost ($)			$186,000	$189,720		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	30%	40%	30%	40%		
Capacity Factor (%)	[redacted]	[redacted]				
Energy Replaced (MW)	48	48				
Duration (Hours)	144	144				
Totals	$27,164	$34,615	$55,800	$75,888	$82,964	$110,503
Total Capital Cost of Alternative						$900,000

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]	[redacted]				
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]	[redacted]				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

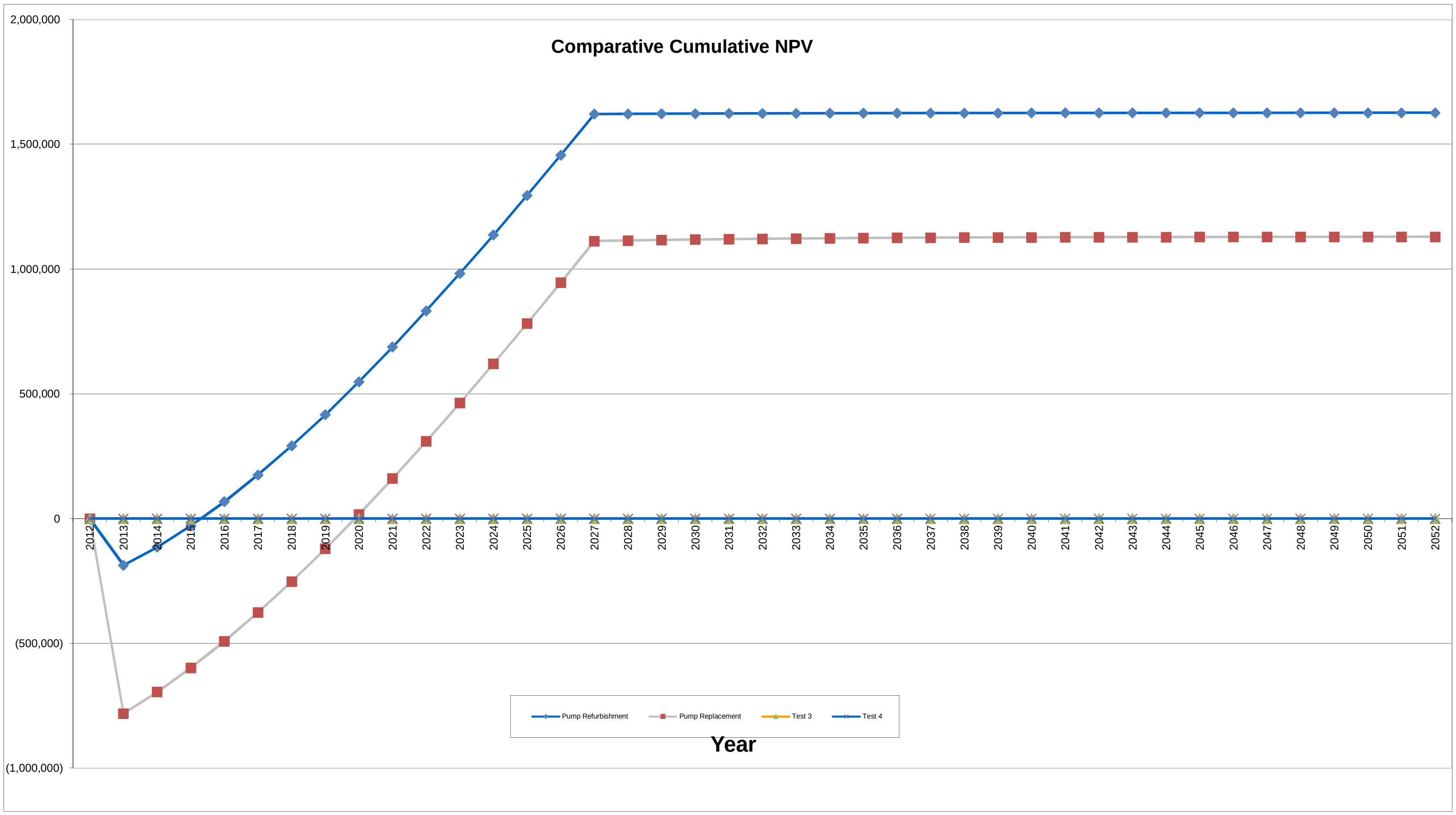
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]	[redacted]				
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]	[redacted]				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

TRE6 6B CW Pump Refurbishment
Pump Refurbishment

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	82,964.2	(259,430.0)	10,674.6	256,189.8	(176,465.8)	(22,409.8)	(198,875.6)	(186,772.739)	0.9	(186,772.7)
2014	-	110,503.3	-	20,495.2	235,694.6	110,503.3	(27,902.5)	82,600.8	72,853.105	0.9	(113,919.6)
2015	-	140,891.7	-	18,855.6	216,839.0	140,891.7	(37,831.2)	103,060.5	85,366.626	0.8	(28,553.0)
2016	-	172,451.4	-	17,347.1	199,491.9	172,451.4	(48,082.3)	124,369.1	96,747.630	0.8	68,194.6
2017	-	205,217.2	-	15,959.4	183,532.5	205,217.2	(58,669.9)	146,547.3	107,062.541	0.7	175,257.2
2018	-	239,224.6	-	14,682.6	168,849.9	239,224.6	(69,608.0)	169,616.6	116,375.116	0.7	291,632.3
2019	-	274,510.3	-	13,508.0	155,341.9	274,510.3	(80,910.7)	193,599.6	124,746.420	0.6	416,378.7
2020	-	311,111.6	-	12,427.4	142,914.6	311,111.6	(92,592.1)	218,519.5	132,234.839	0.6	548,613.5
2021	-	349,067.3	-	11,433.2	131,481.4	349,067.3	(104,666.6)	244,400.7	138,896.102	0.6	687,509.6
2022	-	388,416.7	-	10,518.5	120,962.9	388,416.7	(117,148.4)	271,268.2	144,783.319	0.5	832,293.0
2023	-	429,200.4	-	9,677.0	111,285.9	429,200.4	(130,052.3)	299,148.2	149,947.035	0.5	982,240.0
2024	-	471,460.2	-	8,902.9	102,383.0	471,460.2	(143,392.8)	328,067.4	154,435.295	0.5	1,136,675.3
2025	-	515,238.6	-	8,190.6	94,192.4	515,238.6	(157,184.9)	358,053.7	158,293.707	0.4	1,294,969.0
2026	-	560,579.6	-	7,535.4	86,657.0	560,579.6	(171,443.7)	389,135.9	161,565.524	0.4	1,456,534.5
2027	-	607,528.1	-	6,932.6	79,724.4	607,528.1	(186,184.6)	421,343.5	164,291.717	0.4	1,620,826.2
2028	-	-	-	6,378.0	73,346.5	-	1,977.2	1,977.2	724.026	0.4	1,621,550.3
2029	-	-	-	5,867.7	67,478.7	-	1,819.0	1,819.0	625.567	0.3	1,622,175.8
2030	-	-	-	5,398.3	62,080.4	-	1,673.5	1,673.5	540.498	0.3	1,622,716.3
2031	-	-	-	4,966.4	57,114.0	-	1,539.6	1,539.6	466.997	0.3	1,623,183.3
2032	-	-	-	4,569.1	52,544.9	-	1,416.4	1,416.4	403.491	0.3	1,623,586.8
2033	-	-	-	4,203.6	48,341.3	-	1,303.1	1,303.1	348.621	0.3	1,623,935.4
2034	-	-	-	3,867.3	44,474.0	-	1,198.9	1,198.9	301.213	0.3	1,624,236.6
2035	-	-	-	3,557.9	40,916.1	-	1,103.0	1,103.0	260.251	0.2	1,624,496.9
2036	-	-	-	3,273.3	37,642.8	-	1,014.7	1,014.7	224.860	0.2	1,624,721.8
2037	-	-	-	3,011.4	34,631.4	-	933.5	933.5	194.282	0.2	1,624,916.0
2038	-	-	-	2,770.5	31,860.9	-	858.9	858.9	167.862	0.2	1,625,083.9
2039	-	-	-	2,548.9	29,312.0	-	790.1	790.1	145.035	0.2	1,625,228.9
2040	-	-	-	2,345.0	26,967.0	-	726.9	726.9	125.312	0.2	1,625,354.3
2041	-	-	-	2,157.4	24,809.7	-	668.8	668.8	108.271	0.2	1,625,462.5
2042	-	-	-	1,984.8	22,824.9	-	615.3	615.3	93.547	0.2	1,625,556.1
2043	-	-	-	1,826.0	20,998.9	-	566.1	566.1	80.826	0.1	1,625,636.9
2044	-	-	-	1,679.9	19,319.0	-	520.8	520.8	69.835	0.1	1,625,706.7
2045	-	-	-	1,545.5	17,773.5	-	479.1	479.1	60.338	0.1	1,625,767.1
2046	-	-	-	1,421.9	16,351.6	-	440.8	440.8	52.133	0.1	1,625,819.2
2047	-	-	-	1,308.1	15,043.5	-	405.5	405.5	45.043	0.1	1,625,864.2
2048	-	-	-	1,203.5	13,840.0	-	373.1	373.1	38.918	0.1	1,625,903.2
2049	-	-	-	1,107.2	12,732.8	-	343.2	343.2	33.626	0.1	1,625,936.8
2050	-	-	-	1,018.6	11,714.2	-	315.8	315.8	29.053	0.1	1,625,965.8
2051	-	-	-	937.1	10,777.0	-	290.5	290.5	25.102	0.1	1,625,990.9
2052	-	-	-	862.2	9,914.9	-	267.3	267.3	21.688	0.1	1,626,012.6
Total	-	4,858,365.2	(259,430.0)	256,949.5	3,088,350.9	4,598,935.2	(1,426,438.9)	3,172,496.3	1,626,012.6		

TRE6 6B CW Pump Refurbishment
Pump Replacement

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	82,964.2	(900,000.0)	36,000.0	900,000.0	(817,035.8)	(14,558.9)	(831,594.7)	(780,986.786)	0.9	(780,986.8)
2014	-	110,503.3	-	69,120.0	794,880.0	110,503.3	(12,828.8)	97,674.5	86,147.960	0.9	(694,838.8)
2015	-	140,891.7	-	63,590.4	731,289.6	140,891.7	(23,963.4)	116,928.3	96,853.541	0.8	(597,985.3)
2016	-	172,451.4	-	58,503.2	672,786.4	172,451.4	(35,324.0)	137,127.5	106,672.462	0.8	(491,312.8)
2017	-	205,217.2	-	53,822.9	618,963.5	205,217.2	(46,932.2)	158,285.0	115,637.716	0.7	(375,675.1)
2018	-	239,224.6	-	49,517.1	569,446.4	239,224.6	(58,809.3)	180,415.3	123,784.169	0.7	(251,890.9)
2019	-	274,510.3	-	45,555.7	523,890.7	274,510.3	(70,975.9)	203,534.4	131,147.932	0.6	(120,743.0)
2020	-	311,111.6	-	41,911.3	481,979.5	311,111.6	(83,452.1)	227,659.5	137,765.822	0.6	17,022.8
2021	-	349,067.3	-	38,558.4	443,421.1	349,067.3	(96,257.8)	252,809.5	143,674.938	0.6	160,697.8
2022	-	388,416.7	-	35,473.7	407,947.4	388,416.7	(109,412.3)	279,004.3	148,912.290	0.5	309,610.0
2023	-	429,200.4	-	32,635.8	375,311.6	429,200.4	(122,935.0)	306,265.4	153,514.516	0.5	463,124.6
2024	-	471,460.2	-	30,024.9	345,286.7	471,460.2	(136,844.9)	334,615.2	157,517.641	0.5	620,642.2
2025	-	515,238.6	-	27,622.9	317,663.8	515,238.6	(151,160.9)	364,077.7	160,956.892	0.4	781,599.1
2026	-	560,579.6	-	25,413.1	292,250.7	560,579.6	(165,901.6)	394,678.0	163,866.547	0.4	945,465.6
2027	-	607,528.1	-	23,380.1	268,870.6	607,528.1	(181,085.9)	426,442.2	166,279.829	0.4	1,111,745.5
2028	-	-	-	21,509.6	247,361.0	-	6,668.0	6,668.0	2,441.779	0.4	1,114,187.2
2029	-	-	-	19,788.9	227,572.1	-	6,134.6	6,134.6	2,109.726	0.3	1,116,297.0
2030	-	-	-	18,205.8	209,366.3	-	5,643.8	5,643.8	1,822.829	0.3	1,118,119.8
2031	-	-	-	16,749.3	192,617.0	-	5,192.3	5,192.3	1,574.946	0.3	1,119,694.8
2032	-	-	-	15,409.4	177,207.6	-	4,776.9	4,776.9	1,360.772	0.3	1,121,055.5
2033	-	-	-	14,176.6	163,031.0	-	4,394.7	4,394.7	1,175.724	0.3	1,122,231.2
2034	-	-	-	13,042.5	149,988.6	-	4,043.2	4,043.2	1,015.839	0.3	1,123,247.1
2035	-	-	-	11,999.1	137,989.5	-	3,719.7	3,719.7	877.697	0.2	1,124,124.8
2036	-	-	-	11,039.2	126,950.3	-	3,422.1	3,422.1	758.341	0.2	1,124,883.1
2037	-	-	-	10,156.0	116,794.3	-	3,148.4	3,148.4	655.216	0.2	1,125,538.3
2038	-	-	-	9,343.5	107,450.7	-	2,896.5	2,896.5	566.114	0.2	1,126,104.5
2039	-	-	-	8,596.1	98,854.7	-	2,664.8	2,664.8	489.130	0.2	1,126,593.6
2040	-	-	-	7,908.4	90,946.3	-	2,451.6	2,451.6	422.614	0.2	1,127,016.2
2041	-	-	-	7,275.7	83,670.6	-	2,255.5	2,255.5	365.143	0.2	1,127,381.3
2042	-	-	-	6,693.6	76,977.0	-	2,075.0	2,075.0	315.488	0.2	1,127,696.8
2043	-	-	-	6,158.2	70,818.8	-	1,909.0	1,909.0	272.586	0.1	1,127,969.4
2044	-	-	-	5,665.5	65,153.3	-	1,756.3	1,756.3	235.517	0.1	1,128,204.9
2045	-	-	-	5,212.3	59,941.0	-	1,615.8	1,615.8	203.490	0.1	1,128,408.4
2046	-	-	-	4,795.3	55,145.7	-	1,486.5	1,486.5	175.818	0.1	1,128,584.2
2047	-	-	-	4,411.7	50,734.1	-	1,367.6	1,367.6	151.909	0.1	1,128,736.1
2048	-	-	-	4,058.7	46,675.4	-	1,258.2	1,258.2	131.251	0.1	1,128,867.4
2049	-	-	-	3,734.0	42,941.3	-	1,157.5	1,157.5	113.402	0.1	1,128,980.8
2050	-	-	-	3,435.3	39,506.0	-	1,064.9	1,064.9	97.981	0.1	1,129,078.8
2051	-	-	-	3,160.5	36,345.5	-	979.7	979.7	84.657	0.1	1,129,163.4
2052	-	-	-	2,907.6	33,437.9	-	901.4	901.4	73.144	0.1	1,129,236.6
Total	-	4,858,365.2	(900,000.0)	866,562.1	10,451,464.1	3,958,365.2	(1,237,459.0)	2,720,906.3	1,129,236.6		


Comparative Cumulative NPV
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Pump Refurbishment
Pump Replacement
Test 3
Test 4
Year

Location: Trenton Generating Station
CI# / FP#: 41506
Title: TRE6 6B CW Pump Refurbishment
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Regular Mechanical	hr	[redacted]		$ 20,640.00		26472
1.2	Regular Utility	hr			$ 5,400.00		
1.3	Regular Electrical/Instrumentation	hr			$ 1,640.00		
1.4	Project Management/Supervision	hr			$ 11,200.00		
1.5	Internal Engineering	hr			$ 2,240.00		
1.6					$ -		
				Sub-Total	$ 41,120.00		
2	**002 Overtime Labour**						
2.1					$ -		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ -		
3	**004 Term Labour**						
3.1	Term Mechanical	hr	[redacted]		$ 18,920.00		26472
3.2	Term Utility	hr			$ 2,700.00		
3.3	Term Electrical/Instrumentation	hr			$ 1,640.00		
				Sub-Total	$ 23,260.00		
4	**012 Materials**						
4.1	Complete set of bearings	lot	1	[redacted]			26472
4.2	Complete set of sleeves	lot	1				26472
4.3	Fasteners/hardware	lot	1	$ 5,000.00	$ 5,000.00		
4.4	Consumables/Tools	lot	1	$ 2,000.00	$ 2,000.00		
4.5	Impeller	lot	1	[redacted]		Cost Support 1	
				Sub-Total	$ 133,800.00		
5	**013 Power Production Contracts**						
5.1	Machining Work - Pump Component Rebuilds	lot	1	[redacted]			26472
5.2	Motor Overhaul	lot	1				26472
5.3	Fsbrication Work	lot	1				
5.4					$ -		
5.5					$ -		
				Sub-Total	$ 60,000.00		
6	**028 Consulting**						
6.1					$ -		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ -		
7	**011 Travel**						
7.1		lot	1	$ 500.00	$ 500.00		
				Sub-Total	$ 500.00		
8	**021 Telephones**						
8.1		lot	1	$ 250.00	$ 250.00		
				Sub-Total	$ 250.00		
9	**041 Meals and Entertainment**						
9.1		lot	1	$ 500.00	$ 500.00		
				Sub-Total	$ 500.00		
10	**094 Interest Capitalized**						
10.1	Interest Capitalized	lot	1	$ 1,815.58	$ 1,815.58		
				Sub-Total	$ 1,815.58		
11	**095 Administrative Overhead**						
11.1	Thermal Regular Labour AO	lot	1	$ 10,937.92	$ 10,937.92		
11.2	Thermal Overtime Labour AO	lot	1		$ -		
11.3	Thermal & Hydro Contracts AO	lot	1	$ 7,656.00	$ 7,656.00		
11.4	Thermal Term Labour AO	lot	1	$ 6,187.16	$ 6,187.16		
				Sub-Total	$ 24,781.08		
Cost Estimate				Total	$ 286,026.66		
12	**Original Cost**						
12.1	Retirement				$ 190,000.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project.

Attachment 1

Removed due to confidentiality

CI Number: 42943

Title: **TUC2 - T-G Areas Fire Protection**

Start Date: 2013/05
Final Cost Date: 2013/12
Function: Generation
Forecast Amount: $283,088

DESCRIPTION:

This project includes the addition of a fixed fire protection system for the Unit 2 steam turbine and generator at the Tufts Cove Generating Station. At the time of original construction, the fire protection infrastructure was adequate, but a recent risk analysis identified that existing fire protection around the turbine generator no longer meets current industry standards. Construction will be similar to work recently undertaken at the Lingan (CIs 29039, 38846, 40184 and 40427), and Trenton Generating Stations (CI 28645), as well as on Tufts Cove Unit 3 (CI 41620).

Summary of Related CIs +/- 2 years:
2014 – CI TBD TUC Cable Spreading/Relay Room Fire Protection $75K (est)

JUSTIFICATION: **Justification Criteria:** Health & Safety

Sub Criteria: Buildings

Why do this project?

In the recent assessment of fire protection systems at all NS Power thermal plants, the highest risk items are associated with the turbine generator area of the plants. This risk is best mitigated by applying a fixed fire protection system around the equipment in this area as well as drainage for hydraulic oils and lubricants.

A system of similar design was successfully installed at LIN Unit 4 in 2009 (29039), LIN Unit 1 in 2010 (CI 38846), LIN Units 2 and 3 in 2011 (CIs 40184 and 40427), TRE Unit 6 (28645) and TUC Unit 3 (41620) in 2012. The design and construction of these systems will serve as a model for applying a similar solution for this project.

Why do this project now?

As a result of recent inspections, NS Power's insurance providers have recommended the need to introduce additional fire system risk-control measures. NS Power believes these modifications are important now as the plant's age and a staged installation with one unit at a time is appropriate to reduce risk in the long term. Unit 2 is scheduled for a maintenance outage in 2013 which will facilitate installation of fire suppression equipment. This project is part of NS Power's five- year plan for fire protection upgrades in thermal plants.

Why do this project this way?

The benchmark study used for assessing loss control practices was predicated on fire protection practices, NFPA 850 and FM DS7-1 01. Although they are recommended practices, they have become industry guidelines, widely used by insurers in risk assessments for power generation facilities. The new fire protection system will be integrated into the current system that exists at the plant.

CI Number : 42943 - TUC2 - T-G Areas Fire Protection **Project Number**

Parent CI Number : -

Cost Centre : 318 - 318-TC Unit 2 Capital **Budget Version** 2012 08/04 Forecast

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		8,093	0	8,093
095		095-Thermal Regular Labour AO		8,501	0	8,501
095		095-Thermal Overtime Labour AO		2,681	0	2,681
095		095-Thermal & Hydro Contracts AO		21,692	0	21,692
001	004	001 - THERMAL Regular Labour	004 - SGP - Misc.Equipment	31,960	0	31,960
002	004	002 - THERMAL Overtime Labour	004 - SGP - Misc.Equipment	20,160	0	20,160
012	004	012 - Materials	004 - SGP - Misc.Equipment	20,000	0	20,000
013	004	013 - POWER PRODUCTION Contracts	004 - SGP - Misc.Equipment	170,000	0	170,000
			Total Cost:	283,088	0	283,088
			Original Cost:			

Location: Tufts Cove Generating Station
CI# / FP#: 42943
Title: TUC2 - T-G Areas Fire Protection
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	hr	[redacted]	[redacted]	$ 19,680.00		
1.2	Engineering (P.Eng)	hr	[redacted]	[redacted]	$ 4,480.00		41620, 29039,
1.3	Maintenance Trades	hr	[redacted]	[redacted]	$ 5,160.00		38846, 40184
1.4	CADD Operators	hr	[redacted]	[redacted]	$ 2,640.00		
1.5		hr		$ -	$ -		
				Sub-Total	$ 31,960.00		
2	**002 Thermal Overtime Labour**						
2.1	Electrician	hr	[redacted]	[redacted]	$ 9,840.00		41620, 29039,
2.2	Maintenance Trades	hr	[redacted]	[redacted]	$ 10,320.00		38846, 40184
2.3					$ -		
				Sub-Total	$ 20,160.00		
3	**012 Materials**						
3.1	Panel, Protective wire, Sensors, Cable	lot	1	[redacted]	[redacted]		41620, 29039,
3.2	Miscellaneous Materials	lot	1	[redacted]	[redacted]		38846, 40184
3.3					$ -		
				Sub-Total	$ 20,000.00		
4	**013 Power Production Contracts**						
4.1	Fire Suppression Equipment and Installation	lot	1	[redacted]	[redacted]		41620, 29039,
4.2	Scaffolding	lot	1	[redacted]	[redacted]		38846, 40184
4.3					$ -		
				Sub-Total	$ 170,000.00		
5	**094 Interest Capitalized**						
5.1	Interest Capitalized	lot	1	$ 8,092.99	$ 8,092.99		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 8,092.99		
6	**095 Administrative Overhead**						
6.1	A/O				$ 32,874.64		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 32,874.64		
Project Cost Estimate				**Total**	$ 283,087.63		
7	**Original Cost**				$ -		
7.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

CI Number: 43056

Title: **POT - Cable Spreading Room Fire Protection**

Start Date: 2013/08
Final Cost Date: 2014/04
Function: Generation
Forecast Amount: $281,035

DESCRIPTION:

This project includes the addition of a fixed fire protection system for the two cable spreading rooms at the Point Tupper Generating Station. At the time of construction, the fire protection infrastructure was adequate, but a recent risk analysis identified that existing fire protection in the cable spreading rooms no longer meets current industry standards.

The cable spreading rooms contain a high concentration of critical power and communication cables. Fire protection systems that meet current industry standards are required to protect these cables.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015

JUSTIFICATION:

Justification Criteria: Health & Safety

Sub Criteria: System Protection

Why do this project?

In a recent assessment of fire protection systems at all NS Power thermal plants, the cable spreading rooms were identified as a risk. This risk is best mitigated by applying a fixed fire protection system around the equipment in these rooms.

Why do this project now?

Completing this project now will ensure the fire protection system is returned to current industry standards providing adequate loss control.

Why do this project this way?

The benchmark study used for assessing loss control practices was NFPA 850 and FM DS7-1 01. Although these are not regulated standards, they have become accepted industry guidelines, widely used by insurers in risk assessments for power generation facilities. The new fire protection system will be integrated into existing system at the plant.

CI Number : 43056 - POT - Cable spreading room fire protection **Project Number**

Parent CI Number : -

Cost Centre : 351 - 351-Pt.Tupper Admin./Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		1,806	0	1,806
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
095		095-Thermal Regular Labour AO			0	
001	003	001 - THERMAL Regular Labour	003 - SGP - Bldg.,Struct.Grnd.	5,600	0	5,600
002	003	002 - THERMAL Overtime Labour	003 - SGP - Bldg.,Struct.Grnd.	0	0	0
004	003	004 - THERMAL Term Labour	003 - SGP - Bldg.,Struct.Grnd.	0	0	0
012	003	012 - Materials	003 - SGP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
013	003	013 - POWER PRODUCTION Contracts	003 - SGP - Bldg.,Struct.Grnd.		0	
011	085	011 - Travel Expense	085 Design	1,000	0	1,000
028	085	028 - Consulting	085 Design	[redacted]	0	[redacted]
041	085	041 - Meals & Entertainment	085 Design	1,000	0	1,000
			Total Cost:	281,035	0	281,035
			Original Cost:			

Location: POT
CI# / FP#: 43056
Title: Cable spreading room fire protection
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Maintenance Trades	hr	[redacted]		$ 3,440.00		
1.2	Utility & Unskilled	hr	[redacted]		$ 2,160.00		
1.3							
				Sub-Total	$ 5,600.00		41229, 40428
2	**012 Materials**						
2.1	Pipe, sprinklers, valves, etc.	lot	1	[redacted]			
2.2							
2.3							
				Sub-Total	[redacted]		41229, 40428
3	**013 Power Production Contracts**						
3.1	Sprinkler installation	lot	1	[redacted]			
3.2							
3.3							
				Sub-Total	[redacted]		41229, 40428
4	**011 Travel Expenses**						
4.1	Travel	lot	1	$ 1,000.00	$ 1,000.00		
4.2							
4.3							
				Sub-Total	$ 1,000.00		41229, 40428
5	**028 Consulting**						
5.1	Consulting	lot	1	[redacted]			
5.2							
5.3							
				Sub-Total	[redacted]		41229, 40428
6	**041 Meals and Entertainment**						
6.1	Meals and expenses	lot	1	$ 1,000.00	$ 1,000.00		
6.2							
6.3							
				Sub-Total	$ 1,000.00		41229, 40428
8	**094 Interest Capitalized**						
8.1	AFUDC	lot	1	$ 1,805.69	$ 1,805.69		
8.2							
8.3							
				Sub-Total	$ 1,805.69		
9	**095 Administrative Overhead**						
9.1	Contracts AO	lot	1	[redacted]			
9.2	Regular Labour AO	lot	1				
9.3							
				Sub-Total	[redacted]		
Cost Estimate				**Total**	$ 281,035.28		
10	**Original Cost**						
10.1					N/A		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

CI Number:	**38108**
Title:	**POT – Automatic Voltage Regulator (AVR) Replacement**
Start Date:	2012/01
Final Cost Date:	2014/01
Function:	Generation
Forecast Amount:	$266,276

DESCRIPTION:

The automatic voltage regulator (AVR) is part of the generation control and protection system. The AVR automatically controls the generator voltage via field current regulation. The current AVR at the Point Tupper Generating Station (POT) is original equipment installed in 1973 and has reached the end of its useful life. The AVR is comprised of several modules that control the output from the generator and provide protection from electrical faults.

A failure of the AVR has already occurred at the station resulting in unplanned downtime. Repair was possible in this instance, and personnel were able to re-establish original control and protection properties. Parts have become difficult to find making future repairs much more difficult. This project will modernize the equipment, moving from proprietary equipment to software controlled PLC management.

Summary of Related CIs +/- 2 years:
No other projects in 2011, 2012, 2013, 2014 and 2015

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

This project is necessary to improve the reliability of power generation at the station. The existing AVR is outdated and has reached the end of its useful life, so it must be replaced with a modern, non-proprietary hardware system to provide voltage control and protection to the unit.

Why do this project now?

A failure of the AVR has already occurred at the station resulting in unplanned downtime. Replacement AVR control modules such as phase angle control, firing units, pulse amplifiers, convertor current control units, over-flux and under-excitation, are no longer available or supported. Replacing the excitation system now will mitigate the risk of an unplanned outage and associated replacement energy costs.

Why do this project this way?

Modern AVR systems are built on software-based, readily upgradeable systems with standard non-proprietary hardware components. The existing system must be replaced with a PLC microprocessor based AVR to ensure reliable operation into the future.

CI Number : 38108-SA35 - POT - AVR Replacement **Project Number** SA35

Parent CI Number : -

Cost Centre : 351 - 351-Pt.Tupper Admin./Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		3,435	0	3,435
095		095-Thermal Term Labour AO		4,908	0	4,908
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
095		095-Thermal Regular Labour AO			0	
095		095 - T&CS Regular Labour AO		60	0	60
001	011	001 - THERMAL Regular Labour	011 - SGP - Plant Control and Inst	28,540	0	28,540
004	011	004 - THERMAL Term Labour	011 - SGP - Plant Control and Inst	18,450	0	18,450
012	011	012 - Materials	011 - SGP - Plant Control and Inst	[redacted]	0	[redacted]
013	011	013 - POWER PRODUCTION Contracts	011 - SGP - Plant Control and Inst		0	
011	085	011 - Travel Expense	085 Design	6,600	0	6,600
041	085	041 - Meals & Entertainment	085 Design	550	0	550
			Total Cost:	266,276	0	266,276
			Original Cost:	46,347		

AVR replacement
Summary of Alternatives

Division :	Power Production	**Date :**	**3-Oct-12**
Department :	Point Tupper Generating Station	**CI Number:**	38108
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace AVR	6.48%	414,926	1	20.15%	8.0 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

This project is recommended to proceed based on strong economic analysis.

Notes/Comments :

Replace AVR

Test 2

Test 3

Test 4

AVR replacement
Avoided Cost Calculations

Division :	Power Production	Date :	3-Oct-12
Department :	Point Tupper Generating Station	CI Number:	38108
Originator :		Project No. :	

Replace AVR

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]	[redacted]				
Repair Cost ($)			$103,936	$106,015		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	10%	12%	10%	12%		
Capacity Factor (%)	[redacted]	[redacted]				
Energy Replaced (MW)	158	158				
Duration (Hours)	432	432				
Totals	$10,353	$19,325	$10,394	$12,722	$20,747	$32,047
Total Capital Cost of Alternative						$266,276

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]	[redacted]				
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]	[redacted]				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

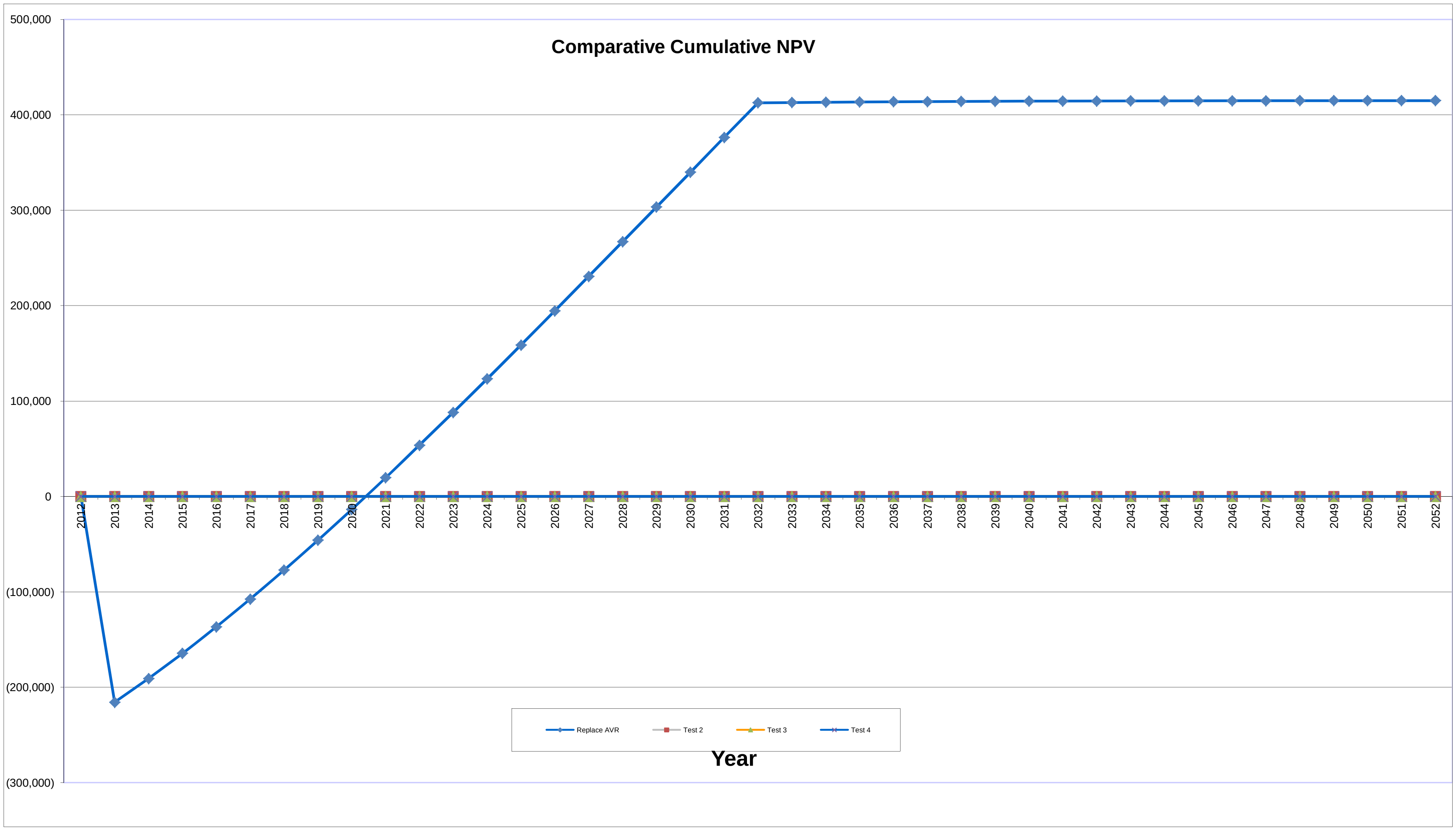
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]	[redacted]				
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]	[redacted]				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]	[redacted]				
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]	[redacted]				
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

AVR replacement
Replace AVR

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	20,746.7	(247,008.3)	10,070.3	241,687.7	(226,261.6)	(3,309.7)	(229,571.3)	(215,600.355)	0.9	(215,600.4)
2014	-	32,047.0	-	19,335.0	222,352.7	32,047.0	(3,940.7)	28,106.3	24,789.447	0.9	(190,810.9)
2015	-	38,135.9	-	17,788.2	204,564.5	38,135.9	(6,307.8)	31,828.1	26,363.712	0.8	(164,447.2)
2016	-	44,455.5	-	16,365.2	188,199.3	44,455.5	(8,708.0)	35,747.5	27,808.252	0.8	(136,638.9)
2017	-	51,012.7	-	15,055.9	173,143.4	51,012.7	(11,146.6)	39,866.1	29,124.855	0.7	(107,514.1)
2018	-	57,814.4	-	13,851.5	159,291.9	57,814.4	(13,628.5)	44,185.9	30,316.251	0.7	(77,197.8)
2019	-	64,867.8	-	12,743.4	146,548.5	64,867.8	(16,158.6)	48,709.2	31,385.911	0.6	(45,811.9)
2020	-	72,180.1	-	11,723.9	134,824.7	72,180.1	(18,741.4)	53,438.7	32,337.882	0.6	(13,474.0)
2021	-	79,759.1	-	10,786.0	124,038.7	79,759.1	(21,381.7)	58,377.4	33,176.639	0.6	19,702.6
2022	-	87,612.3	-	9,923.1	114,115.6	87,612.3	(24,083.6)	63,528.6	33,906.970	0.5	53,609.6
2023	-	95,747.7	-	9,129.2	104,986.3	95,747.7	(26,851.7)	68,896.0	34,533.877	0.5	88,143.4
2024	-	104,173.5	-	8,398.9	96,587.4	104,173.5	(29,690.1)	74,483.4	35,062.491	0.5	123,205.9
2025	-	112,898.0	-	7,727.0	88,860.4	112,898.0	(32,603.0)	80,295.0	35,498.003	0.4	158,703.9
2026	-	121,929.8	-	7,108.8	81,751.6	121,929.8	(35,594.5)	86,335.3	35,845.611	0.4	194,549.5
2027	-	131,277.8	-	6,540.1	75,211.5	131,277.8	(38,668.7)	92,609.1	36,110.470	0.4	230,660.0
2028	-	140,950.9	-	6,016.9	69,194.6	140,950.9	(41,829.5)	99,121.4	36,297.659	0.4	266,957.7
2029	-	150,958.4	-	5,535.6	63,659.0	150,958.4	(45,081.1)	105,877.3	36,412.146	0.3	303,369.8
2030	-	161,309.9	-	5,092.7	58,566.3	161,309.9	(48,427.3)	112,882.5	36,458.770	0.3	339,828.6
2031	-	172,015.0	-	4,685.3	53,881.0	172,015.0	(51,872.2)	120,142.8	36,442.220	0.3	376,270.8
2032	-	183,083.8	-	4,310.5	49,570.5	183,083.8	(55,419.7)	127,664.0	36,367.021	0.3	412,637.8
2033	-	-	-	3,965.6	45,604.9	-	1,229.3	1,229.3	328.887	0.3	412,966.7
2034	-	-	-	3,648.4	41,956.5	-	1,131.0	1,131.0	284.162	0.3	413,250.9
2035	-	-	-	3,356.5	38,600.0	-	1,040.5	1,040.5	245.519	0.2	413,496.4
2036	-	-	-	3,088.0	35,512.0	-	957.3	957.3	212.132	0.2	413,708.5
2037	-	-	-	2,841.0	32,671.0	-	880.7	880.7	183.284	0.2	413,891.8
2038	-	-	-	2,613.7	30,057.3	-	810.2	810.2	158.360	0.2	414,050.2
2039	-	-	-	2,404.6	27,652.7	-	745.4	745.4	136.825	0.2	414,187.0
2040	-	-	-	2,212.2	25,440.5	-	685.8	685.8	118.218	0.2	414,305.2
2041	-	-	-	2,035.2	23,405.3	-	630.9	630.9	102.142	0.2	414,407.4
2042	-	-	-	1,872.4	21,532.9	-	580.5	580.5	88.252	0.2	414,495.6
2043	-	-	-	1,722.6	19,810.2	-	534.0	534.0	76.251	0.1	414,571.9
2044	-	-	-	1,584.8	18,225.4	-	491.3	491.3	65.882	0.1	414,637.7
2045	-	-	-	1,458.0	16,767.4	-	452.0	452.0	56.922	0.1	414,694.7
2046	-	-	-	1,341.4	15,426.0	-	415.8	415.8	49.182	0.1	414,743.8
2047	-	-	-	1,234.1	14,191.9	-	382.6	382.6	42.494	0.1	414,786.3
2048	-	-	-	1,135.4	13,056.6	-	352.0	352.0	36.715	0.1	414,823.1
2049	-	-	-	1,044.5	12,012.0	-	323.8	323.8	31.722	0.1	414,854.8
2050	-	-	-	961.0	11,051.1	-	297.9	297.9	27.408	0.1	414,882.2
2051	-	-	-	884.1	10,167.0	-	274.1	274.1	23.681	0.1	414,905.9
2052	-	-	-	813.4	9,353.6	-	252.1	252.1	20.461	0.1	414,926.3
Total	-	1,922,976.1	(247,008.3)	242,404.4	2,913,529.7	1,675,967.9	(520,977.2)	1,154,990.6	414,926.3		


Comparative Cumulative NPV
500,000
400,000
300,000
200,000
100,000
0
(100,000)
(200,000)
(300,000)
2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052
Replace AVR
Test 2
Test 3
Test 4
Year

Location: POT
CI# / FP#: 38108
Title: AVR replacement
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	001 Regular Labour						
1.1	Electrician	hr	[redacted]	[redacted]	$ 8,200.00		
1.2	Engineering (P.Eng)	hr	[redacted]	[redacted]	$ 5,600.00		
1.3	Maintenance Trades	hr	[redacted]	[redacted]	$ 3,440.00		
1.4	Power Plant Technician	hr	[redacted]	[redacted]	$ 8,600.00		
1.5	Utility & Unskilled	hr	[redacted]	[redacted]	$ 2,700.00		
1.6		hr		$ -	$ -		
				Sub-Total	$ 28,540.00		39926
2	012 Materials						
2.1	AVR equipment	lot	1	[redacted]	[redacted]		
2.2	Spares and control cables	lot	1	[redacted]	[redacted]		
2.3	Contingency	%	[redacted]	[redacted]	[redacted]		
2.4					$ -		
				Sub-Total	[redacted]		39926
3	013 Power Production Contracts						
3.1	Contractors	lot	1	[redacted]	[redacted]		
3.2	Contingency	%	[redacted]	[redacted]	[redacted]		
3.3					$ -		
				Sub-Total	[redacted]		39926
4	011 Travel Expenses						
4.1	Travel	lot	1	$ 6,600.00	$ 6,600.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 6,600.00		
5	041 Meals and Entertainment						
5.1	Meals and expenses	lot	1	$ 550.00	$ 550.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 550.00		
6	004 Term Labour						
6.1	Electricians	hr	[redacted]	[redacted]	$ 18,450.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 18,450.00		
8	094 Interest Capitalized						
8.1	AFUDC	lot	1	$ 3,435.18	$ 3,435.18		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 3,435.18		
9	095 Administrative Overhead						
9.1	T&CS Labour AO	lot	1	$ 60.48	$ 60.48		
9.2	Term Labour AO	llot	1	$ 4,907.70	$ 4,907.70		
9.3	Contract AO	lot	1	[redacted]	[redacted]		
9.4	Regular Labour AO	lot	1	[redacted]	[redacted]		
				Sub-Total	$ 15,832.56		
Cost Estimate				**Total**	$ 266,276.48		
10	**Original Cost**						
10.1					46,346.97		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

CI Number: 43169

Title: **LIN Circulating Water (CW) Screen Refurbishment**

Start Date: 2013/04
Final Cost Date: 2014/04
Function: Generation
Forecast Amount: $262,003.19

DESCRIPTION:

There are eight travelling screens (two per unit) at the Lingan Generating Station. The self-cleaning screens remove sea debris from the incoming sea water before it enters the circulating water (CW) pump and downstream cooling systems.

The screens consist of bottom, top and intermediate section. The bottom section includes the tail sprocket assembly and support structure. The top section is comprised of the drive sprocket assembly and the support structure. The intermediate section spans vertically between the bottom and top sections and supports the entire structure. The screens' intermediate sections and top sections require replacement, as they have corroded over time. These sections will be replaced with stainless steel components.

During periods of low seaweed loading, one of the two screens on each unit is taken out of service and refurbished. The original plan was to refurbish two screens per year until all eight screens have been upgraded. Based on operational changes such as seasonal operation of Units 1 and 2, projects past 2013 will be re-evaluated. Screens 4A and 3A are planned for 2013.

Summary of Related CIs +/- 2 years
2011 40223 LIN CW Travelling Screen Refurbish $253,879
2012 41124 LIN CW Travelling Screen Refurbish $251,544

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

Eel grass passing through degraded or non-functioning traveling screen panels results in downstream fouling of strainers at CW and ACW locations and increases the risk of unit de-rating or outages due to inadequate cooling capacity, particularly during the late summer and fall. The degree of fouling also results in high mechanical loading on the screens and circulating water pumps. This high loading causes component failure at the screens and CW pumps and increases the risk of de-rating or unit outages due to the loss of cooling water.

Why do this project now?

The screens have degraded over time, and are in need of refurbishment. Completing this project will reduce existing issues with the circulating water system during periods of heavy seaweed and debris. This will reduce the risk of unit de-ratings and subsequent associated replacement energy costs.

Why do this project this way?

The screens operate in an aggressive sea water environment and have experienced normal corrosion and wear. The most cost effective solution is to replace the corroded and worn components as opposed to replacing the complete screen. Primary components to be refurbished include the top drives (sprocket refurbishment, bearing replacement, shaft refurbishment, top boot replacement with stainless steel material), Intermediate Section (guides, supports and screen panels replacement) and Lower Section (sprocket refurbishment, bearing replacement, shaft refurbishment, bottom boot replacement with stainless steel material).

CI Number : 43169 - LIN CW Screen Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 301 - 301-Lingan Admin./Common Capital **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		8,117	0	8,117
095		095-Thermal Regular Labour AO		[redacted]	0	[redacted]
095		095-Thermal & Hydro Contracts AO			0	
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	121,520	0	121,520
002	014	002 - THERMAL Overtime Labour	014 - SGP - Circ.Water Sys.	0	0	0
004	014	004 - THERMAL Term Labour	014 - SGP - Circ.Water Sys.	0	0	0
012	014	012 - Materials	014 - SGP - Circ.Water Sys.	[redacted]	0	[redacted]
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.		0	
			Total Cost:	262,003	0	262,003
			Original Cost:	86,748		

LIN Refurbish CW Screens
Summary of Alternatives

Division :	Power Production		**Date :**	**31-Oct-12**
Department :	Lingan GS		**CI Number:**	43169
Originator :			**Project No. :**	

	Alternative	**After Tax WACC**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Refurbish 2 CW Screens	6.48%	304,788	1	42.92%	3.5 years
B	Replace 2 CW Screens	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

Refurbish 2 CW screens to avoid risk of derating during warm water peak loading

Notes/Comments :

Refurbish 2 CW Screens

Screen operate in a severly corrosive envirornment. Screens must often be extracted from the CW intake to allow repair / replacement. Major drive components, screen panels and housing materials require replacement which cannot be done in situ.

Replace 2 CW Screens

Full replacement of the screen assembly is not required at this time, and would be more costly than refurbishment. This option is not evaluated further.

Test 3

Test 4

LIN Refurbish CW Screens
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Lingan GS	CI Number:	43169
Originator :		Project No. :	

Refurbish 2 CW Screens

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh	[redacted]					
Repair Cost ($)			$66,280	$67,606		
Events/Outages (#)	1	2	1	2		
Probability of Occurance (%)	80%	60%	80%	60%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	20	20				
Duration (Hours)	336	240				
Totals	$7,040	$6,235	$53,024	$81,127	$60,064	$87,361

Total Capital Cost of Alternative	$262,003

Replace 2 CW Screens

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative	$0

Test 3

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative	$0

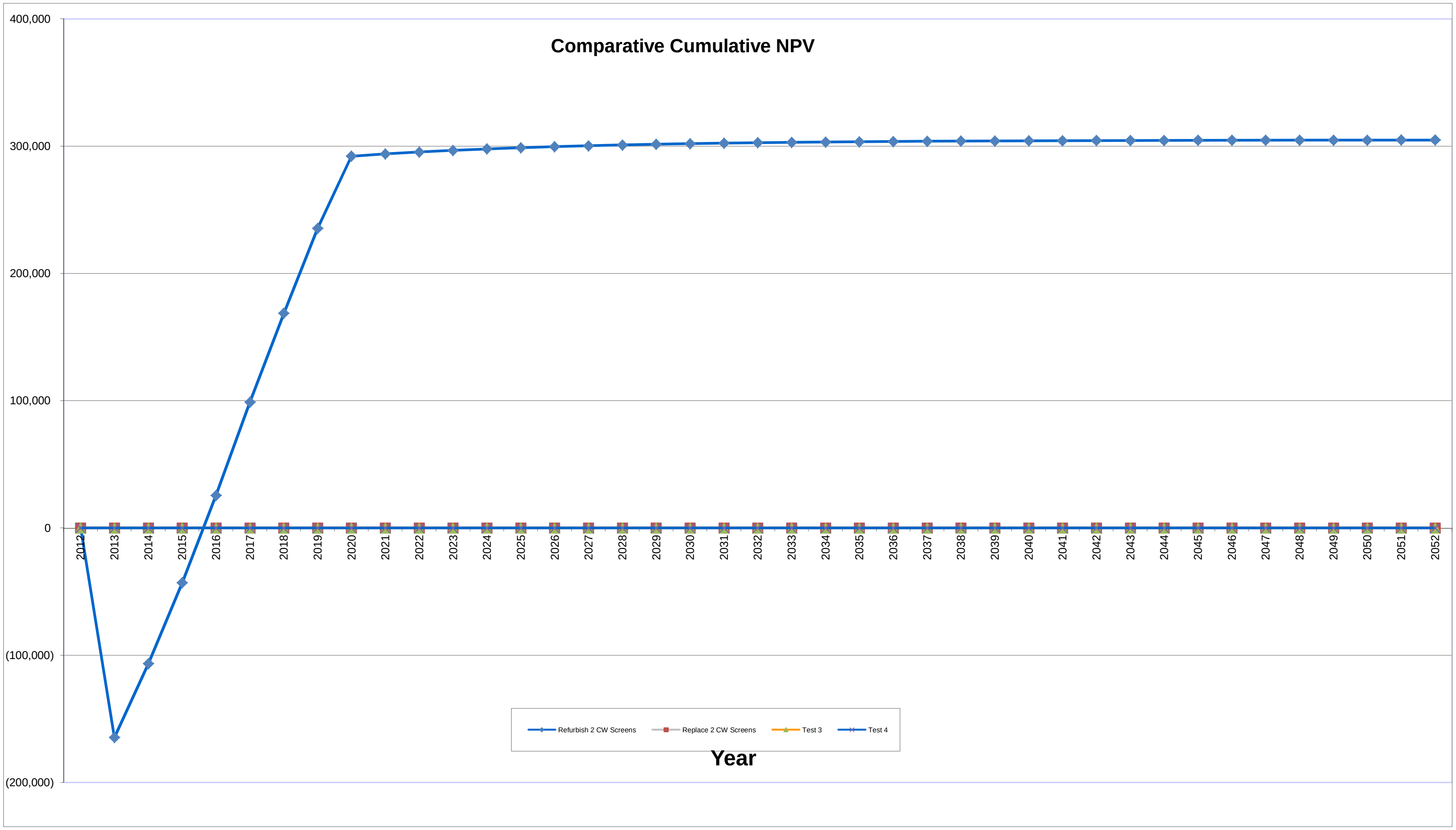
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative	$0

LIN Refurbish CW Screens
Refurbish 2 CW Screens

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	60,063.9	(219,520.0)	9,193.2	220,636.6	(159,456.1)	(15,769.9)	(175,226.0)	(164,562.396)	0.9	(164,562.4)
2014	-	87,361.3	-	17,650.9	202,985.7	87,361.3	(21,610.2)	65,751.1	57,991.860	0.9	(106,570.5)
2015	-	103,960.0	-	16,238.9	186,746.8	103,960.0	(27,193.6)	76,766.4	63,586.848	0.8	(42,983.7)
2016	-	121,187.7	-	14,939.7	171,807.1	121,187.7	(32,936.9)	88,250.8	68,650.942	0.8	25,667.3
2017	-	139,062.8	-	13,744.6	158,062.5	139,062.8	(38,848.7)	100,214.2	73,213.122	0.7	98,880.4
2018	-	141,844.1	-	12,645.0	145,417.5	141,844.1	(40,051.7)	101,792.4	69,840.443	0.7	168,720.8
2019	-	144,681.0	-	11,633.4	133,784.1	144,681.0	(41,244.7)	103,436.2	66,649.419	0.6	235,370.2
2020	-	131,177.4	-	10,702.7	123,081.4	131,177.4	(37,347.2)	93,830.3	56,780.419	0.6	292,150.7
2021	-	-	-	9,846.5	113,234.9	-	3,052.4	3,052.4	1,734.729	0.6	293,885.4
2022	-	-	-	9,058.8	104,176.1	-	2,808.2	2,808.2	1,498.827	0.5	295,384.2
2023	-	-	-	8,334.1	95,842.0	-	2,583.6	2,583.6	1,295.004	0.5	296,679.2
2024	-	-	-	7,667.4	88,174.6	-	2,376.9	2,376.9	1,118.899	0.5	297,798.1
2025	-	-	-	7,054.0	81,120.7	-	2,186.7	2,186.7	966.742	0.4	298,764.9
2026	-	-	-	6,489.7	74,631.0	-	2,011.8	2,011.8	835.277	0.4	299,600.1
2027	-	-	-	5,970.5	68,660.5	-	1,850.8	1,850.8	721.689	0.4	300,321.8
2028	-	-	-	5,492.8	63,167.7	-	1,702.8	1,702.8	623.548	0.4	300,945.4
2029	-	-	-	5,053.4	58,114.3	-	1,566.6	1,566.6	538.753	0.3	301,484.1
2030	-	-	-	4,649.1	53,465.1	-	1,441.2	1,441.2	465.489	0.3	301,949.6
2031	-	-	-	4,277.2	49,187.9	-	1,325.9	1,325.9	402.188	0.3	302,351.8
2032	-	-	-	3,935.0	45,252.9	-	1,219.9	1,219.9	347.496	0.3	302,699.3
2033	-	-	-	3,620.2	41,632.7	-	1,122.3	1,122.3	300.240	0.3	302,999.5
2034	-	-	-	3,330.6	38,302.0	-	1,032.5	1,032.5	259.411	0.3	303,259.0
2035	-	-	-	3,064.2	35,237.9	-	949.9	949.9	224.134	0.2	303,483.1
2036	-	-	-	2,819.0	32,418.8	-	873.9	873.9	193.655	0.2	303,676.7
2037	-	-	-	2,593.5	29,825.3	-	804.0	804.0	167.320	0.2	303,844.1
2038	-	-	-	2,386.0	27,439.3	-	739.7	739.7	144.567	0.2	303,988.6
2039	-	-	-	2,195.1	25,244.2	-	680.5	680.5	124.907	0.2	304,113.5
2040	-	-	-	2,019.5	23,224.6	-	626.1	626.1	107.921	0.2	304,221.5
2041	-	-	-	1,858.0	21,366.7	-	576.0	576.0	93.245	0.2	304,314.7
2042	-	-	-	1,709.3	19,657.3	-	529.9	529.9	80.565	0.2	304,395.3
2043	-	-	-	1,572.6	18,084.7	-	487.5	487.5	69.609	0.1	304,464.9
2044	-	-	-	1,446.8	16,638.0	-	448.5	448.5	60.143	0.1	304,525.0
2045	-	-	-	1,331.0	15,306.9	-	412.6	412.6	51.964	0.1	304,577.0
2046	-	-	-	1,224.6	14,082.4	-	379.6	379.6	44.898	0.1	304,621.9
2047	-	-	-	1,126.6	12,955.8	-	349.2	349.2	38.792	0.1	304,660.7
2048	-	-	-	1,036.5	11,919.3	-	321.3	321.3	33.517	0.1	304,694.2
2049	-	-	-	953.5	10,965.8	-	295.6	295.6	28.959	0.1	304,723.1
2050	-	-	-	877.3	10,088.5	-	272.0	272.0	25.021	0.1	304,748.2
2051	-	-	-	807.1	9,281.4	-	250.2	250.2	21.618	0.1	304,769.8
2052	-	-	-	742.5	8,538.9	-	230.2	230.2	18.679	0.1	304,788.5
Total	-	929,338.2	(219,520.0)	221,290.9	2,659,759.8	709,818.2	(219,494.7)	490,323.5	304,788.5		



Comparative Cumulative NPV
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(200,000)
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Year
Refurbish 2 CW Screens
Replace 2 CW Screens
Test 3
Test 4

Location: Lingan
CI# / FP#: 43169
Title: CW Screens Refurbishment
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	001 Regular Labour						
1.1	Engineering (P.Eng)	hr	[redacted]	[redacted]	$ 1,120.00		
1.2	Maintenance Trades	hr	[redacted]	[redacted]	$ 120,400.00		
1.3							
				Sub-Total	$ 121,520.00		41124
2	012 Materials						
2.1	Top boot screen components	each	2	[redacted]	[redacted]		
2.2	Screen Section Panels -stainless	each	2	[redacted]	[redacted]		
2.3	Bottom Boot screen components	each	2	[redacted]	[redacted]		
2.4							
2.5							
				Sub-Total	[redacted]		41124
3	013 Power Production Contracts						
3.1	Machining and Refurbishment	each	2	[redacted]	[redacted]		41124
3.2					$ -		
3.3					$ -		
				Sub-Total	[redacted]		
4	094 Interest Capitalized						
4.1	Interest Capitalized	lot	1	$ 8,117.27	$ 8,117.27		
4.2							
4.3							
				Sub-Total	$ 8,117.27		
5	095 Administrative Overhead						
5.1	Thermal Hydro Contracts	lot	1	[redacted]	[redacted]		
5.2	Thermal Regular Labour AO	lot	1	[redacted]	[redacted]		
5.3							
				Sub-Total	[redacted]		
Cost Estimate				**Total**	$ 262,003.19		
6	**Original Cost**						
6.1					$ 86,748.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43170

Title: **LIN4 Automatic Voltage Regulator (AVR) Replacement**

Start Date: 2013/02
Final Cost Date: 2015/02
Function: Generation
Forecast Amount: $874,245

DESCRIPTION:

The excitation system for a synchronous generator provides the DC field current to the generator rotor. The DC field current is derived from rectifying an AC supply. The excitation system includes the thyristor rectifier bridges, Automatic Voltage Regulator (AVR), field circuit breaker, monitoring and control. The AVR automatically controls the generator voltage via field current regulation and is integral to the excitation system.

The existing excitation system will be completely replaced with modern digital static excitation system equipment, excluding the existing exciter transformer.

This project includes the specification and replacement of existing AVR devices on Unit 4 at the Lingan Generating Station. The existing AVR devices are obsolete and are no longer supported by the Original Equipment Manufacturer (OEM). Similar replacements have been completed or are taking place on Lingan Unit 3 (CI 37611), Tufts Cove Unit 2 (CI 39923) and Unit 3 (CI 39926), and Point Tupper (CI 38108 included in 2013 ACE Plan).

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

The excitation system for Lingan Unit 4 generator is now obsolete. The OEM no longer supports this equipment and it is no longer possible to source spare parts, or to receive technical support service. A dependable excitation system is required for reliable operation of Unit 4.

Why do this project now?

The spare parts originally supplied with the system have now been depleted and replacement parts are no longer available. Replacing the excitation system will mitigate the risk of an unplanned outage and associated replacement energy costs.

Why do this project this way?

Replacement of the obsolete excitation system and AVR is the only option. The existing AVR equipment removed from Unit 4 will be salvaged where possible and used for spares to support repairs that may be required for the remaining life of Units 1 and 2.

CI Number : 43170 - LIN4 AVR Replacement

Project Number

Parent CI Number : -

Cost Centre : 305 - 305-Lingan 3&4 Prod.Unit

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		54,786	0	54,786
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
095		095-Thermal Regular Labour AO			0	
001	010	001 - THERMAL Regular Labour	010 - SGP - Turbo Gen.Instal.	170,920	0	170,920
002	010	002 - THERMAL Overtime Labour	010 - SGP - Turbo Gen.Instal.	0	0	0
004	010	004 - THERMAL Term Labour	010 - SGP - Turbo Gen.Instal.	0	0	0
011	010	011 - Travel Expense	010 - SGP - Turbo Gen.Instal.	34,980	0	34,980
012	010	012 - Materials	010 - SGP - Turbo Gen.Instal.	[redacted]	0	[redacted]
013	010	013 - POWER PRODUCTION Contracts	010 - SGP - Turbo Gen.Instal.		0	
028	010	028 - Consulting	010 - SGP - Turbo Gen.Instal.		0	
			Total Cost:	874,245	0	874,245
			Original Cost:	263,000		

LIN4 Replace AVR
Summary of Alternatives

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Lingan GS	**CI Number:**	43170
Originator :		**Project No. :**	

	Alternative	**After Tax WACC**	**PV of EVA / NPV**	**Rank**	**IRR**	**Disc Pay**
A	Replace AVR	6.48%	389,111	1	14.26%	9.1 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

Based on positiive economic analysis, it is recommended that the excitation system and AVR be replaced.

Notes/Comments :

Replace AVR

Test 2

Test 3

Test 4

LIN4 Replace AVR
Avoided Cost Calculations

Division :	Power Production	Date :	31-Oct-12
Department :	Lingan GS	CI Number:	43170
Originator :		Project No. :	

Replace AVR

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	[redacted]		2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$823,650	$840,123		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	[redacted]		5%	6%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	154	154				
Duration (Hours)	2016	2016				
Totals	$20,328	$20,163	$41,183	$50,407	$61,510	$70,570
Total Capital Cost of Alternative						$874,245

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	[redacted]		2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	[redacted]		0%	0%		
Capacity Factor (%)						
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

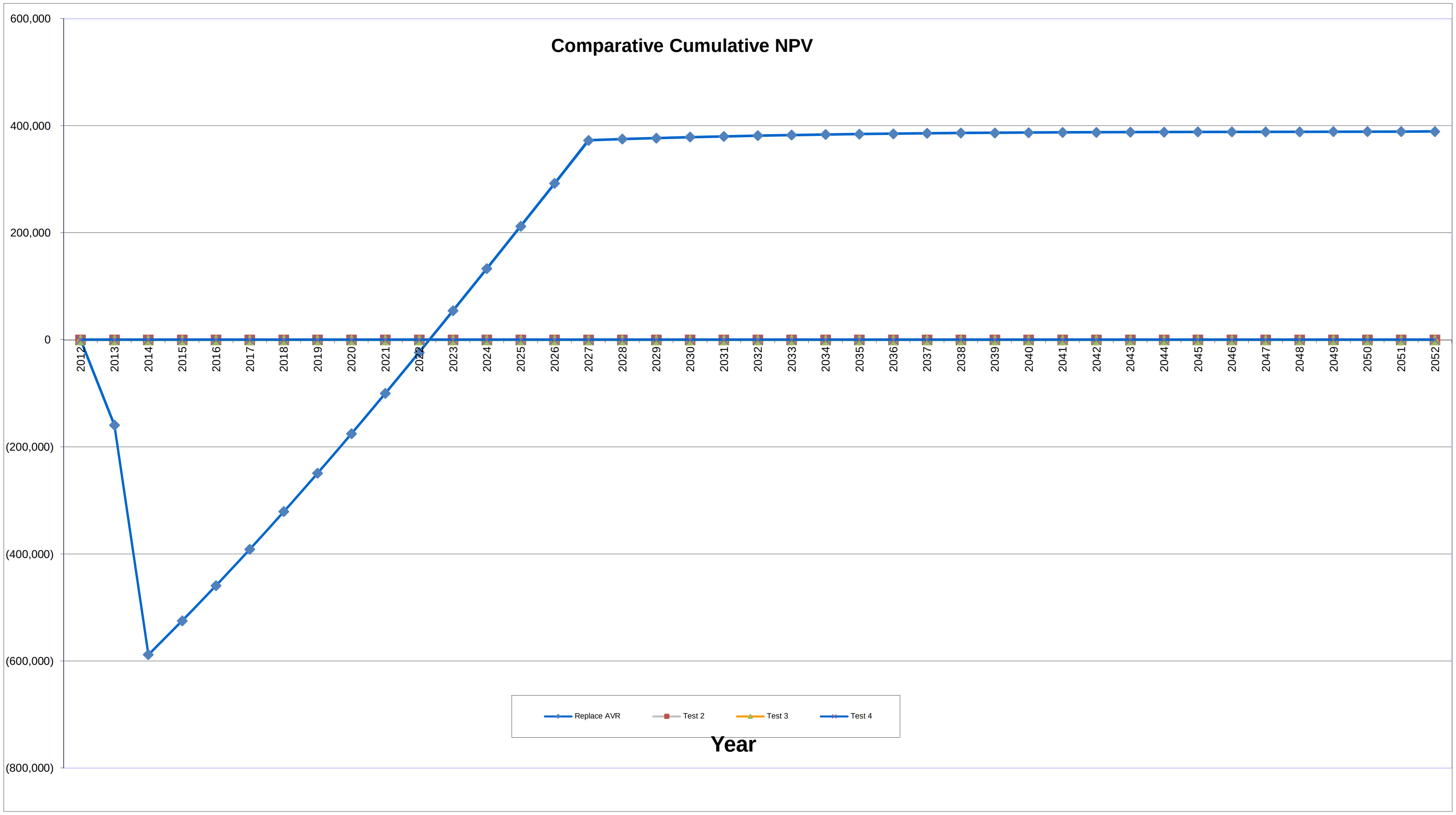
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	[redacted]		2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	[redacted]		0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	2013	2014	2013	2014	2013	2014
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

LIN4 Replace AVR
Replace AVR

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	61,510.1	(212,000.0)	-	-	(150,489.9)	(19,068.1)	(169,558.0)	(159,239.303)	0.9	(159,239.3)
2014	-	70,570.2	(544,569.0)	31,017.4	744,418.5	(473,998.8)	(12,261.3)	(486,260.2)	(428,876.874)	0.9	(588,116.2)
2015	-	83,978.5	-	59,553.5	684,865.0	83,978.5	(7,571.8)	76,406.7	63,288.893	0.8	(524,827.3)
2016	-	97,894.9	-	54,789.2	630,075.8	97,894.9	(13,362.8)	84,532.1	65,758.171	0.8	(459,069.1)
2017	-	112,334.4	-	50,406.1	579,669.8	112,334.4	(19,197.8)	93,136.6	68,042.506	0.7	(391,026.6)
2018	-	127,312.3	-	46,373.6	533,296.2	127,312.3	(25,091.0)	102,221.3	70,134.749	0.7	(320,891.9)
2019	-	142,844.4	-	42,663.7	490,632.5	142,844.4	(31,056.0)	111,788.4	72,031.174	0.6	(248,860.7)
2020	-	158,946.9	-	39,250.6	451,381.9	158,946.9	(37,105.9)	121,841.1	73,730.861	0.6	(175,129.8)
2021	-	175,636.3	-	36,110.6	415,271.3	175,636.3	(43,253.0)	132,383.3	75,235.179	0.6	(99,894.6)
2022	-	192,929.8	-	33,221.7	382,049.6	192,929.8	(49,509.5)	143,420.3	76,547.338	0.5	(23,347.3)
2023	-	210,844.7	-	30,564.0	351,485.7	210,844.7	(55,887.0)	154,957.7	77,672.012	0.5	54,324.7
2024	-	229,399.0	-	28,118.9	323,366.8	229,399.0	(62,396.8)	167,002.2	78,615.025	0.5	132,939.7
2025	-	248,611.2	-	25,869.3	297,497.5	248,611.2	(69,050.0)	179,561.2	79,383.080	0.4	212,322.8
2026	-	268,500.1	-	23,799.8	273,697.7	268,500.1	(75,857.1)	192,643.0	79,983.533	0.4	292,306.3
2027	-	289,085.1	-	21,895.8	251,801.8	289,085.1	(82,828.7)	206,256.4	80,424.206	0.4	372,730.6
2028	-	-	-	20,144.1	231,657.7	-	6,244.7	6,244.7	2,286.767	0.4	375,017.3
2029	-	-	-	18,532.6	213,125.1	-	5,745.1	5,745.1	1,975.794	0.3	376,993.1
2030	-	-	-	17,050.0	196,075.1	-	5,285.5	5,285.5	1,707.110	0.3	378,700.2
2031	-	-	-	15,686.0	180,389.1	-	4,862.7	4,862.7	1,474.963	0.3	380,175.2
2032	-	-	-	14,431.1	165,957.9	-	4,473.6	4,473.6	1,274.386	0.3	381,449.6
2033	-	-	-	13,276.6	152,681.3	-	4,115.8	4,115.8	1,101.085	0.3	382,550.7
2034	-	-	-	12,214.5	140,466.8	-	3,786.5	3,786.5	951.351	0.3	383,502.0
2035	-	-	-	11,237.3	129,229.5	-	3,483.6	3,483.6	821.978	0.2	384,324.0
2036	-	-	-	10,338.4	118,891.1	-	3,204.9	3,204.9	710.199	0.2	385,034.2
2037	-	-	-	9,511.3	109,379.8	-	2,948.5	2,948.5	613.621	0.2	385,647.8
2038	-	-	-	8,750.4	100,629.4	-	2,712.6	2,712.6	530.176	0.2	386,178.0
2039	-	-	-	8,050.4	92,579.1	-	2,495.6	2,495.6	458.078	0.2	386,636.1
2040	-	-	-	7,406.3	85,172.7	-	2,296.0	2,296.0	395.785	0.2	387,031.8
2041	-	-	-	6,813.8	78,358.9	-	2,112.3	2,112.3	341.963	0.2	387,373.8
2042	-	-	-	6,268.7	72,090.2	-	1,943.3	1,943.3	295.460	0.2	387,669.3
2043	-	-	-	5,767.2	66,323.0	-	1,787.8	1,787.8	255.281	0.1	387,924.5
2044	-	-	-	5,305.8	61,017.2	-	1,644.8	1,644.8	220.566	0.1	388,145.1
2045	-	-	-	4,881.4	56,135.8	-	1,513.2	1,513.2	190.572	0.1	388,335.7
2046	-	-	-	4,490.9	51,644.9	-	1,392.2	1,392.2	164.656	0.1	388,500.3
2047	-	-	-	4,131.6	47,513.3	-	1,280.8	1,280.8	142.265	0.1	388,642.6
2048	-	-	-	3,801.1	43,712.3	-	1,178.3	1,178.3	122.919	0.1	388,765.5
2049	-	-	-	3,497.0	40,215.3	-	1,084.1	1,084.1	106.203	0.1	388,871.7
2050	-	-	-	3,217.2	36,998.1	-	997.3	997.3	91.761	0.1	388,963.5
2051	-	-	-	2,959.8	34,038.2	-	917.6	917.6	79.282	0.1	389,042.8
2052	-	-	-	2,723.1	31,315.2	-	844.1	844.1	68.501	0.1	389,111.3
Total	-	2,470,397.8	(756,569.0)	744,120.8	8,945,106.9	1,713,828.8	(535,145.9)	1,178,683.0	389,111.3		


Comparative Cumulative NPV
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200,000
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(400,000)
(600,000)
(800,000)
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Replace AVR
Test 2
Test 3
Test 4
Year

Location: Lingan
CI# / FP#: 43170
Title: LIN4 AVR Replacement
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Engineering (P.Eng)	hr	[redacted]		$ 36,400.00		
1.2	Maintenance Trades	hr			$ 126,420.00		
1.3	Utility & Unskilled	hr			$ 8,100.00		
1.4		hr		$ -	$ -		
				Sub-Total	$ 170,920.00		37611
2	**012 Materials**						
2.1	Excitation / AVR System Replacement	lot	1	[redacted]		Cost Support 1 p.4. Exchange assumed to be 1.0.	37611
2.2	Assembly for remote IDP 1200	lot	1				
2.3	Tools and Rigging - Misc	lot	1				
2.4	Cable Tray - new wire runs	lot	1				
2.5	DC Cables	lot	1				
2.6	Control , AC Cable and misc matl	lot	1				
2.7	AVR Commissioning Spares	lot	1				
2.8	86 Lock out for Excite, Xfmr	lot	1				
2.9	86 Lock out for Excite system	lot	1				
2.10	Shipping	lot	1				
2.11	CSA Certification	lot	1			Cost Support 1 p.11. Exchange assumed to be 1.0.	
2.12					$ -		
				Sub-Total	[redacted]		
3	**013 Power Production Contracts**						
3.1	AVR TA Supervision / commission 5 days plus travel plus 5 days cont.	each	2	[redacted]		Cost Support 1 p.17. Exchange assumed to be 1.0.	
3.2	OEM TA for interface commissionning / debug	lot	1				
3.3	Concrete work cut new and fill old - deck recovery	lot	1				
3.4	Additional costs for design phase changes	lot	1				
3.5	Training 3 - 5 people OEM site - 5 days	lot	1			OEM service rates	
3.6							
				Sub-Total	[redacted]		
4	**028 Consulting**						
4.1	Electrical install detail design	hr	120	[redacted]			
4.2	Drawing Control	hr	60				
4.3	Concrete Deck civil review and design for remove / replace	hr	40				
				Sub-Total	[redacted]		
5	**011 Travel Expenses**						
5.1	Travel and Living , Meals FAT and Progress review	lot	1	$ 8,430.00	$ 8,430.00		
5.2	Travel and Living , Meals Factory Training	lot	1	[redacted]			
5.3	Travel and Living , Meals Progress Review - contingency	lot	1				
				Sub-Total	$ 34,980.00		
6	**094 Interest Capitalized**						
6.1	Interest Capitalized		1	$ 54,786.10	$ 54,786.10		
6.2					$ -		
				Sub-Total	$ 54,786.10		
7	**095 Administrative Overhead**						
7.1	Thermal Hydro Contracts		1	[redacted]			
7,2	Thermal Regular Labour AO		1				
7.3					$ -		
				Sub-Total	$ 62,889.78		
Cost Estimate				**Total**	$ 874,244.88		
8	**Original Cost**						
8.1					$ 263,000.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 & 2

Removed due to confidentiality

TOSHIBA

技術連絡書

発行番号 ECS－R7－AVR－10048

宛先

（火Ｐ統）［火技Ｅ］（火ＥＳ） 御中

☐ 承認用 ☑ 検討用 ☐ 確認用	☐ 参考用 ☐ 指示用	回答希望日 ☑ 回答不要
システム Excitation System	機器名 ＡＶＲ	Ｏ／＃・Ｑ／＃ ―

題 目

Notification of Change of AVR Type (Analog AVR → Digital AVR)

アナログＡＶＲの廃型通知を以下に連絡します。
宜しく御査収ください。

― 記 ―

1. General
2. Replacement Item
3. Part deterioration

以上

配付先	部数					発行	
（火ＥＳ）	1	(府)（発 SC)	1			発電ｼｽﾃﾑ制御部 発電調整制御 設計担当 (発 SC) TEL：042－333－2640 FAX：042－340－8029	承 認 中井 柴田 10・3・29 調 査 大林 10. 3. 26 担 当 Deni 2010 /3 / 26

株式会社**東芝** 府中事業所

Excitation Control System

(Analog System→ Digital System)

1. GENERAL

1.1. Function

This ECS is written in relation to obsolescence of Analog AVR.

1.2. Summary

Analog AVR became obsolete due to production discontinuance of some parts and components. Because of this we would like you to consider changing your system to the new Digital AVR.

1.3. Condition

The excitation control device of our company consisted of the analog circuit which uses IC and the magnetic amplifier. In recent years, high performance and high density new element such as the integrated circuit semiconductor memory had been developed through the rapid progress of technological innovation and semiconductor technology. Because of this, movement from the analog product to the digital product is widely being expanded. The op-Amp and transistor which are the main component of analog AVR are nowadays no longer being produced and for some cases the substitutes for these parts are not available.

With the above circumstances, we would like you to consider changing your system to the new system in line (Digital AVR).

2. REPLACEMENT ITEM

2.1. Analog AVR type

Production Discontinuance Time

I Type AVR		
Q Type AVR		
R Type AVR	}	Already obsolete
P Type AVR		
S Type AVR		

2.2. Reason for Replacement

Production discontinuance

When problem arise in the future, there is possibility that repairmen can not be done perfectly because of some parts are no longer available and this may affect to the plant operation.

3. Part deterioration

The main causes of part deterioration are temperature, humidity, dust, chemical reaction, vibration, impact, over load and surge current. Actual degradation phenomenon due these factors will influence installation condition and in several years, it will be quite hard to predict these parts deteriorations.

For AVR, calculate the level of component lifetime from next data and then use table below to decide the deterioration life of the component

- Accelerated life test data of various electronic equipment applications.
- Test data of the remain equipment at the time of renewal
- Life time estimation through the data acquired when the fault occurred at the existing plant.
- Arrhenius chemical reaction kinetic
- Average life time of cable insulation degradation data

Deterioration and life time of main components and parts of AVR are shown on the next page

Component/Parts		Lifetime (years)	Deterioration factors
Semiconductor	IC	15	Degradation by environmental condition （temperature, gas etc）. Static electricity and heat stress.
	Silicon Transistor and Diode		
	Germanium Transistor and Diode	12～15	
Capacitor	Aluminum electrolytic	7～10	Deterioration due to temperature rise. Insulation degradation due to heat stress.
	Tantalum	15	
	Plastic		
	Mica		
	Ceramic		
Resistor	Coil	10～15	Corrosion due to environmental condition (temperature, gas etc). Contact failure due to time-dependent decrease of sliding spring pressure.
	Metal Coat	15	
	Carbon	15	
Relay	Contactor	10～15	Electric wear, damage and mechanical wear. Accumulation of dust in the contact resistance which causes adhesion of impurities. Thermal stress.
	Magnetic part		
	Switch limit		
	Mercury Relay		
Wiring Material	Connector	20～30	Corrosion due to environmental condition (temperature, gas etc). Decrease of contact pressure.
	Terminal Block		
	Wire insulation		
Coil	Magnetic Amplifier	20～30	Thermal deterioration
	PT・CT, Aux-TR		
	IVR・IM		

TOSHIBA ECS－R7－AVR－10048

REVISIONS

Rev. 番号	区 分	見直し 日 付	内 容 変更箇所・変更内容	承 認	調 査	担 当	全ﾍﾟｰｼﾞ 枚数 *注意 1
0	E	10-3-26	新規発行			Deni	5

区分; D:廃止 E:制定 R:改正 C:確認 *注意 1:付図・付表及び本用を含む全ﾍﾟｰｼﾞ枚数
備考 1) 内容追加または変更の場合は、その理由と内容を簡潔に記録し、Rev.番号を加算する。
2) 内容追加または変更を伴わない定期見直しの場合は、Rev.番号を加算せずに[確認]の記事を残す。

TOSHIBA INTERNATIONAL CORPORATION
POWER SYSTEMS DIVISION
101 MONTGOMERY STREET, 23RD FLOOR,
SAN FRANCISCO, CA 94104
PHONE: (415) 403-5000
FACSIMILE: (415) 403-5622

ECS-GEI-XXX-0180

ENGINEERING COMMUNICATION SHEET (ECS)

APPLICABILITY:

Applicable Static Excitation Plants

☐ FOR REVIEW ☐ FOR CONFIRMATION ■ FOR INFORMATION ☐ FOR NOTICE	☐ REQUEST ☐ REPLY	REPLY DEAD LINE ______________ ■ NO REPLY REQUIRED
PROJECT ----------------	EQ/SYS. Thyristor Rectifier System	JOB/QUOTE NO. ______________

SUBJECT:

Obsolescence of Thyristor Rectifier System

⚠ WARNING

The information contained in this letter is for your evaluation.

The operation of your plant is your responsibility. Read your owner's manual carefully.

The operation of your plant is in your control. Toshiba International Corporation is not involved in the operation of your plant. The information contained in this letter is for your evaluation.

TOSHIBA INTERNATIONAL CORPORATION DISCLAIMS ANY LIABILITY FOR CLAIMS FOR DAMAGES OF ANY TYPE. THIS MEANS THAT TOSHIBA INTERNATIONAL CORPORATION WILL NOT BE LIABLE FOR ANY DAMAGES ALLEGEDLY ARISING OUT OF THIS LETTER. TOSHIBA INTERNATIONAL CORPORATION WILL NOT BE LIABLE

FOR DAMAGES UNDER ANY LEGAL THEORY INCLUDING BREACH OF WARRANTY, BREACH OF CONTRACT, NEGLIGENCE, GROSS NEGLIGENCE OR PRODUCT LIABILITY. TOSHIBA INTERNATIONAL CORPORATION WILL NOT BE LIABLE UNDER ANY CIRCUMSTANCES FOR CONSEQUENTIAL DAMAGES OR INCIDENTAL DAMAGES OF ANY KIND.

Nothing in this letter alters the terms or conditions of any written agreement with TOSHIBA INTERNATIONAL CORPORATION. Nothing in this letter alters the terms or conditions of any warranties provided by TOSHIBA INTERNATIONAL CORPORATION. Please refer to your written warranty.

This Engineering Communication Sheet (ECS) recommends the following specific measures for improvement in equipment operability and reliability.

We would greatly appreciate your contacting us through our Key Account Manager as early as possible to discuss your decision over this ECS.

1. General

1.1 Function

This ECS is written in relation to obsolescence of Thyristor rectifier system (THY) using TOSHIBA power rectifiers, which is an integral part of the equipment in the static excitation system.

1.2 Summary

TOSHIBA has already ceased production of the power rectifiers used for the excitation system. In order to avoid serious damage and/or steam turbine generator downtime, we recommend replacement with the new rectifier system as soon as reasonably possible. Please consult with your Key Account Manager.

1.3 Condition

Several types of the power semiconductors such as thyristors and/or diodes manufactured by TOSHIBA have been already expired due to various conditions and TOSHIBA is unable to provide the spare parts. The THY is composed of series/parallel thyristors/diodes and the replacement of just some elements may cause an unequal current distribution and consequently may require a long time for adjustment and/or a large scale modification which may reduce both quality and reliability.

2. TOSHIBA Recommendation

2.1 Recommendation

TOSHIBA recommends the whole cubicle replacement which includes all new parts mounted in the cubicle and integrated with internal cables. The complete THY is tested and qualified in the factory to maintain high quality and reduce the site work and associated costs.

TOSHIBA
Leading Innovation >>>

TOSHIBA INTERNATIONAL CORPORATION
POWER SYSTEMS DIVISION
101 MONTGOMERY STREET, 23RD FLOOR,
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PHONE: (415) 403-5000
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ECS-GEI-XXX-0181

ENGINEERING COMMUNICATION SHEET (ECS)

APPLICABILITY:

Applicable Static Excitation Plants

□ FOR REVIEW □ FOR CONFIRMATION ■ FOR INFORMATION □ FOR NOTICE	□ REQUEST □ REPLY	REPLY DEAD LINE ______ ■ NO REPLY REQUIRED
PROJECT ----------------	EQ/SYS. Field Circuit Breaker	JOB/QUOTE NO. ______

SUBJECT:

Recommendation of replacement for Field Circuit Breaker

⚠ WARNING

The information contained in this letter is for your evaluation.

The operation of your plant is your responsibility. Read your owner's manual carefully.

The operation of your plant is in your control. Toshiba International Corporation is not involved in the operation of your plant. The information contained in this letter is for your evaluation.

TOSHIBA INTERNATIONAL CORPORATION DISCLAIMS ANY LIABILITY FOR CLAIMS FOR DAMAGES OF ANY TYPE. THIS MEANS THAT TOSHIBA INTERNATIONAL CORPORATION WILL NOT BE LIABLE FOR ANY DAMAGES ALLEGEDLY ARISING OUT OF THIS LETTER. TOSHIBA INTERNATIONAL CORPORATION WILL NOT BE LIABLE

Issued by:		Release Date:	Approved By/Date	ECS No.
Toshiba International Corporation Power Systems Division		8/12/2010	T. Kordick 6/20/10	ECS-GEI-XXX-0181
Prepared by: E. Williams	Reviewed by: T. Osako			Page 1 of 5

FOR DAMAGES UNDER ANY LEGAL THEORY INCLUDING BREACH OF WARRANTY, BREACH OF CONTRACT, NEGLIGENCE, GROSS NEGLIGENCE OR PRODUCT LIABILITY. TOSHIBA INTERNATIONAL CORPORATION WILL NOT BE LIABLE UNDER ANY CIRCUMSTANCES FOR CONSEQUENTIAL DAMAGES OR INCIDENTAL DAMAGES OF ANY KIND.

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This Engineering Communication Sheet (ECS) recommends the following specific measures for improvement in equipment operability and reliability.

We would greatly appreciate your contacting us through our Key Account Manager as early as possible to discuss your decision over this ECS.

1. General

1.1 Function

This ECS is written in relation to recommendation of replacement of the Field Circuit Breaker (FCB), which is an integral part of the static excitation system.

1.2 Summary

TOSHIBA has delivered FCBs for many years and has some experience of malfunction with the FCB that have been in service for extended periods of time.

In order to avoid serious damage, we recommend replacement with the new FCB equipment within 12 years from the original delivery date. TOSHIBA can provide an overhaul of the dismounted FCB if customers desire to stock a spare FCB. Replacement should take place as soon as reasonably possible. Please consult with your Key Account Manager for complete details.

1.3 Condition

The FCB is one of the most important components which supplies current to the field; however there is no redundancy. Failure of the FCB would cause the steam turbine generator to trip offline and may also cause serious damage with other components.

Materials such as springs, bearings, grease and rubber used in the FCB will deteriorate with age and the lifetime of these materials is considered to be 8 - 12 years; depending upon environmental exposure and use.

Considering all of factors, TOSHIBA has recommended the periodic inspection and/or overhaul to extend the useful lifetime of the FCB. TOSHIBA recommends the FCB overhaul be implemented at the manufacturer's factory which takes approximately 4 months including transportation time; therefore a spare FCB may be necessary for continuous operation while the FCB is overhauled.

In addition, asbestos was utilized in some parts of FCBs prior to 1993. Toshiba ceased the use of asbestos in FCBs after 1992; therefore FCBs delivered after 1993 do not contain any asbestos.

The FCB parts prior to 1993 which contain asbestos are described below:

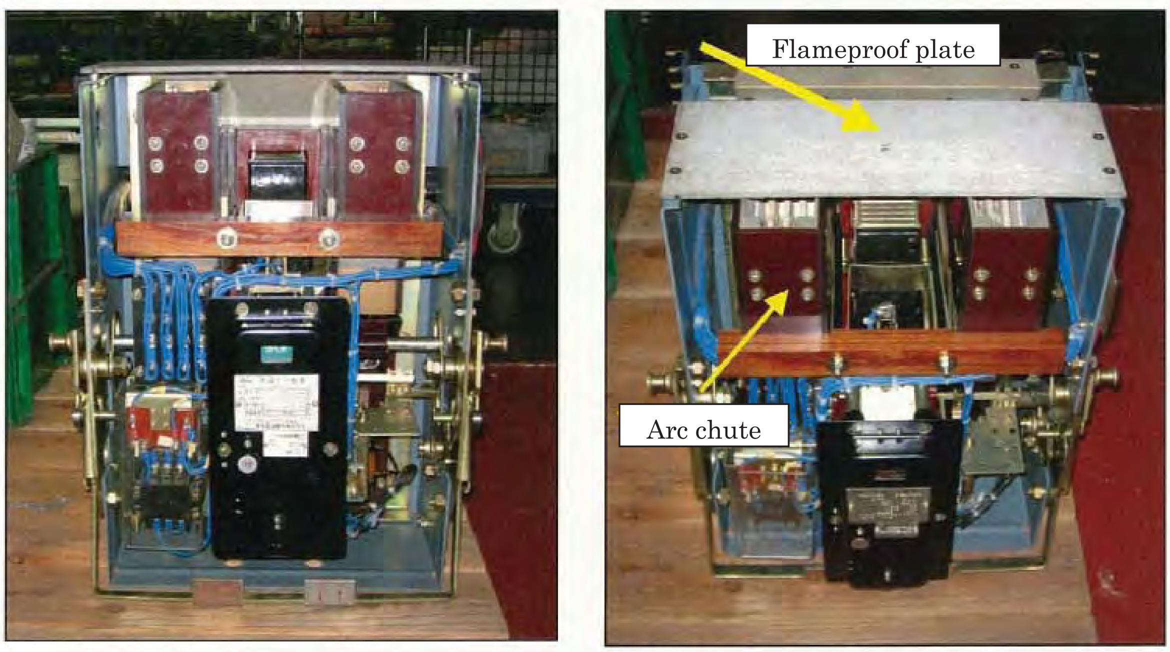
(1) Arc chute

Arc chute is used for weakening arc when arc occurs at open/close action of the FCB. Zirconium silicate and Chrysotile asbestos are solidified and formed into plate shape with Orthophosphoric acid All type FCBs use this Arc chute.

(2) Flameproof plate

Flameproof plate is used for preventing flame from reaching outside. Chrysotile asbestos is solidified and formed into plate form with Portland cement.
Only BFB-R6S and BFB-R6SD type use this flameproof plate.

Fig. 1 indicates the location of the parts written above in the FCB.



* This picture shows the typical model. The actual equipment can vary from this.

Fig. 1 The location of Asbestos parts

As written above, asbestos is solidified and formed with a curing agent so the removal work of these parts is quite simple and should pose no drift hazard during the normal removal process. Please follow all applicable state and federal regulations concerning the proper handling and disposal of asbestos containing materials.

2. TOSHIBA Recommendation

2.1 Recommendation

TOSHIBA recommends that FCB should be replaced within 12 years from the original delivery date. If the customer does not store any spare equipment, TOSHIBA recommends purchasing new FCB equipment.

TOSHIBA also recommends the replacement to the asbestos-free FCB for the customer who uses the FCB with asbestos.

Concerning the dismounted FCB, TOSHIBA can provide some options for overhaul if the customer is interested in keeping the stocked equipment. Please consult with your Key Account Manager for complete details.

CI Number: 43154

Title: **CT – TUC4 and TUC5 Critical Spares**

Start Date: 2013/03
Final Cost Date: 2013/12
Function: Generation
Forecast Amount: $593,963

DESCRIPTION:

This project is to provide adequate critical engine, generator, auxiliary and insurance spare parts and equipment for Tufts Cove Units 4 and 5 (the LM6000 units).

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015

JUSTIFICATION:

Justification Criteria: Thermal
Sub Criteria: **R**equirement to Serve

Why do this project?

The LM6000 units do not have many areas of redundancy, and most of the components are essential for operation. Spare parts are critical to reduce lengthy outages caused by long lead times on some parts. Shipping costs can also be extremely high as Aircraft On Ground (AOG) rates are often incurred to ensure delivery within 24 hours to meet system generation and reserve requirements.

The Original Equipment Manufacturer (OEM) has provided a list of recommended spares. NS Power Combustion Turbine personnel, together with the Asset Management Office (AMO), have reviewed this list, taking into consideration the likelihood of failure (health of component), the criticality of the component (resultant loss of generation on component failure) and the ability to detect a problem with the component prior to failure. This review resulted in a Risk Priority Number (RPN). Components with an RPN of 75 or greater were identified as being recommended capital spares.

Why do this project now?

Reliance on these units for economic dispatch is increasing. Loss of one of these units results in both the lost generation from the unit itself, as well as partial lost generation from Tufts Cove Unit 6. Trends of forced outages show older components are failing at increased rates. Having spares on the shelf will reduce the frequency of outages and shorten the return to service time significantly.

Why do this project this way?

Selective proactive purchase of critical spares is the most economic approach. Having spares on-hand will minimize the length of forced outages, and eliminate costly expediting fees that may be incurred to return the unit to service promptly.

CI Number : 43154 - CT - TUC4 and TUC5 Critical Spares **Project Number**

Parent CI Number : -

Cost Centre : 394 - 394-LM 6000 TC #4 **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
012		012 - Materials		593,963	0	593,963
			Total Cost:	593,963	0	593,963
			Original Cost:			

CT - TUC4 and TUC5 Critical Spares
Summary of Alternatives

Nova Scotia POWER An Emera Company

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Combustion Turbines - LM6000, TUC4 &	**CI Number:**	43154
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Procure Critical Spares	6.48%	2,251,642	1	295.70%	1.3 years
B	Test 2	6.48%	0	2	#NUM!	0.0 years
C	Test 3	6.48%	0	2	#NUM!	0.0 years
D	Test 4	6.48%	0	2	#NUM!	0.0 years

Recommendation :

Procure critical spares based on positive economic analysis and short discount payback period.

Notes/Comments :

Procure Critical Spares

Items with a failure liklihood/health number of 5 were assumed to have a 4% chance of failure each year. Items with a failure liklihood/health number of 4 were assumed to have a 3% chance of failure, and items with a 3 were assumed to have a 2%. These probabilities are felt to be conservative. Due to the number of items evaluated, this calculation has taken place outside the EAM and the probabilities are built into the avoided downtime hours (Duration). 100% chance of failure is shown on the calculation sheet of the EAM.
The outage time per year, per item, was determined by multiplying the probability of failure of the item by the quoted lead time. The outage time entered in the EAM is the sum of the calculated outage time per item for all items proposed for purchase.

Test 2

Test 3

Test 4

CT - TUC4 and TUC5 Critical Spares
Avoided Cost Calculations

Division :	Power Production	**Date :**	**31-Oct-12**
Department :	Combustion Turbines - LM6000, TUC4 & TUC5	**CI Number:**	43154
Originator :		**Project No. :**	

Procure Critical Spares

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	100%	100%	100%	100%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	75	75				
Duration (Hours)	995	995				
Totals	$676,639	$489,756	$0	$0	$676,639	$489,756
Total Capital Cost of Alternative						$593,963

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

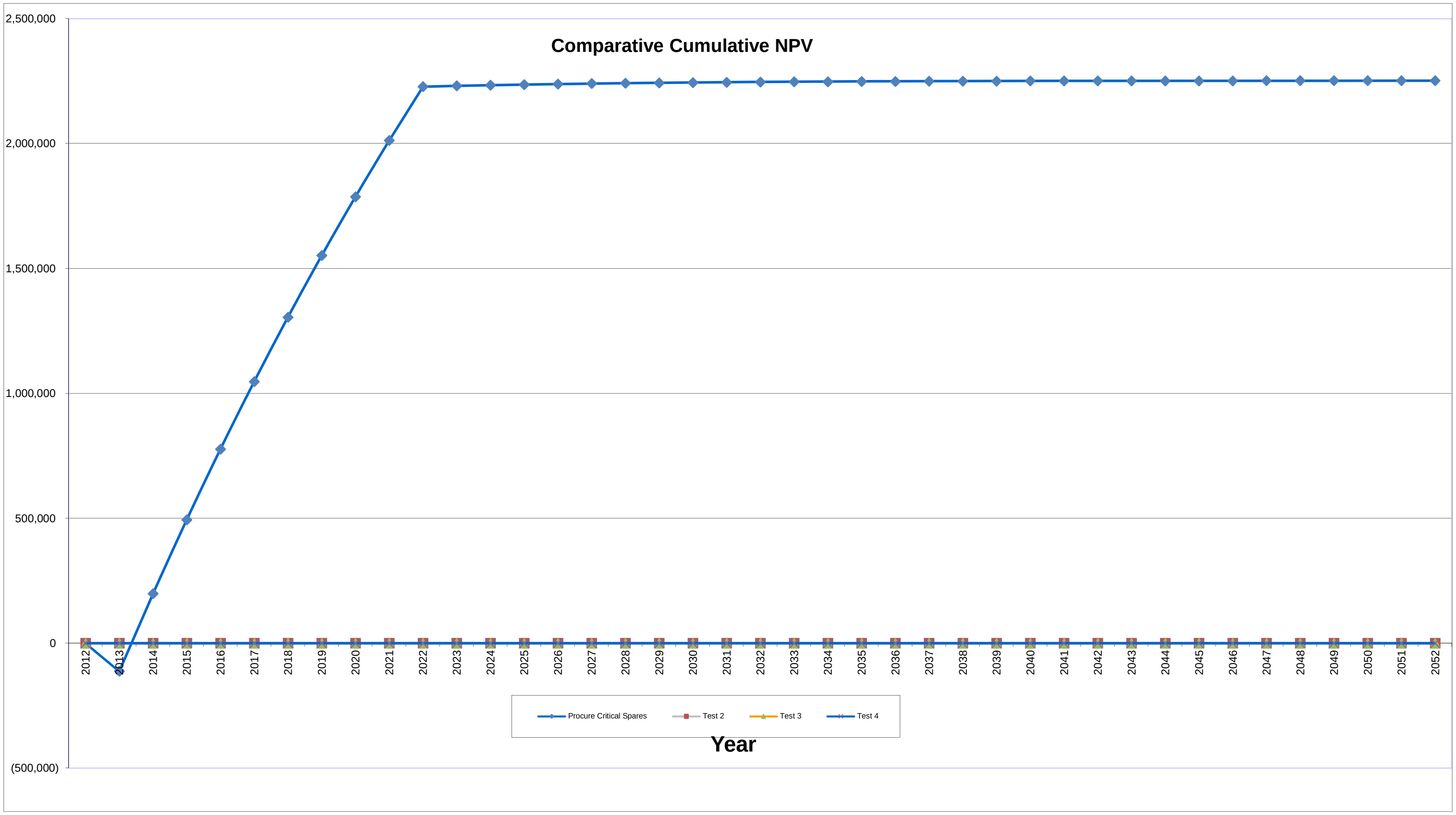
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			$0	$0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

CT - TUC4 and TUC5 Critical Spares
Procure Critical Spares

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2012	-	-	-	-	-	-	-	-	-	1.0	-
2013	-	676,639.0	(593,963.3)	23,758.5	570,204.7	82,675.7	(202,392.9)	(119,717.2)	(112,431.668)	0.9	(112,431.7)
2014	-	489,756.2	-	45,616.4	524,588.4	489,756.2	(137,683.3)	352,072.8	310,524.891	0.9	198,093.2
2015	-	499,551.3	-	41,967.1	482,621.3	499,551.3	(141,851.1)	357,700.2	296,288.654	0.8	494,381.9
2016	-	509,542.3	-	38,609.7	444,011.6	509,542.3	(145,989.1)	363,553.2	282,810.674	0.8	777,192.6
2017	-	519,733.1	-	35,520.9	408,490.7	519,733.1	(150,105.8)	369,627.4	270,037.387	0.7	1,047,229.9
2018	-	530,127.8	-	32,679.3	375,811.4	530,127.8	(154,209.1)	375,918.8	257,920.429	0.7	1,305,150.4
2019	-	540,730.4	-	30,064.9	345,746.5	540,730.4	(158,306.3)	382,424.1	246,416.015	0.6	1,551,566.4
2020	-	551,545.0	-	27,659.7	318,086.8	551,545.0	(162,404.4)	389,140.5	235,484.401	0.6	1,787,050.8
2021	-	562,575.9	-	25,446.9	292,639.8	562,575.9	(166,510.0)	396,065.9	225,089.417	0.6	2,012,140.2
2022	-	573,827.4	-	23,411.2	269,228.6	573,827.4	(170,629.0)	403,198.4	215,198.055	0.5	2,227,338.3
2023	-	-	-	21,538.3	247,690.4	-	6,676.9	6,676.9	3,346.759	0.5	2,230,685.0
2024	-	-	-	19,815.2	227,875.1	-	6,142.7	6,142.7	2,891.640	0.5	2,233,576.7
2025	-	-	-	18,230.0	209,645.1	-	5,651.3	5,651.3	2,498.412	0.4	2,236,075.1
2026	-	-	-	16,771.6	192,873.5	-	5,199.2	5,199.2	2,158.658	0.4	2,238,233.7
2027	-	-	-	15,429.9	177,443.6	-	4,783.3	4,783.3	1,865.106	0.4	2,240,098.8
2028	-	-	-	14,195.5	163,248.1	-	4,400.6	4,400.6	1,611.474	0.4	2,241,710.3
2029	-	-	-	13,059.9	150,188.3	-	4,048.6	4,048.6	1,392.333	0.3	2,243,102.6
2030	-	-	-	12,015.1	138,173.2	-	3,724.7	3,724.7	1,202.993	0.3	2,244,305.6
2031	-	-	-	11,053.9	127,119.4	-	3,426.7	3,426.7	1,039.400	0.3	2,245,345.0
2032	-	-	-	10,169.5	116,949.8	-	3,152.6	3,152.6	898.054	0.3	2,246,243.1
2033	-	-	-	9,356.0	107,593.8	-	2,900.4	2,900.4	775.930	0.3	2,247,019.0
2034	-	-	-	8,607.5	98,986.3	-	2,668.3	2,668.3	670.413	0.3	2,247,689.4
2035	-	-	-	7,918.9	91,067.4	-	2,454.9	2,454.9	579.244	0.2	2,248,268.7
2036	-	-	-	7,285.4	83,782.0	-	2,258.5	2,258.5	500.474	0.2	2,248,769.1
2037	-	-	-	6,702.6	77,079.5	-	2,077.8	2,077.8	432.416	0.2	2,249,201.6
2038	-	-	-	6,166.4	70,913.1	-	1,911.6	1,911.6	373.612	0.2	2,249,575.2
2039	-	-	-	5,673.0	65,240.1	-	1,758.6	1,758.6	322.806	0.2	2,249,898.0
2040	-	-	-	5,219.2	60,020.9	-	1,618.0	1,618.0	278.908	0.2	2,250,176.9
2041	-	-	-	4,801.7	55,219.2	-	1,488.5	1,488.5	240.980	0.2	2,250,417.9
2042	-	-	-	4,417.5	50,801.6	-	1,369.4	1,369.4	208.209	0.2	2,250,626.1
2043	-	-	-	4,064.1	46,737.5	-	1,259.9	1,259.9	179.895	0.1	2,250,806.0
2044	-	-	-	3,739.0	42,998.5	-	1,159.1	1,159.1	155.432	0.1	2,250,961.4
2045	-	-	-	3,439.9	39,558.6	-	1,066.4	1,066.4	134.295	0.1	2,251,095.7
2046	-	-	-	3,164.7	36,393.9	-	981.1	981.1	116.032	0.1	2,251,211.7
2047	-	-	-	2,911.5	33,482.4	-	902.6	902.6	100.253	0.1	2,251,312.0
2048	-	-	-	2,678.6	30,803.8	-	830.4	830.4	86.620	0.1	2,251,398.6
2049	-	-	-	2,464.3	28,339.5	-	763.9	763.9	74.841	0.1	2,251,473.4
2050	-	-	-	2,267.2	26,072.4	-	702.8	702.8	64.663	0.1	2,251,538.1
2051	-	-	-	2,085.8	23,986.6	-	646.6	646.6	55.870	0.1	2,251,594.0
2052	-	-	-	1,918.9	22,067.6	-	594.9	594.9	48.272	0.1	2,251,642.3
Total	-	5,454,028.3	(593,963.3)	571,895.6	6,873,781.1	4,860,065.0	(1,513,461.1)	3,346,603.9	2,251,642.3		


Comparative Cumulative NPV
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2,000,000
1,500,000
1,000,000
500,000
0
(500,000)
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Procure Critical Spares
Test 2
Test 3
Test 4
Year

Location: Burnside Generating
CI# / FP#: 43154
Title: CT - TUC4 and TUC5 Critical Spares
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**012 Materials**						
1.1	Critical Spares	lot	1	[redacted]		Cost Support 1	
1.2	Contingency on Critcal Spares	%	[redacted]				
1.3							
1.4							
1.5							
				Sub-Total	$ 593,963.26		
Cost Estimate				**Total**	$ 593,963.26		
2	**Original Cost**						
2.1					N/A		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

#	PART NUMBER	DESCRIPTION	UNIT PRICE	QUANTITY	EXTENDED PRICE	LEAD TIME [days]	LEAD TIME [hours]	[A] FAILURE LIKELIHOOD / HEALTH 1 = good 5 = poor	[B] CRITICALITY / BUSINESS LOSS 1 = little 5 = great	[C] EARLY DETECTION (w SYSTEM 1) 1 = very early 5 = little to none	[A x B x C] RPN (Note 1)	% OF FAILURE / YEAR	AVOIDED DOWNTIME / YEAR [hours] (entered into EAM)
1	[redacted]	Replacement Element for TLO Air/Oil Separator	[redacted]	1	[redacted]	56	1344	2	3	5	30	N/A	N/A
2	[redacted]	Valve,Gas Shut Off	[redacted]	1	[redacted]	46	1104	5	5	5	125	4%	44.16
3	[redacted]	Valve,Gas	[redacted]	1	[redacted]	101	2424	5	5	5	125	4%	96.96
4	[redacted]	Overruning Clutch	[redacted]	1	[redacted]	49	1176	5	5	5	125	4%	47.04
5	[redacted]	Hydraulic Pump / SOV Actuated	[redacted]	1	[redacted]	86	2064	5	5	5	125	4%	82.56
6	[redacted]	Valve,Control-Generator/Pressure	[redacted]	1	[redacted]	45	1080	3	5	3	45	N/A	N/A
7	[redacted]	Detector,Optical Flame	[redacted]	1	[redacted]	31	744	5	5	4	100	4%	29.76
8	[redacted]	CPU,MK6,W/DUAL EGD	[redacted]	1	[redacted]	46	1104	5	5	5	125	4%	44.16
9	[redacted]	TERMINATION BD. RELAY	[redacted]	1	[redacted]	62	1488	3	5	5	75	2%	29.76
10	[redacted]	VME ANALOG I/O	[redacted]	1	[redacted]	77	1848	3	5	5	75	2%	36.96
11	[redacted]	CONTACTS IN, RELAYS OUT	[redacted]	1	[redacted]	56	1344	4	5	5	100	3%	40.32
12	[redacted]	MARK VI, VME RTD CARD	[redacted]	1	[redacted]	77	1848	3	5	5	75	2%	36.96
13	[redacted]	VME SERVO CARD, DRIVER	[redacted]	1	[redacted]	36	864	3	5	5	75	2%	17.28
14	[redacted]	MARK VI THERMOCOUPLE CARD	[redacted]	1	[redacted]	41	984	3	5	5	75	2%	19.68
15	[redacted]	VME TURBINE CARD, SPEED	[redacted]	1	[redacted]	76	1824	3	5	5	75	2%	36.48
16	[redacted]	POWER SUPPLY, MARK VI, 24V	[redacted]	1	[redacted]	76	1824	5	5	5	125	4%	72.96
17	[redacted]	CARD ASSEM. DSVO RAIL MTG.	[redacted]	1	[redacted]	50	1200	3	5	5	75	2%	24.00
18	[redacted]	CARD ASSEM. DTAI RAIL MTG.	[redacted]	1	[redacted]	36	864	3	5	5	75	2%	17.28
19	[redacted]	CARD ASSEM. DTCI RAIL MTG.	[redacted]	1	[redacted]	50	1200	3	5	5	75	2%	24.00
20	[redacted]	CARD ASSEM. DTRT RAIL MTG.	[redacted]	1	[redacted]	26	624	3	5	5	75	2%	12.48
21	[redacted]	CARD ASSEM. DTTC RAIL MTG.	[redacted]	1	[redacted]	36	864	3	5	5	75	2%	17.28
22	[redacted]	CARD ASSEM. DTUR RAIL MTG.	[redacted]	1	[redacted]	36	864	3	5	5	75	2%	17.28
23	[redacted]	VME COMMUNICATIONS ASSM.	[redacted]	1	[redacted]	44	1056	3	5	5	75	2%	21.12
24	[redacted]	HOT STANDBY - CPU MODULE	[redacted]	1	[redacted]	36	864	5	5	5	125	4%	34.56
25	[redacted]	THRUST SHOE SET - CW	[redacted]	1	[redacted]	58	1392	5	2	2	20	N/A	N/A
26	[redacted]	THRUST SHOE SET - CCW	[redacted]	1	[redacted]	58	1392	5	2	2	20	N/A	N/A
27	[redacted]	TE OUTBOARD OIL DEFL	[redacted]	1	[redacted]	125	3000	2	5	3	30	N/A	N/A
28	[redacted]	CE OUTBOARD OIL DEFL	[redacted]	1	[redacted]	105	2520	2	5	3	30	N/A	N/A
29	[redacted]	TERMINAL ASSY	[redacted]	1	[redacted]	58	1392	2	5	3	30	N/A	N/A
30	[redacted]	JOURNAL SHOE SET	[redacted]	1	[redacted]	58	1392	5	2	2	20	N/A	N/A
31	[redacted]	JOURNAL SHOE SET	[redacted]	1	[redacted]	58	1392	5	2	2	20	N/A	N/A
32	[redacted]	T48 THERMOCOUPLE	[redacted]	4	[redacted]	19	456	5	5	4	100	4%	18.24
33	[redacted]	PUMP, VG HYDRAULIC	[redacted]	1	[redacted]	19	456	3	5	4	60	N/A	N/A
34	[redacted]	ACCELEROMETER, CRF	[redacted]	1	[redacted]	19	456	4	5	5	100	3%	13.68
35	[redacted]	ACCELEROMETER, TRF	[redacted]	1	[redacted]	19	456	5	5	5	125	4%	18.24
36	[redacted]	T3 SENSOR	[redacted]	1	[redacted]	19	456	5	5	4	100	4%	18.24
37	[redacted]	VSV/ VIGV ACTUATOR	[redacted]	1	[redacted]	19	456	5	5	5	125	4%	18.24
38	[redacted]	VBV ACTUATOR	[redacted]	1	[redacted]	19	456	4	5	5	100	3%	13.68
39	[redacted]	VBV ACTUATOR	[redacted]	1	[redacted]	19	456	4	5	5	100	3%	13.68
40	[redacted]	PUMP, L&S	[redacted]	1	[redacted]	19	456	3	5	4	60	N/A	N/A
41	[redacted]	CHECK VALVE	[redacted]	1	[redacted]	19	456	5	5	5	125	4%	18.24
42	[redacted]	CHECK VALVE & TUBE	[redacted]	1	[redacted]	19	456	5	5	5	125	4%	18.24
43	[redacted]	PUMP, VG HYDRAULIC	[redacted]	1	[redacted]	19	456	3	5	4	60	N/A	N/A
44	[redacted]	HYDRAULIC CONTROL UNIT (For ESN 191-332)	[redacted]	1	[redacted]	19	456	4	5	5	100	3%	13.68
45	[redacted]	T2/P2 SENSOR (CIT)	[redacted]	1	[redacted]	19	456	4	5	4	80	3%	13.68
46	[redacted]	T25/P25 SENSOR	[redacted]	1	[redacted]	19	456	4	5	4	80	3%	13.68
47	[redacted]	NOZZLE, DUAL	[redacted]	6	[redacted]	19	456	3	5	4	60	N/A	N/A
48	[redacted]	NOZZLE, DUAL	[redacted]	1	[redacted]	19	456	3	5	4	60	N/A	N/A
49	[redacted]	NOZZLE, WATER	[redacted]	2	[redacted]	19	456	3	5	4	60	N/A	N/A
50	[redacted]	NOZZLE, INLET	[redacted]	2	[redacted]	19	456	3	3	5	45	N/A	N/A
51	[redacted]	NOZZLE, WATER	[redacted]	2	[redacted]	19	456	3	5	4	60	N/A	N/A

SUM OF RECOMMENDED PURCHASES: **$ 539,966.60**

SUM OF AVOIDED DOWNTIME PER YEAR: **994.56**

NOTE: Items recommended for purchase have a Risk Proprity Number (RPN) greater than or equal to 75.

CI Number: 43157

Title: **CT - Tusket Fuel Control & Automatic Voltage Regulator (AVR)**

Start Date: 2013/05
Final Cost Date: 2014/01
Function: Generation
Forecast Amount: $332,606

DESCRIPTION:

The scope of this project is to complete a fuel control unit and fuel flow modulating valve upgrade in conjunction with an automatic voltage regulator (AVR) upgrade for the Tusket gas turbine.

Summary of Related CIs +/- 2 years:
No other project 2011, 2012, 2013, 2014 or 2015

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

Due to its age, the Tusket gas turbine is an uncommon model of aeroderivative. Components for its fuel control unit are not common to the Burnside or Victoria Junction units. The AVR is also original equipment consisting of a combination of solid state electronics, servo motors, potentiometers and rheostats. Failure of either the fuel control unit or AVR will result in lengthy forced outages.

Why do this project now?

The fuel control units are difficult to calibrate, and personnel who are capable to perform the calibration are becoming more and more difficult to source. In addition, spares are very difficult to obtain and are very expensive. The existing AVR has contributed to issues with synchronizing the unit. Upgrading the fuel control unit and AVR in the near term will mitigate the risk of a lengthy forced outage due to their failure.

Why do this project this way?

Fuel control unit and AVR upgrades have been completed at both Burnside and Victoria Junction. These upgrades are programmable logic controller (PLC) and digital technology based units. These systems provide more precise control and increased reliability.

CI Number : 43157 - Tusket fuel control & AVR **Project Number**

Parent CI Number : -

Cost Centre : 391 - 391-Tusket C/T **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		5,250	0	5,250
095		095-Thermal Regular Labour AO		[redacted]	0	[redacted]
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
001	022	001 - THERMAL Regular Labour	022 - GTG - Elec Contr.Equip.	10,600	0	10,600
012	022	012 - Materials	022 - GTG - Elec Contr.Equip.	8,000	0	8,000
013	022	013 - POWER PRODUCTION Contracts	022 - GTG - Elec Contr.Equip.	[redacted]	0	[redacted]
			Total Cost:	332,606	0	332,606
			Original Cost:	65,538		

Location: Tusket Generating Station
CI# / FP#: 43157
Title: Tusket Fuel Control & AVR Upgrade
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	hr	[redacted]		$ 3,280.00		
1.2	Engineering (P.Eng)	hr			$ 2,240.00		
1.3	Gas Turbine Operator	hr			$ 1,640.00		
1.4	Maintenance Trades	hr			$ 3,440.00		
1.5							
				Sub-Total	$ 10,600.00		
2	**012 Materials**						
2.1	Wires and misc. Materials	lot	1	$ 8,000.00	$ 8,000.00		
2.2							
				Sub-Total	$ 8,000.00		
3	**013 Power Production Contracts**						
3.1	Fuel control upgrade	lot	1	[redacted]		Cost Support 1 (exchange rate risk included in line 3.3)	
3.2	AVR upgrade	lot	1			Cost Support 2 (exchange rate risk included in line 3.3)	
3.3	Contingency	%					
3.4							
				Sub-Total	[redacted]		
4	**094 Interest Capitalized**						
4.1	Interest Capitalized	lot	1	$ 5,250.40	$ 5,250.40		
4.2							
				Sub-Total	$ 5,250.40		
5	**095 Administrative Overhead**						
5.1	Contracts AO	lot	1	[redacted]			
5.2	Labour AO	lot	1				
5.3							
				Sub-Total	[redacted]		
Project Cost Estimate				**Total**	$ 332,605.98		
6	**Original Cost**						
6.1					$ 65,538.12		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 & 2

Removed due to confidentiality

Transmission

CI Number: 43205

Title: **L5510 Insulator Replacements**

Start Date: 2013/03
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $2,953,689

DESCRIPTION:

The project provides the costs associated with replacement of insulators on L5510 from Bridge Ave to Malay Falls. The insulators which are identified for this project have an industry known cement growth failure mechanism which leads to unplanned transmission and customer outages.

The expected project life for this project is 30-40 years.

Depreciation classes applicable to this project are as follows:

- Transmission Plant Station Equipment
- Transmission Plant Poles and Fixtures
- Transmission Plant Overhead Conductors and Devices

Summary of Related CIs +/- 2 years:
No projects in 2011, 2012, 2014 and 2015

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Maintenance

Why do this project?

Throughout NS Power’s system the type of insulator on these circuits has failed due to an industry known cement growth failure mechanism. As the cement in the insulators ages, cracks occur and water is able to penetrate the cracks. Through freezing and thawing cycles, pressure is placed upon the porcelain material in the insulator. Over time, the pressure caused by cement growth will crack the porcelain and result in failure of the insulator. The insulators on this transmission line have been identified to be this type through the transmission inspection program. The reliability of this line will be improved through avoiding unplanned customer and transmission outages by replacing the defective insulators.

Why do this project now?

Through the transmission inspection program, the insulators on this transmission line have been identified as being of a type that have a failure mechanism. Removal and replacement of these insulators will mitigate the risk of future failures.

Why do this project this way?

Replacing the existing defective insulators with a new improved type of insulators is the only option. The labour for this project will be source through NS Power’s existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements

CI Number : 43205 - L5510 Insulator Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		20,004	0	20,004
094		094 - Interest Capitalized		81,494	0	81,494
095		095-COPS Regular Labour AO		35,442	0	35,442
095		095-COPS Contracts AO		654,018	0	654,018
013	007	013 - COPS Contracts	007 - TP - Environmental	[redacted]	0	[redacted]
012	035	012 - Materials	035 - TP - Wood Poles	21,868	0	21,868
013	035	013 - COPS Contracts	035 - TP - Wood Poles	[redacted]	0	[redacted]
012	038	012 - Materials	038 - TP - Insulators	107,272	0	107,272
013	038	013 - COPS Contracts	038 - TP - Insulators	[redacted]	0	[redacted]
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	1,684	0	1,684
002	039	002 - T&D Overtime Labour	039 - TP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - TP - O/H Cond.	19	0	19
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	[redacted]	0	[redacted]
001	085	001 - Regular Labour (No AO)	085 Design	2,583	0	2,583
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	46,833	0	46,833
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	2,953,689	0	2,953,689
			Original Cost:	187,744		

Location: Transmission
CI# / FP#: 43205
Title: L5510 Insulator Replacements
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (No AO)	Lot	1	$ 2,583.18	$ 2,583.18		
1.2	T&D Labour (Line Switching)	Person Days	[redacted]		$ 1,684.45		
1.3	T&D Labour (Site Supervision)	Lot	1	$ 46,832.54	$ 46,832.54		
1.4					$ -		
				Sub-Total	$ 51,100.17		
2	**012 Materials**						
2.1					$ -		
2.2	Insulators, Poles, Conductor	Lot	1	$ 129,159.06	$ 129,159.06	Work Order Generated	
2.3					$ -		
2.4					$ -		
2.5					$ -		
				Sub-Total	$ 129,159.06		
3	**013 T&D Contracts**						
3.1	Line Work		[redacted]			Contract Rate 2013	
3.2	Bog Mats						
3.3	Pole Hauling						
				Sub-Total	$ 1,982,472.58		
4	**094 Interest Capitalized**						
4.1	Interest		1	$ 81,494.01	$ 81,494.01		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 81,494.01		
5	**095 Administrative Overhead**						
5.1	Contracts AO			$ 654,017.73	$ 654,017.73		
5.2	Labour AO			$ 35,441.67	$ 35,441.67		
5.3	Vehicle AO			$ 20,003.57	$ 20,003.57		
				Sub-Total	$ 709,462.97		
Cost Estimate				**Total**	$ 2,953,688.79		
6	**Original Cost**						
6.2					$ 187,744.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

[14] S.W.Lee and R.C.Menendez, "Side force in coil sheet magnetic levitation systems." ibid, Vol.63, No.5 1975 pp.768-776.

[15] L.Urankar, "Electrodynamics of finite width guideway Maglev systems in an integral equation formulation." Siemens Forsch, Vol.8, No.4 1979 pp.204-208.

[16] H.H.Woodson and J.R.Melcher, "Electromechanical Dynamics Part II: Fields, Forces and Motion." John Wiley 1968 pp.335-338.

APPENDIX A: DERIVATION OF BULLARD'S EQUATION

Magnetic Field System

$$\nabla \times \tilde{H} = \tilde{J} \qquad \text{(A-1)}$$

$$\nabla \cdot \tilde{B} = 0 \qquad \text{(A-2)}$$

$$\tilde{B} = \mu \tilde{H} \qquad \text{(A-3)}$$

$$\tilde{B} \quad t \qquad \text{(A-4)}$$

$$+ \tilde{\nu} \times \tilde{B}) \qquad \text{(A-5)}$$

eliminate $\tilde{E}$ in (A-4):

$$\times (\tilde{\nu} \times \tilde{B}) = -\frac{\partial \tilde{B}}{\partial t} \qquad \text{(A-6)}$$

he curl of (A-1) into (A-6) yields:

$$\tilde{B}) - \nabla \times (\tilde{\nu} \times \tilde{B}) = -\frac{\partial \tilde{B}}{\partial t} \qquad \text{(A-7)}$$

dentity:

$$= \nabla (\nabla \cdot \tilde{B}) - \nabla^2 \tilde{B} \qquad \text{(A-8)}$$

ENDIX B: FORMULAE

$$\begin{array}{c c} & \begin{array}{cc} N & N \end{array} \\ \begin{array}{c} N \\ N \end{array} & \left[\begin{array}{c|c} [D\ B_m(y+t/2)] & [0] \\ \hline [0] & [D\ B_m(y+t/2)] \end{array}\right] \end{array} \qquad \text{(B-1)}$$

2)] is a diagonal NxN matrix whose

$$\underline{\Delta} \quad \beta_{mn} \quad e^{-\beta_{mn}(y+t/2)} \qquad \text{(B-2)}$$

$$[G\ F_m] \ \underline{\Delta} \ \begin{array}{c c} & \begin{array}{cc} L & L \end{array} \\ \begin{array}{c} N \\ N \end{array} & \left[\begin{array}{c|c} [G_m] & [F_m] \\ \hline [\hat{G}_m] & [\hat{F}_m] \end{array}\right] \end{array} \qquad \text{(B-3)}$$

$$[F\ G_m] \ \underline{\Delta} \ \begin{array}{c c} & \begin{array}{cc} L & L \end{array} \\ \begin{array}{c} N \\ N \end{array} & \left[\begin{array}{c|c} [F_m] & [G_m] \\ \hline [\hat{F}_m] & [\hat{G}_m] \end{array}\right] \end{array} \qquad \text{(B-4)}$$

The formulae of the n-ℓth elements of the sub-matrices are:

$$(G_m)_{n\ell} \ \underline{\Delta} \ \frac{z_{n\ell}\, e^{-\Gamma_{m\ell} t/2}}{\beta_{mn} + \Gamma_{m\ell}} \qquad \text{(B-5)}$$

$$(F_m)_{n\ell} \ \underline{\Delta} \ \frac{z_{n\ell}\, e^{\Gamma_{m\ell} t/2}}{\beta_{mn} - \Gamma_{m\ell}} \qquad \text{(B-6)}$$

$$(\hat{G}_m)_{n\ell} \ \underline{\Delta} \ -\frac{z^*_{n\ell}\, e^{-\Gamma_{m\ell} t/2}}{\beta_{mn} + \Gamma_{m\ell}} \qquad \text{(B-7)}$$

$$(\hat{F}_m)_{n\ell} \ \underline{\Delta} \ -\frac{z^*_{n\ell}\, e^{\Gamma_{m\ell} t/2}}{\beta_{mn} - \Gamma_{m\ell}} \qquad \text{(B-8)}$$

$$[S_{m1}] \ \underline{\Delta} \int_{-h/2}^{h/2} [DD\ R_m(y)]^{*T} [ARCL]^{*T} [DG\ B_m(y+t/2)]\,dy \qquad \text{(B-9)}$$

$$[S_{m2}] \ \underline{\Delta} \int_{-h/2}^{h/2} [DD\ R_m(y)]^{*T} [ARCL]^{*T} [DG\ B_m(-y+t/2)]\,dy \qquad \text{(B-10)}$$

$$[S_{m3}] \ \underline{\Delta} \int_{-h/2}^{h/2} [DD\ R_m(y)]^{*T} [ARCL]^{*T} [DG\ B_m(-y+h)]\,dy \qquad \text{(B-11)}$$

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Line Stops

NOMENCLATURE

Superscripts T, * denote a transpose, a complex conjugate operation, respectively. A field vector has ~ over the symbol, whereas a linear algebraic vector is underscored. [A] denotes a matrix, with $(A)_{ij}$ as its (i,j)-th element.

PRINCIPAL SYMBOLS

Subscripts

- s = magnet
- r = guideway
- m,n = Fourier Series indices in x,z direction
- l = guideway mode number
- x,y,z = components of Cartesian co-ordinates
- β, Γ = solutions of Laplace's; Bullard's equations

Field Vector

- $\tilde{H}$ = magnetic field intensity, A/m
- $\tilde{K}$ = sheet current density, A/m
- $\tilde{J}$ = bulk current density, A/m^2
- $\tilde{u}_x, \tilde{u}_y, \tilde{u}_z$ = direction vectors in x,y,z
- $\tilde{v}$ = velocity m/s

Algebraic Vectors

- $\underline{A}_m, \underline{A}_{sm}, \underline{A}_{rm}$ = vector of Fourier Series coefficients
- $\underline{b}_m$ = vector of Fourier Series base
- $\underline{D}_m$ = vector of weights of eddy-current modes

Scalars

- d = guideway width
- h = suspension height
- t = guideway thickness
- L = Fourier base length
- W = Fourier base width

Greek Symbols

- α_m = see eq.(15)
- β_{mn} = eq.(38)
- γ_n = eq.(16)
- Γ_{ml} = eq.(24)

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IEEE Transactions on Power Apparatus and Systems, Vol. PAS-102, No. 8, August 1983

CEMENT GROWTH FAILURE OF PORCELAIN SUSPENSION INSULATORS

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Abstract - The paper provides the results and analyses of investigations into porcelain suspension insulator failures on the Ontario Hydro system. The high failure rate of suspension insulators on transmission and distribution lines has been attributed to the volume expansion of the neat cement, a process commonly referred to as "cement growth". Analytical analysis of the suspension insulator design and autoclave expansion tests on insulators support the cement growth failure mechanism.

INTRODUCTION

The basic principles for porcelain suspension insulator designs that still prevail today were established in about 1909. Since their introduction, the porcelain suspension insulator has been applied universally in North America for the mechanical support and electrical insulation of overhead lines. As failure of any insulator string is detrimental to the operation and safety of an overhead line, it can be stated that the reliability of overhead lines rests largely on the electromechanical integrity of the suspension insulators. To this end, and because of a long history of puncture and fracture problems with porcelain suspension insulators, common practice has been to add one or more additional units to strings as a precautionary measure of insulation.

During the late 1950's, when insulator failure rates became very small on the Ontario Hydro system, the practice of routine testing of insulators on transmission lines fell into disuse. Unlike transmission lines, insulators on distribution lines were never tested on a routine basis. In the 1970's, a trend of increasing lighting outage rates on transmission lines was noticed. Insulator failures experienced by Ontario Hydro and other utilities gave rise to concerns about the quality of porcelain insulators manufactured in recent years. In 1976, an investigation into the poor performance of a number of older transmission lines was undertaken. Failure rates on these lines were seen to be significantly higher than the average and an increased number of line drops caused by insulator strings parting was observed. About 170 suspension insulators from 115 kV lines and a few insulators from 27.6 kV lines were removed for hi-pot tests. Approximately 30 per cent of the 5-3/4 x 10 in, 15 000 lb insulators removed were found to be electrically defective. Mechanical tests indicated a reduced strength ranging from 33 to 90 per cent of the nominal rated strength. However, an unexpected finding was that 50 per cent of the newer suspension insulators removed from 27.6 kV lines were found to be defective as well. Unfortunately, these insulators were not examined to determine whether electrical failure was the result of lightning puncture or fracture of the porcelain dielectric.

Following the separation failure of a dead-end insulator assembly early in 1980 on a recently constructed 500 kV line, and a line drop later in the same year, a study into the electromechanical integrity of porcelain insulators manufactured in recent years was initiated. The identification of a latent defect in the design of the 50 000 lb insulators used led to the replacement of nearly 125 000 insulators. Field surveys and studies continued on lower strength insulators used on lower voltage transmission and on distribution lines. A second type of latent defect was identified as being present and related to the volume expansion of the neat portland cement used in the insulator assembly. The study of insulator failure by cement growth is discussed in this paper.

History of Cement Growth

In summing up the experience gained during comparative tests on suspension insulators, Sothman, in 1912, commented on a number of points for consideration [1]. One of these was the possibility of cement expansion leading to fracture of the porcelain shell. Although unknown in suspension insulators at that time, radial cracks in cemented two-piece cap-and-pin insulators were suggested as being brought about by the subsequent expansion of the cementing paste.

For the next fifty years, problems with various designs of insulators were generally believed to be due to the uncontrolled cement chemistry which produced some of the unpredictable volumetric changes, later referred to as "cement growth". Although evidence of radial cracks in the shells of apparatus cap-and-pin and suspension insulator designs has been abundant, and generally attributed to cement growth, the mechanism as it pertains to insulators has not been very well documented.

In an attempt to clarify the confusion and misunderstanding regarding cement growth, Lapp Insulator, in 1962, prepared an explanation as to the phenomenon in support of a post insulator design in which porcelain is stressed in compression under cement expansion [2]. This document, although not published, became widely circulated and known to the industry.

In 1962, Zobel reported on Mechanical and Electrical (M&E) tests on 15 000 lb insulators that were removed from service [3]. In these tests, fracture of the porcelain within the head was detected electrically prior to mechanical separation. A very high percentage of units failed this way. In fact the loss of M&E strength reached 32 per cent. Nearly all new suspension insulators show electrical failure that is simultaneous with mechanical separation. To the insulator manufacturers and some utilities this was not a new phenomenon, but one that surfaced once every

83 WM 136-9 A paper recommended and approved by the IEEE Transmission and Distribution Committee of the IEEE Power Engineering Society for presentation at the IEEE/PES 1983 Winter Meeting, New York, New York, January 30-February 4, 1983. Manuscript submitted July 12, 1982; made available for printing November 17, 1982.

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10 to 15 years. While some explanations invoked ageing as being due to thermal and mechanical stresses and drying of the bituminous layers, others attributed it to volume expansion of the cement.

Kaminski [4], in 1963, reported on accelerated tests on the long-term M&E strength of suspension insulators concluded that the principal cause of such reduction is due to the deterioration of the bituminous coating used as a lubricant in the insulator design. In the discussion, it was pointed out that the accelerated tests totally ignored the expansion of the cement volume due to the delayed hydration of the cement.

The cement growth mechanism was invoked again in 1966 in a Doble paper as the explanation for cracks in apparatus insulators [5]. These cracks were radial and extended from cap to base. Post insulators from the same manufacturer which were installed at the same time did not show evidence of radial cracks. In the post insulator design, cement expansion stresses the porcelain in compression rather than in tension as in the former design.

However, from tests on cubes of portland cement, Alexander in 1976 [6] concluded that neat cement contracted rather than expanded and therefore the cement growth failure mechanism that has been put forth over the years as the principal reason for insulator failures was unfounded.

Throughout the development of cemented porcelain insulators, the volumetric changes produced by an unstable cement has been attributed as the mechanism for insulator failures. Evidence for this has been abundant in the field on insulator designs in which the porcelain dielectric is stressed in tension by cement expansion. On designs in which the porcelain is stressed in compression by cement expansion, no known failures have been known to occur. However, to date, no thorough systematic study of the phenomenon has been carried out. Furthermore after approximately 75 years of porcelain insulator use, there still is no method of making certain that a suspension insulator will perform satisfactorily 20 years after the day it was assembled.

ANALYTICAL MODEL

As radial cracks in porcelain suspension insulators, usually concealed in the head section of the insulator as in Fig. 1, but sometimes visible in the shell of the insulator, Fig. 2, are consistent with an outward force originating from the pin-hole region of the insulator, an analytical study was done to estimate the cement expansion necessary for porcelain fracture.

Figure 3 shows the design of a typical 5-3/4 x 10 in, 15 000 lb porcelain suspension insulator. For simplicity of calculation, a multi-cylindrical section of long extent was taken as an approximation to the complex insulator design. Calculations at the level of the porcelain skirt using the cylindrical approximation yield similar stresses as at the level of the base of the steel cap. This indicates that the porcelain stresses are fairly uniform in the axial direction at least to the taper in the steel pin. Poisson's ratio is taken into account for tensile stress in the axial and angular directions. For axial strain, the steel boundaries are assumed not to support shear because of the bituminous coatings. The porcelain boundaries were taken to be tightly bound by the presence of the sand band.

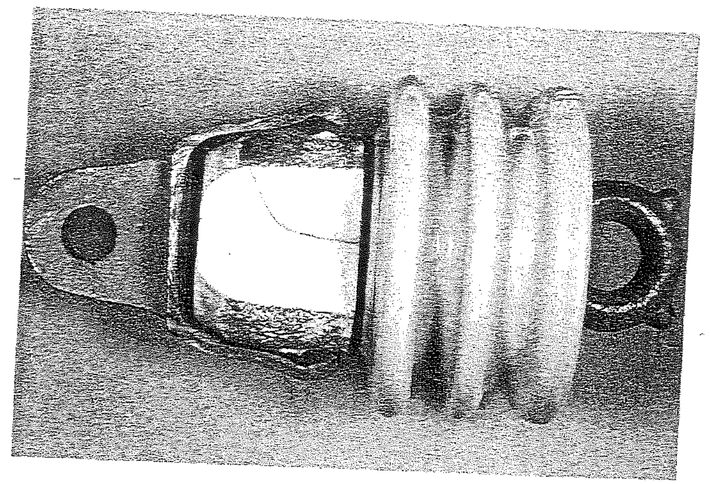

Fig. 1. Radial crack concealed in the head of an insulator.

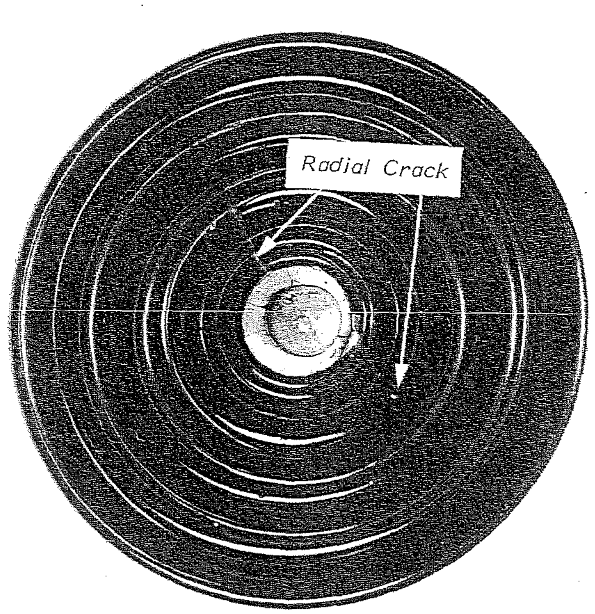

Fig. 2. Radial crack visible in the shell of a suspension insulator.

The equations governing the stress are

$$S_r = E(\varepsilon_r - c) + \sigma(S_\theta + S_z) \qquad (1)$$

in the radial direction, and

$$S_\theta = E(\varepsilon_\theta - c) + \sigma(S_r + S_z) \qquad (2)$$

in the circumferential direction, where

E is the modulus of elasticity,
c is the expansion in strain units,
σ is Poisson's ratio,
ε_r is the radial strain, and
ε_θ is the circumferential strain.

The equations governing the strains are

$$\varepsilon_r = du/dr \qquad (3)$$

in the radial direction, and

$$\varepsilon_\theta = u/r \qquad (4)$$

in the circumferential direction, where u represents the component of the displacement vector in the r direction.

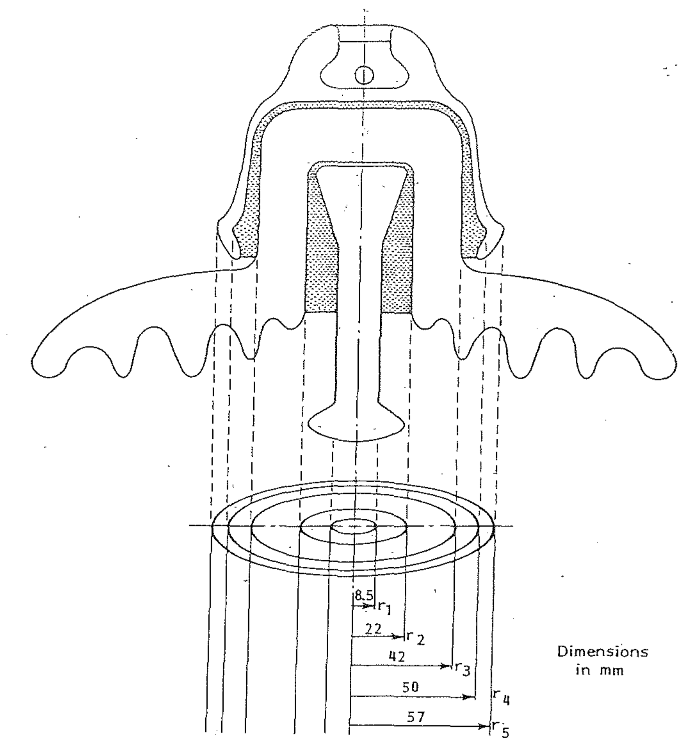

Fig. 3. Cylindrical approximation of the 5-3/4 x 10 in suspension insulator.

Equations 1-4 and the equation of equilibrium

$$\frac{dS_r}{dr} + \frac{S_r - S_\theta}{r} = 0 \qquad (5)$$

yield the differential equation

$$r^2 \frac{d^2u}{dr^2} + r\frac{du}{dr} - u = 0 \qquad (6)$$

with general solution

$$u = ar + b/r \qquad (7)$$

Thus, strain in the circumferential direction becomes

$$\varepsilon_\theta = a + b/r^2 \qquad (8)$$

and stress in the radial direction becomes

$$S_r = \frac{E}{1 - \sigma^2}\left[(a - \frac{b}{r^2} - c) + \sigma(a + \frac{b}{r^2} - c)\right] + \frac{\sigma}{1 - \sigma} S_z \qquad (9)$$

where a and b are constants.

TABLE 1: Properties of Insulator Components Used in Analysis

PROPERTY	PORCELAIN		CEMENT	CAP AND PIN
	QUARTZ	ALUMINA		
MODULUS OF ELASTICITY psi $\times 10^6$	7-8.5	10-12	3	30
THERMAL COEFFICIENT OF EXPANSION $\times 10^{-6}$/°C	5	7	9	12
FLEXURE STRENGTH psi $\times 10^3$	10-12.5	18.5-22	—	—
POISSON'S RATIO	0.3	0.3	0.2	0.3

Five boundary conditions on the radial stress and four boundary conditions on the circumferential strain yield nine differential equations. The solution applying the physical properties of the insulator components listed in Table 1 gives the dependence of circumferential stress at the porcelain boundary, r_2 in Fig. 3, on cement expansion. Temperature is factored into the model as a separable variable. The results are shown in Figs. 4 and 5 for quartz and alumina porcelains. The departure of circumferential stress from a straight line relationship at elevated temperatures is due to thermal expansion of the cap being greater than cement expansion. The values of flexure strength shown are for American porcelains reported in EPRI RP 425-1 [7]. Flexural strengths have higher values than tensile strengths because, in the case of flexing, the maximum tensile stress covers only a small cross-sectional area. The probability of weaknesses within this small area is lower than over the whole cross-sectional area. In the case of cement expansion and thermal stresses which have their maximum values over small areas near the interfaces, the same reasoning applies.

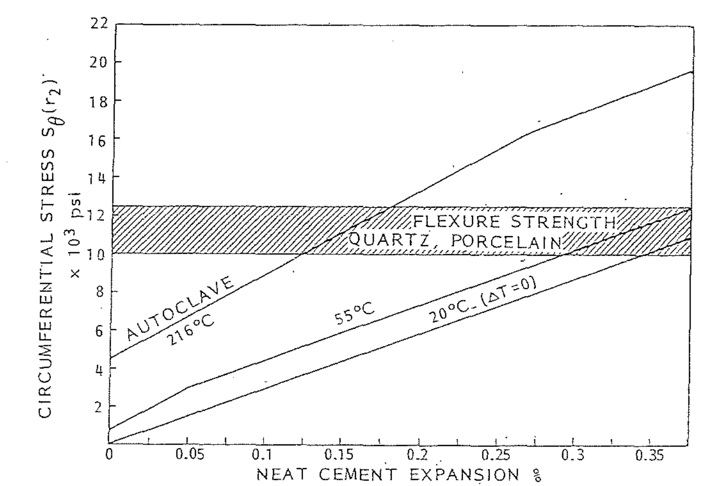

Fig. 4. Circumferential stress S_θ (r_2) in quartz porcelain for cement expansion in per cent.

The calculations show that temperature alone will not fracture quartz or alumina porcelain shells in the 15 000 lb insulator design. However, cement expansion assisted by temperature, will give rise to high enough stresses to produce radial fracture in quartz or alumina porcelain shells. For quartz porcelain, an expansion above 0.3 per cent at 55°C is predicted to cause fracture. For shells of alumina porcelain, cement expansion above 0.5 per cent is needed at 55°C for fracture in the same design of insulator.

At higher temperatures, for example at the ASTM C151 autoclave expansion test temperature of 216°C [8], insulators with quartz shells will fracture if the cement expansion is above 0.13 per cent and above 0.33 per cent for alumina shells.

Although the range for flexure strength shown in Figs. 4 and 5 are for sound porcelain, flaws acquired in manufacturing will greatly reduce the cement expansion necessary for fracture.

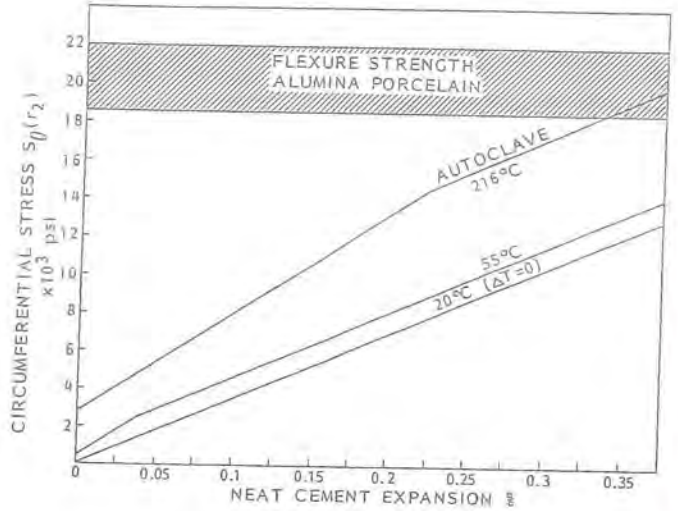

Fig. 5. Circumferential stress $S\theta$ (r_2) in alumina porcelain for cement expansion in per cent.

INSULATOR TESTS

Field Tests

Megger tests involving some 30 000 insulators on transmission and distribution circuits showed that insulators used only in horizontal applications were affected. On both systems, dead-end strings exhibited an average defective rate in the neighbourhood of 10 per cent. In-span openers on distribution lines were found to have a similar defective rate. Radial cracks in many defective insulators were visible in the shell of the insulator. In other defective insulators, a radial crack in the porcelain shell that was concealed by the insulator cap was confirmed on dissection. Insulators in normal suspension positions were found to have a failure rate less than about 0.2 per cent. The surveys included 10 000 and 15 000 lb insulators on distribution lines and 15 000 and 25 000 lb insulators on transmission lines that had been in service for periods up to 20 years. Insulators removed from in-span openers were not energized.

The field tests suggest that direct wetting of the insulator cement plays an important role in the failure mechanism. Voltage is not a factor as many unenergized insulators in in-span openers were found to be defective as well. Furthermore, due to the inconsistent defective rate from line to line, failure could not be correlated to mechanical tension.

Thermal Tests

As cement growth produces a constantly increasing stress on the porcelain dielectric until, inevitably, the shell fails in tension by cracking, some 50 25 000 lb insulators were subjected to thermal tests to test this hypothesis. Referring to Fig. 4, the temperature at which the circumferential stress exceeds the flexural strength of porcelain is dependent on the volume expansion of the cement. On new insulators, with no cement growth, the temperature necessary for porcelain fracture was verified to be above 216°C. However, on aged insulators whether used or unused that were first demonstrated to be sound electrically by a hi-pot test, 30 per cent of the 25 000 lb units fractured when the insulator cap was heated. Radial fracture of the shell occurred at a temperature of 60 to 70°C confirming that the cement had expanded and subjected the porcelain shell to tension. To confirm that cement expansion was responsible for the hoop stress in the porcelain head, the pin cement was removed from eight insulators, as in Fig. 6, and the thermal test repeated. Fracture of the insulator shell did not occur.

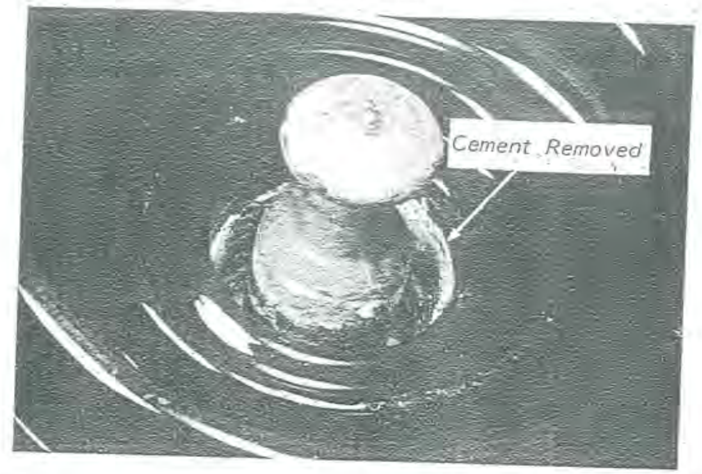

Fig. 6 Insulator pin cement removed for Thermal tests.

Mechanical and Electrical Tests

Random samples of insulators were removed from both transmission and distribution dead-end structures for combined mechanical and electrical (M&E) strength tests. Unlike new insulators, many insulators exhibited electrical failure prior to mechanical failure. This was found on insulators of 10 000, 15 000 and 25 000 lb designs.

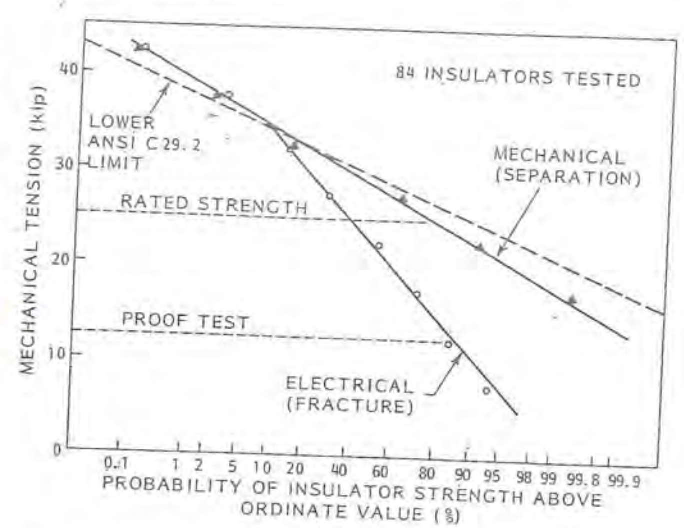

Fig. 7. Distribution of M&E strength for 25 000 lb insulators removed from the field.

The results of M&E strength tests on 25 000 lb insulators, removed from dead-end structures, is shown in Fig. 7. The sample of 84 insulators tested covered the period 1961 to 1973. These tests consisted of energizing at 60 kV and tensioning the insulator to mechanical failure (separation). Recorded was the tension at which electrical failure occurred (cracking) and the tension for mechanical failure (separation).

Although the distribution of mechanical strength is not greatly different from the lower limit specified in ANSI C29.2 (S = 3 400 lb) [9], electrical failure of insulators occurred as low as 7 500 lb tension. Ninety per cent of the insulators showed electrical failure prior to mechanical failure. On new insulators, this is generally less than one per cent. The reduction in M&E strength is at least 25 per cent. At the proof test tension of 12 500 lb, which corresponds to the maximum working load as specified by most manufacturers, about 15 per cent of the insulators became defective.

Additional M&E tests were done on a sample of 98 unused 25 000 lb insulators. These insulators, manufactured in 1965, were left over from the construction of a 500 kV transmission line and stored outdoors in crates for 17 years. The results of these tests are shown in Fig. 8.

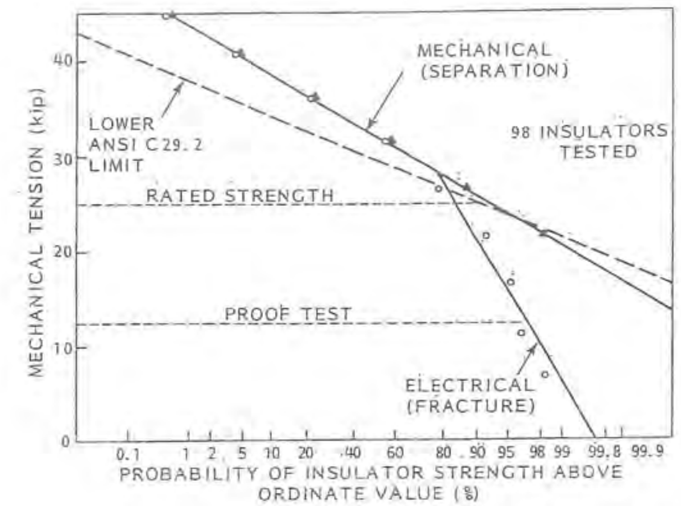

Fig. 8 Distribution of M&E strength of unused 25 000 lb insulators manufactured in 1965.

The distribution of mechanical strength lies above the ANSI C29.2 mean lower conformance limit (historical standard deviation S = 3 400 lb). However, an unexpected result was that electrical failures occurred as low as 6 000 lb tension. Twenty per cent of the insulators tested showed electrical failure (cracking) prior to mechanical failure (separation).

Several insulators that failed electrically during mechanical tensioning were examined and found to contain radial cracks in the porcelain shell.

The reduction of M&E strength of aged insulators is consistent with a cement growth mechanism. Cement growth produces an outward force which subjects the porcelain dielectric to a bursting stress. Tension loading of the insulator, transformed by the design of the insulator into a outward stress applied to the porcelain, is additive to the stress on the shell produced by cement growth. Failure of the porcelain in tension occurs by radial cracks; a failure mode not present in new insulators.

Time-Load Tests

Fig. 9 shows the results of time-load tests on 25 000 lb insulators. The insulators were held at constant tension (60 per cent of M&E strength) for 16 days. All but a few of the 96 units were unused 1965 insulators that were stored outdoors in crates for 17 years. Initially, the insulators were hi-pot tested before the string was assembled. After the string was tensioned, the insulators were retested and the hi-pot test repeated seven times during the 16 day constant tension period. The failure rate was found to increase with time, reaching approximately 65 per cent in 16 days. Failure was due to radial fracture of the porcelain dielectric, some of which were visible in the shells of the insulators.

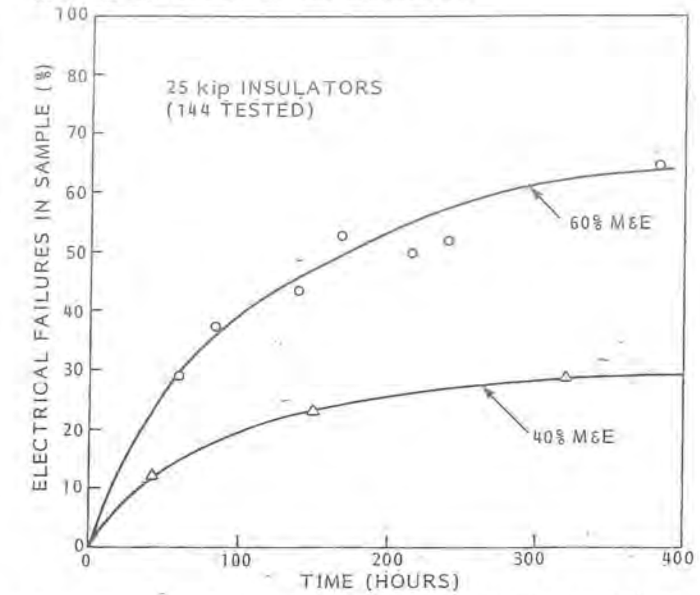

Fig. 9. Time-load test on unused 25 000 lb insulators manufactured in 1965.

The time-load test was repeated on 48 additional units of the same type at 40 per cent of M&E strength for 4 weeks. The failures levelled off at approximately 27 per cent after about two weeks. Once again, radial cracks were visible in the insulator shells.

Autoclave Expansion Tests

Table 2: Summary of Autoclave Expansion Tests on Insulators

MANUFACTURER	INSULATOR		TESTED		
	YEAR	RATING (kip)	STATUS	NO	RESULT
A&B	80-82	10	NEW	8	8 PASS
A&B	68&75	10	USED	3	2 FAIL
A	65	25	UNUSED	5	1 FAIL
A	64	15 kV CAP & PIN	USED	3	3 FAIL
B	69	15	USED	5	5 FAIL
B	50	15	USED	5	5 PASS
B	79	50	USED	5	4 FAIL
C	82	10	NEW	3	3 PASS
C	74	10	USED	3	3 PASS
D	82	10	NEW	2	2 PASS
E	80	10	USED	3	2 FAIL
E,F&G	64	10	USED	4	2 FAIL

The soundness of portland cement is tested by the ASTM C151 Autoclave Expansion Test [8]. The test, which subjects bars of neat cement to high pressure steam at 295 psi for three hours at 216°C, provides an index of the potential expansion caused by the delayed hydration of free magnesia (MgO) and free lime (CaO). These tests were performed on various insulators, the results of which are summarized in Table 2.

On aged insulators, autoclave tests produced radial cracks that duplicated those found in insulators in the field. This was demonstrated not only in suspension insulators, but also in apparatus cap-and-pin insulators (Fig. 10).

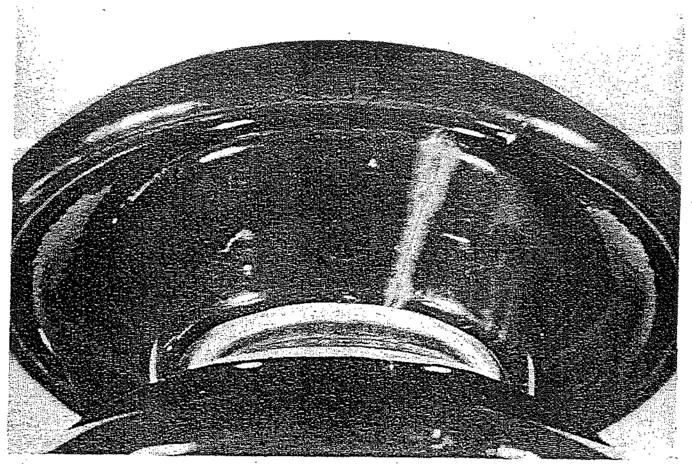

Fig. 10. Aged apparatus cap-and-pin insulator subjected to cement autoclave expansion test.

However, this could not be shown in new and unaged suspension insulators. New insulators assembled with high autoclave expansion cement, 0.33 per cent, without the bituminous coating on the hardware parts, did not fail during autoclave tests, ruling out the possibility that a cushioning effect was offered by the coating during cement expansion.

Generally, a 100 per cent insulator failure of one design and year of manufacture was not found in the autoclave tests. Unused, but aged, insulators also failed by radial fracture. Furthermore, some years of manufacture did not exhibit failure.

FAILURE MECHANISM

From the day of assembly, the neat cement in an insulator shrinks. This shrinkage is very rapid, reaching a maximum within about 100 days, and remains approximately constant thereafter when held at constant humidity. When cured in air, a shrinkage of about 0.6 per cent takes place and somewhat less shrinkage occurs when cured in water. This shrinkage manifests itself in suspension insulators in the form of drying cracks that are visible in the pin-hole cement. On complete wetting, the neat cement swells but not sufficiently to return to its original cast volume. Thus, new insulators assembled with 0.33 per cent expansion cement, subjected to autoclaving, do not fracture as the expansion due to the hydration of MgO and CaO essentially returns the neat cement to its original cast volume.

As many of the aged insulators have been shown to fracture radially during autoclave tests, the delayed hydration expansion of MgO and CaO cannot be the sole reason for radial cracks in insulators. Thermal tests on new insulators have ruled out temperature as the reason for fracture. Calculations support this finding as well.

According to the Portland Cement Association [10], there are mainly three compounds in portland cement liable to cause expansion. These are magnesia, free lime and calcium sulphate ($CaSO_4$); the latter results from gypsum ($CaSO_4 \cdot 2H_2O$), a hydrate of calcium sulphate, that is added to the cement clinker during manufacture of portland cement.

One of the four binding compounds of portland cements is tricalcium aluminate [11]. Its presence is undesirable as it contributes little to the cement except at early ages. The reaction of pure tricalcium aluminate is rapid and leads to immediate hardening of the paste which is referred to as flash set. To retard the setting of the paste, gypsum is added to cement clinker. Gypsum and tricalcium aluminate react to form insoluble calcium sulphoaluminate ($3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 31H_2O$). Gypsum, when present in excess, will cause excessive expansion after setting and hardening owing to the continued formation of calcium sulphoaluminate in the presence of moisture. The presence of this compound, characterized by long needle-like shapes as in Fig. 11, was confirmed in insulator cement, by electron dispersive analysis. The elemental weight ratios of Ca:Al, Ca:S and S:Al were found to compare quite closely to the expected molecular weight ratios for $3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 31H_2O$. In several insulator cements, the needle-like shape crystals were found predominantly in voids where presumably moisture collects.

As the hydration expansion due to gypsum is undetected by the accelerated autoclave test for cement soundness, but proceeds slowly with time and moisture, excessive gypsum is likely the main reason for cement growth failures of suspension insulators. Historically, excessive gypsum has been one of the principal causes of cement unsoundness [13]. The variation in the autoclave results with year of manufacture is likely to be due to variations in the cement chemistry and strength of the porcelain.

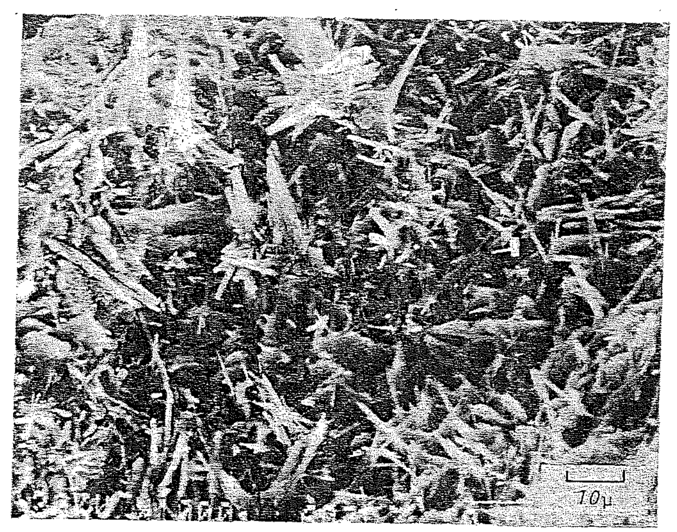

Fig. 11 Scanning electron microscope photograph of tricalcium sulphoaluminate crystals in an insulator cement at 1000 X.

CEMENTS IN USE

In the past, due to cement growth problems in insulators, many manufacturers introduced an internal specification on the cement autoclave expansion. Table 3 summarizes the cements in use by eight porcelain insulator manufacturers. All but two manufacturers listed have an internal specification. Two manufacturers, which do not, rely on the ASTM C150 [12] specification of 0.8 per cent as compiled by the cement suppliers. None has a specification as to the expansion due to gypsum.

TABLE 3: Insulator Cements in Use

INSULATOR			AUTOCLAVE EXPANSION (%)	
MANUFACTURER	CEMENT		INTERNAL SPECIFICATION (MAX)	TYPICAL
	ASTM	TYPE		
A	III	NEAT	NONE	0.36
B	I	NEAT	0.2	-
C	III	MORTAR	0.03	-
E	I	NEAT	NONE	-
F	I	NEAT	0.2	-
G	I	NEAT	0.13	0.08
H	I	NEAT	0.21	0.17
I	I	NEAT	0.12	0.08

Low Expansion Cements

As type I cement requires less gypsum added to the clinker as type III cement, the expansion of type I cement due to gypsum excess can be expected to be lower. Alternatively, use of a type V cement, one which is normally used when high sulfate resistance is needed, will also exhibit lower expansion. Use of a mortar with silica sand greatly reduces the expansion as well. In addition, as unsoundness in high-alumina cement is unknown, use of this cement will eliminate the problem entirely.

CONCLUSIONS

The cause for electrical failures in many porcelain suspension insulators which occur on transmission and distribution lines in dead-end strings is radial cracks in the shells of the insulators. An analytical study and laboratory tests have demonstrated that the cracks are the result of an expansive force produced by the insulator pin-hole cement. This volume expansion is the result of an unsuitable cement used in the assembly of the insulator which requires ten or more years to manifest itself in the field. A reduction in mechanical strength of the insulator is also associated with cement expansion. Laboratory tests on various insulators support the mechanism for cement growth as being mainly due to excessive gypsum present in the cement for which there is no accelerated expansion test. Not all cements used in the assembly of insulators exhibit this long-term expansion.

ACKNOWLEDGEMENTS

The author is grateful to Dr. J.S. Barrett for developing the analytical model and to Dr. R.D. Hooton for useful discussions on portland cements.

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Discussion

G. L. Gaibrois (Detroit Edison Co., Detroit, MI): Mr. Cherney should be commended for a comprehensive study of the suspension insulator failures sustained by Ontario Hydro. This paper, however, may infer that utilities have cement growth problems that warrant the replacement of numbers of suspension insulators.

The failure rate of suspension insulators experienced by the Detroit Edison Company has been very low. Line dropping due to ageing cement has not occurred. Most, if not all, failures of insulators except for flashover damage, were attributed to contamination corroding the pin itself or the area around the pin in contact with the cement. The corrosion at the later location resulted in excessive pressure causing the porcelain disc to crack. Most of these cases have been documented and occurred in localized, heavily contaminated areas.

Contrary to the statement in the paper, "common practice has been to add one or more additional units to strings as a precautionary measure of insulation", the number of suspension discs per voltage level used on the Detroit Edison system was and is presently based on a desired BIL level and leakage distance to obtain satisfactory operation of the lines under expected contamination. At no time were insulators added to counteract the expected failure of discs.

The paper notes that other utilities have experienced unusual failure rates. Could the author expand on this? Is this a fairly new experience? Does the problem exist for United States, Canadin or foreign manufacturers; and were the insulators produced since 1961?

Mr. Cherney also refers to an increase in lightning line outages. On the Detroit Edison system, 120-kV line outages have not increased over the years. The outage rate is higher on older lines, but this is due to improved shielding of modern lines, and not related to the status of the insulators. Mr. Cherney also refers to various papers that discuss insulator strength versus time. The paper that emphasized the loss of strength of suspension insulators with age was written by Mr. E. Zobel from AEP. In this paper, mention is made of the reduction in strength of the insulators while being tested. These insulators had been in service for years, but in no case were line droppings or insulator field breakage mentioned. The discussions associated with Mr. Zobel's paper and a subsequent paper on the strength versus time of suspension insulators by D. Fiero, indicates that all insulators built after 1961 have improved cement which causes the insulator strength to remain above rating. In any case, the strength would definitely not drop below the manufacturer's recommended insulator loading of 50% of their tested strength or about 25-30% of the ultimate strength.

Manuscript received February 8, 1983.

Bruce E. Kingsbury (Locke Insulators, Inc., Baltimore, MD.): The author is to be commended for his quite extensive study and anlysis for the cause of porcelain suspension insulator failures on the Ontario Hydro System. This will be a valuable addition to our understanding about how insulators behave in service.

Perhaps the key question that we have is where do the cracks initiate? And, are the radial cracks a direct result of an unfavorable reaction within the insulator, or are the radial cracks a later-occurring indirect result of a distressed condition which was caused by a phenomena incapable of generating a radial crack?

We have long felt that the cement used in suspension insulators is in a shrinkage mode always. It may show more shrinkage when it becomes dried, and somewhat less shrinkage when it becomes wetted; but the cement never has shown to become expansive. In fact, we employ a significant amount of silica filler which will minimize this shrinkage effect in order to minimize local stress concentrations at the edges of the cob of the insulator pin.

The author comments that some evidence of the calcium sulphoaluminate, ettringite, was visible in the pores of several cements. We would agree that this is where we would expect to find such a compound. However, when we consider that since there is at least ten percent pore volume in cement, and that in order to cause a significant expansion, an appreciable amount of this compound would have to be available. This should be detectable by X-Ray Diffraction. Admittedly, we have examined only a small number of 20-year old cement specimens, but we have yet to obtain a trace of any calcium sulphoaluminate.

We also have difficulty with the theory that there is sufficient, or excess, gypsum available to react with tricalcium aluminate on a long-term basis. Typically, the cement, via clinker SO_3 and added gypsum, contains only about one-third the amount of SO_3 to totally react with the calcium aluminate in the cement to form ettringite. This leads us to believe that the SO_3 is consumed early in the hydration process, and that little or none would be available for reaction at prolonged periods of time. Also, the addition of SO_3 is carefully controlled by the cement manufacturer and the likelihood of excess of gypsum is extremely small. Have you considered the possibility of SO_3-laden rain?

The author states that the dead-end position for the insulator provides a far greater failure rate than the tangent position. Since he also noted a significant failure rate due to lightning in the 1970's, has he ruled out any evidence of electrical puncture or partial damage due to lightning on these particular insulators?

We would also ask whether there is any possibility that a freeze-thaw situation might explain the difference in failure frequency between dead-end and tangent insulator positions. That is, would the combination of the opportunity for greater water absorption, coupled with excursions from freezing to thawing temperatures cause sufficient expansive stresses to crack dead-end insulators whereas the lack of the necessary moisture would not cause such high stresses in tangent insulators?

Manuscript received February 22, 1983.

K. Morita (NGK INSULATORS, LTD., Nagoya, Japan): The author is to be commended for the extensive researches and analyses on quality of the porcelain insulator. We also have been making studies on long-term performance of insulators. Thus the test results and analyses in the paper are very informative and interesting to us. We would like to make some comments on failure mechanism of the deteriorated insulator and evaluation test method.

The author concluded that the deterioration of the insulator was attributable to cement growth (expansion) and also claimed that this was supported by existing of radial cracks in the porcelain shell.

However, it is our basic opinion that the main cause of the deterioration is due to lack of total quality of the insulator. Total quality of the insulator means the combination of quality of material, mechanical design to avoid the stress concentration, assembling method, quality control in the manufacturing process, and so on.

Under above mentioned conditions, following stresses promote the deterioration of the insulators,

i) Stress transduced from working load on the insulator.
ii) Stress due to the difference of thermal expansion among the insulator components.
iii) Stress due to the change of the cement such as expansion, shrinkage, hardening, etc.

Followings are our findings not coincident with author's view in this paper.

1. Normally the neat cement being used for insulator assembling shrinks with age as described in Mr. Alexander's paper. Expansion of the cement is a rather rare case under special condition such as action of brine, alkaline or acdic action, etc.
   According to our analysis, shrinkage of the cement also brings out tensile stress on the head portion of insulator.
2. The fact of many electrical failure at M & E strength test shown in Figs. 7 and 8 suggests the growth of the circumferential crack in the plan corresponding to the pin top prior to propagation of the radial crack. The circumferential crack is produced by giving of excess tensile stress concentration around the pin top portion, not by cement expansion. There are many cases that radial cracks in the porcelain shell are propagated from the circumferential crack at the head portion. Therefore, it is required to investigate carefuly the starting point of the fractured surface.
3. Tensile load on the insulator gives influence to insulator deterioration. This is supported by following facts.
   i) Deterioration rate of the insulator at the dead end tower is higher than that of the suspension tower.
   ii) From the time load test result shown in Fig. 9, the heavier load test shows the higher electrical failure rate.

As the author pointed out, the insulator should not be evaluated only by the initial performance but also by the long-term performance and actual field performance. In the IEC Pub. 575, "Thermal Mechanical Performance Test" is specified to evaluate long-term performance of insulators. This test has been developed as an artificial accelerated ageing test and is an effective evaluation method of long-term performance, since poor quality insulators exhibit same fracture mode by this test as deteriorated insulators in actual transmission line.

Performance of suspension insulator depends upon not only quality of the material (cement) but also porcelain strength, manufacturing technique, insulator design and quality control. Moreover, these factors are related each other and all of them should be controlled. It is considered that the deteriorated insulators mentioned in this paper seem to be lacking in the above mentioned factors. It should be noted that the qualified porcelain insulator have exhibited excellent field performance for years without any deterioration. Quality of such insulators can be evaluated by the "Thermal Mechanical Performance Test".

Insulator manufacturers must carry out at least Thermal Mechanical Performance Test prescribed in IEC Pub. 575 to evaluate the long-term performance of the insulators.

In NGK, severer test methods than IEC Pub. 575 have been developed and applied to evaluate quality of the insulators. Our own test methods have wider temperature range, more frequent cycle of mechanical stress and longer test duration.

Manuscript received February 22, 1983.

Laurent Pargamin (Technical Director of Ceraver, Saint Yorre, France): The author should be commended for his valuable work which emphasizes the importance of cement as a factor related to suspension insulator reliability. Insulator manufacturers have been concerned about this problem for many years.

Alumina Cement, as it is well known in the cement industry (1), does not present an expansion or 'growth' problem. In fact, it has several distinct advantages over Portland Cement for the manufacture of suspension insulators:

- Due to its manufacturing process (by melting of the raw materials), it has a very constant quality.
- Its composition, with high alumina, gives good resistance to corrosion compared to Portland Cement, and in particular to salt water.
- It reaches a high strength very quickly; thus the insulators can be handled a short time after the initial setting of the cement.
- When properly cured, cement strength constantly increases with age.

It should also be noted, however, that in the early Fifties it was discovered that improperly prepared and cured Alumina Cement could lead to a crystalline conversion reaction resulting in a slight, but temporary, reduction in early high strength. Numerous investigations have since established the optimum conditions for using Alumina Cement, and have been employed by manufacturing of suspension insulators for almost thirty years. The reliability of Alumina Cement is also shown by the worldwide successful service record of more than 250 million toughened glass insulators assembled with this cement type.

Concerning the 'Cement Growth' of Portland Cement, the author states that gypsum is responsible for the problem. Is there direct evidence for this, for example chemical analysis of the cement of failed insulators showing a high amount of Tricalcium Sulfoaluminate and analysis of the cement of batches of insulators which have not failed in similar conditions but showing less gypsium?

The analytical model shows that the composition of the porcelain is a critical parameter. In a view of the flexure strength of alumina porcelain no such 'Cement' problem should occur with it. Has this been confirmed by the field test of insulators and are the numbers statistically significant?

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Manuscript received February 22, 1983.

A. E. Schwalm, (Brown Boveri Electric, Inc., Victor, NY): The author is to be congratulated for an extremely interesting paper. The detailed experimental work indicates the author's interest in attempting to explain the behavior of suspension insulators.

The conclusion, establishing cement growth as the critical factor in loss of strength in suspension insulators, is based in part on the large percentage of electrical breakdown preceding ultimate mechanical fracture under combined M & E testing. It should be pointed out, however, that this type of breakdown mode has been observed for many years and under various circumstances, including new insulators less than two weeks old.

For example, suspension insulators of equivalent rating and style to those cited by the author were tested with the following results:

Insulator	Per Cent Exhibiting Electrical Breakdown Prior to Mechanical Fracture
1) Insulators assembled with bituminous coating on cap and pin, tested 7 days after assembly	0%
2) Insulators assembled with bituminous coating on cap, none on pin, tested 7 days after assembly	40%
3) Insulators assembled with bituminous coating on pin, none on cap, tested 7 days after assembly	40%
4) Insulators assembled with no bituminous coating on cap or pin, tested 7 days after assembly	60%
5) Insulators assembled with bituminous coating on cap and pin, subjected to -25° C for 24 hours and then tested (7 days)	20%
6) Insulators assembled with no bituminous coating on cap or pin, subjected to -25° C for 24 hours and then tested (7 days)	100%

The percentages given above are averages for series of tests. The results clearly indicate the importance of both the presence of and the effect of the flexibility of bituminous coatings in determining breakdown mode during M & E testing. The electrical breakdown during the M & E test is indicative of a crack forming at a particular applied tensile load.

The crack forms in the new insulators upon load application in the absence of bituminous coatings because there is no stress relief mechanism. The same effect occurs when the coating flexibility of new insulators is decreased by exposure to lost temperatures.

In older insulators, such as investigated by the author, the bituminous coatings in many cases have lost flexibility due to aging, and the incidence of electrical breakdown preceding mechanical fracture would be expected to increase to levels similar to those reported in tests described above.

Thus, the results presented by the author is Fig. 7 through Fig. 9 can be interpreted as being indicative of the effects of reduction in stress relieving ability of bituminous coatings with time.

The results of the autoclave testing, as reported by the author, are consistent with this interpretation when factors such as exposure history of the cement, variations in coating flexibility, and variations in coating thickness are taken into account.

The author reports that prior to the combined M & E testing, time loading, thermal tests and autoclave tests, the insulators were electrically sound. This fact is very important since the subsequent electrical breakdowns did not occur until the application of a mechanical or thermal stress to the insulators. We believe these facts to be more consistent with the interpretation regarding coating flexibility as discussed above, than with the proposed cement growth mechanism.

Manuscript received March 7, 1983.

E. A. Cherney: With reference to the discussion by Mr. Gaibrois, cement growth failure of porcelain insulators is not a new experience but one that has existed for many years. Of course not all insulators are affected but many manufacturers have had problems with cement growth in the past while presently some seem to have problems every 10 to 15 years. In the United States, although field observations of suspension insulators with cracked shells are known, cement growth is probably better known in the multi piece apparatus type cap-and-pin insulator mainly because of publications. However, it is for this reason that US utilities began to routinely test suspension insulators at great expense. A number of utilities still follow this practice today.

At Ontario Hydro, routine testing of insulators was discontinued during the late 1950's. Between 1960 and 1980, we did not think we had an insulator problem as there were only a few dead end string separations from power arc penetration of defective insulators. However, since then, routine sample testing of insulators involving over 30,000 units has revealed an average defective rate approaching 10 per cent on both transmission and distribution systems. Only horizontal strings are affected; vertical strings are virtually free of cement growth failure presumably due to shielding by the insulator shell of the pin cement from direct wetting. I suspect that as most American utilities do not routinely test insulators, the extent of the problem, if it exists, is virtually unknown.

In Canada, the first real indication of problems was probably in 1976 on the Nova Scotia Power System. Currently, most utilities in Canada have defective insulators in horizontal strings. In the United States, there are several utilities that are known to have comparable failure rates but details of the failures are not known. Radial cracks in the shells of porcelain insulators are known to be associated with many line failures in a number of countries including England, and Saudi Arabia.

Line dropping due to cement growth is not a direct occurrence. Mechanically, the strength of aged insulators is still quite high as evidenced by the figures in the paper but the shell cracks and the insulator becomes defective electrically at low tensions. As long as the insulator string supports the line voltage, mechanical separation will not occur from cracked insulators. However, if enough defective insulators develop in a string and proceeds to flashover, which may be brought about by system overvoltages, wetting or contamination, power arc penetration of one or more of the defective insulators, depending on the level of fault energy, may cause the insulators to rupture thereby dropping the conductor. Unless the insulators are carefully examined after such an occurrence, the true cause for separation failure may be masked by secondary causes, for example, contamination. I suspect that in most field problems of this type, a thorough analysis of the insulators is generally not done by the utility.

Regarding the practice of adding one or more additional suspension insulators to strings as a precautionary measure of insulation, this only applies to distribution and is indeed common practice. For example, the withstand voltage of a single insulator varies from 90 to 115 kV depending on insulator type. The recommended minimum BIL for 15 kV systems is 110 kV yet at least two units are used on wood poles in normal environments. Similarly at 46 kV with minimum BIL of 250 kV, normally three 5-¾ × 10 inch units are used rather than two units on wood poles. On transmission lines, insulation is selected on the basis of BIL in normal environments and BIL and leakage distance in contaminated environments.

Ontario Hydro has kept detailed performance records of transmission lines for many years. The five year moving average plotted since 1960 shows a definite upward trend in the number of line fault trips/100 line miles/year for the 230 kV system. Initially, this was suspected to be due to deterioration of the grounding system by corrosion which could not be confirmed and now believed to be due to reduced insulation brought about by defective insulators in dead end strings. As dead end strings are being changed out on many 230 kV circuits, a downward trend in the lightning outage rate over the next few years will support our hypothesis. The reason why more line drops have not occurred is thought to be due to the fact that three or more defective insulators are needed in a string for power arc penetration.

Regarding the mechanical strength of insulators affected by cement growth, as already mentioned and emphasized in the paper, the separation failure for aged insulators in near the lower ANSI conformance test limit for new insulators for each class of insulator tested so that the effect of cement growth on the mechanical strength is really quite small. However, this is not so on the electrical strength as the insulator becomes defective electrically at tensions well below the manufacturer's maximum loading value which is the proof test tension. Thus, the combined M&E strength or electromechanical strength is reduced as much as 30 percent from conformance test values.

With reference to the discussion by Mr. Kingsbury, shrinkage cracks resulting from the cement curing process were initially viewed as possible sites to collect rain water. Consequently, expansive forces could be produced in the porcelain insulator body by freeze-thaw action. Over 20 free-thaw tests on ten insulators did not precipitate a failure, either electrically or mechanically, albeit, the cement spalled and with continued tests, a reduction in the pin pullout strength would be likely. These tests supported the findings of Alexander who ruled out freeze-thaw action as being responsible for cracked porcelain shells.

Dissection of defective insulators confirmed that electrical puncture, probably due to steep wave lightning surges, was the reason for some of the defective insulators. However, the number of punctures was not as great as insulators with cracks. Porcelain punctures invariably were found in the corners of the insulator head and presumably due to design and manufacturing problems.

In the corners of the insulator pinhole, along with voids, grains of sand from the sand band were found fired into the porcelain. The pinhole radius of curvature in some designs was also deemed much too sharp giving rise to enhanced electrical stress. Following these observations, our suspension insulator specification was revised to include a design test requirement for puncture. This test consists of five negative and five positive steep front of wave applications (2500 kV/μS) to 12 insulators which is followed by three low frequency dry flashovers to confirm the electrical integrity of the insulators.

Regarding the initiation of shell cracks, the thermal tests described in the paper on aged but unused 25 kip insulators, with and without the pin cement in place, firmly established that the radial cracks originate from within the insulator head and the result of an expanded cement, which subjects the porcelain head to a hoop stress. Heating simply causes the cap to expand removing the restraining force from the expanded cement, thus causing the shell to crack. This mechanism was also confirmed by autoclave tests which accelerate cement expansion. As to the principle mechanism for cement growth, SO_3 laden rain may certainly contribute to expansion but as the phenomenon of cement growth has existed for many years, other factors are believed to be responsible.

Although all manufacturers of Portland Cement carefully control the addition of gypsum to cement to obtain optimum setting characteristics and to stay within the ANSI C150 specification, no such specification exists for porcelain suspension insulators. The degree of control necessary without producing significant expansion is exemplified in Table 2 of Reference 13 of the paper which shows that cement expansion increases from 0.14 to 1.7 per cent when gypsum is increased from 4 to 6 per cent.

Excessive cement shrinkage during curing can also result in radial shell cracks in suspension insulators. However, these cracks will occur only during mechanical tensioning. This problem can be discovered in new insulators during conformance tests as failure will occur electrically prior to mechanical separation. The additional of silica filler not only reduces cement shrinkage but also expansion by simple dilution of the cement.

The EDAX probe is far more sensitive than XRD for the detection of either ettingite or brucite. Preliminary tests on various cement pastes immersed in water for durations up to 91 days and tested at intervals show increasing expansion and levels of both ettingite and brucite.

With reference to the discussion by Mr. Morita, I agree that factors such as insulator design, cement characteristics, porcelain strength, bituminous coatings, manufacturing processes and quality control are all important aspects of insulator quality and therefore long term performance. However, although the IEC thermal mechanical tests has been developed as an accelerated aging test for suspension insulators, as no moisture is involved in the test, I do not believe that the test is an effective one for cement growth.

Regarding the conflicting findings reported in the paper with those of NGK, to suggest that Portland Cement shrinks rather than expands in the long term infers that ASTM C151 or Japanese Industrial JISR 5201 standards for cement expansion are irrelevant tests. Also, no tensile load was necessary to produce radial cracks in the thermal tests of aged but unused insulators. Furthermore, insulators on distribution circuits experience tensile loads of only hundreds of pounds. Of course tensile load will accentuate failure but is not the principle reason for radial cracks in our investigation. In addition, the only insulator which exhibited both circumferential and radial cracks was the 50 kip design, Table 2 of the paper, which occurred during autoclave tests. In this case only, the radial cracks in the porcelain shell may have propagated from the circumferential crack near the top of the pin. As you can see, we have investigated the cracks very carefully.

With reference to the discussion by Dr. Pargamin, we have no direct evidence from failed insulators for excessive gypsum as being responsible for the cement growth problem. Data accumulated to date on various cement pastes show increasing autoclave expansion with MgO and increasing water expansion with SO_3. However, at this time both appear to be equally significant so that we cannot differentiate whether brucite or ettingite is the principle reason for expansion.

Regarding the cement problem in insulators of alumina porcelain, we have field tested thousands of 36 and 50 kip insulators on dead end towers and have not found any with radial cracks. Problems of another type were found with 50 kip insulators in which circumferential cracks developed at the top of the pin. Failures were related to mechanical tension. The problem was diagnosed to be due to a deficiency in insulator design and strength of the porcelain.

Now with reference to the discussion by Dr. Schwalm, the results of tests on new insulators certainly demonstrates the importance of the presence and flexibility of the bituminous coatings on insulator strength. The importance of such coatings has been emphasized by various authors in the past. Although the argument that many of the test results provided in the paper can be interpreted as being due to aging effects of the coatings, this does not explain the significantly lower failure rate, one order of magnitude lower, of insulators on tangent towers than on dead end towers. These failure rates are statistically significant as they are based on field tests involving many thousands of insulators tested with 5 kV meggers.

Finally, I would like to thank the discussers for their valuable contributions to the paper.

Manuscript received April 12, 1983.

IEEE Transactions on Power Apparatus and Systems, Vol. PAS-102, No. 8, August 1983

SINGLE PHASE SWITCHING TESTS ON THE AEP 765 KV SYSTEM – EXTINCTION TIME FOR LARGE SECONDARY ARC CURRENTS

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Abstract – Single Phase Switching (SPS) tests were performed on AEP's Kammer-Marysville 765 kV line during April of 1980 in order to determine the self-extinction times of large secondary arc currents in circuits with varying degrees of SPS compensation. Five fault tests were performed and the results are presented along with an analysis of various secondary arc parameters such as: volt-ampere characteristic, air gap dielectric recovery, harmonic spectrum and energy. An arc model was developed and verified in a computer simulation of one of the test circuits.

INTRODUCTION

Single phase switching (SPS) is becoming a widely accepted means of improving the transient stability of transmission systems and of reducing the torsional impact on generator rotors during circuit reclosing [1]. An SPS scheme has been operational on the AEP Kammer-Marysville 765 kV line since 1980, and it has successfully single phase reclosed two (out of a total of three) SLG faults since its installation. The third fault resulted in a three phase lockout due to a relay misoperation. Two 765 kV lines serving the new AEP Rockport plant will have an SPS capability in order to maintain stability with one line out of service and a single line to ground (SLG) fault on the other.

Successful single phase reclosing on long EHV lines requires some means of ensuring interruption of the secondary arc current (I_1) produced by capacitive and inductive coupling with the two energized phases. This interruption can be accomplished through some combination of these two means: 1) prevent reclosing until the arc gradually self-extinguishes, and 2) install special 4-legged reactive compensation to reduce the magnitude of the secondary arc current, thereby insuring its rapid extinction. The former technique may only be applied to lines where the stability criteria permits longer SPS dead times.

A first series of SPS tests [2,3] were conducted during April and May of 1979. They were performed to determine the effectiveness of shunt reactor compensation schemes and to investigate the conditions of secondary arc current and recovery voltage for successful reclosing within an SPS dead time of one-half second. It was determined that if the 60 Hz component of secondary arc current (I_1) were limited to less than 45 A rms and the rate of rise of peak recovery voltage (RRRV) kept to less than 10 kV/msec, the secondary arc would extinguish in the 0.5 second dead time [3].

This paper reports the results of a second series of SPS tests performed during April of 1980.

83 WM 147-6 A paper recommended and approved by the IEEE Transmission and Distribution Committee of the IEEE Power Engineering Society for presentation at the IEEE/PES 1983 Winter Meeting, New York, New York, January 30-February 4, 1983. Manuscript submitted September 3, 1982; made available for printing November 30, 1982.

The purpose of the tests was to determine the self-extinction times of large secondary arc currents in circuits with varying degrees of SPS compensation. The test data which was obtained can be generalized to systems with either simple or no SPS compensation. The paper also analyzes the secondary arc voltage and current waveforms, introduces an arc model and applies the model in a computer simulation of one of the test circuits.

TEST DESCRIPTION

Single line to ground faults were applied to the Kammer-Marysville 765 kV line at the Marysville Station (Figure 1). The line was energized from

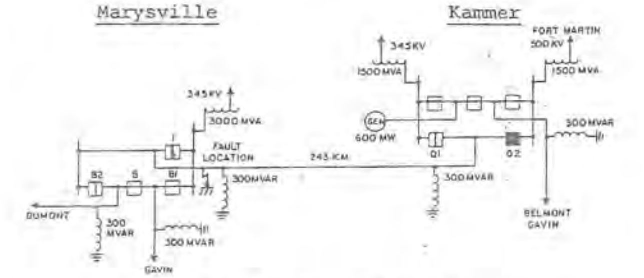

Figure 1: – One Line Diagram of the Test Line
▪ – Breaker used for SPS Operations
◫ – Open Breaker
⊟ – Closed Breaker

Kammer and open ended at Marysville. Therefore, magnetic coupling from load currents was not involved. This is a 243 km, horizontal, three phase, single circuit line [4]. Source strength at Kammer is approximately 20,000 MVA. The line circuit breakers used for the SPS operations are two cycle air blast type, with 640 ohm closing resistors and no opening resistors.

Prior to each test, the arc extinction time was not known. Therefore, the possibility of reinitiating the fault was eliminated by opening the healthy phases rather than attempting to reclose on the faulted phase. The time lag between the faulted phase opening and unfaulted phases opening was up to two seconds.

The line charging current is 86% compensated by a 300 MVAR reactor bank at each end of the line. A neutral reactor was added to each reactor bank to reduce the contribution to secondary arc current by interphase capacitive and inductive coupling. Optimum SPS compensation required neutral reactors of 800 ohms at Kammer and 300 ohms at Marysville [4]. For testing purposes, the neutral reactors were provided with taps of 400 and 200 ohms at Kammer and 150 ohms at Marysville. In addition, the reactor bank at Kammer Station has a special neutral switching scheme to compensate for the difference in interphase capacitance due to the untransposed nature of the line. The steady state 60 Hz component of secondary arc current (I_1) is limited to less than 20 A rms by the specified SPS compensation scheme [2].

The SPS compensation scheme on the line was modified throughout the tests in order that variations in the secondary arc could be obtained. At Marysville, the neutral reactor was shorted to ground for all the

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Insulator Selection is a Complex Balancing Act

Jun 1, 2003 12:00 PM
By Edward A. Cherney, EACH Engineering Inc.

Porcelain and non-ceramic insulators (NCIs) have developed by following similar paths. In the early stages, various problems with both types sometimes occurred because of the learning curve on proper handling and use. More often, however, problems arose from the lack of understanding of the effects of the electrical, mechanical and environmental stresses on the materials, interfaces and insulator constructions. Through service experience and the manufacturers' resulting material and design modifications, both insulator types have become viable products.

The weaknesses of porcelain insulators are well known, largely because of the longer period of development, use and standardization. Apart from acts of vandalism, and occasional problems from poor quality control and misuse, porcelain insulators have served the industry well, and users have attained a significant level of confidence in their long-term reliability. Maintenance methods are well established, and porcelain insulators commonly outlive their 40- to 50-year life expectancy.

NCIs, however, have not yet attained the same level of experience or standardization, and their weaknesses are still being discovered.

NCI Damage

At one time, weathering was considered likely to become the NCIs' predominant cause of failure. This has not proven to be the case. The majority of today's problems stem from the relative ease of damage to the insulator from handling, vandals, birds and animals, flashover, higher operating temperatures, or dry band arcing in contaminated environments. These failure modes have caused heightened concern and increased field inspections.

Furthermore, it is difficult to assess the electrical integrity of NCI insulators while in service, thereby affecting maintenance methods. Although they cost less to install, their maintenance cost, particularly at transmission voltage levels, is becoming noticeable. Increased inspection and maintenance costs will result in a higher anticipated life-cycle cost. In certain applications, the longevity of these insulators is also being questioned.

Porcelain Damage

Porcelain insulators can certainly be damaged by rough handling , acts of vandalism or from flashover. Under normal fault conditions, the glaze sustains only superficial damage. The electrical or mechanical strengths usually are not affected under normal conditions, so change-out is not required. However, under extreme or sustained fault conditions, damage often occurs to the porcelain dielectric and sometimes to the hardware (Fig. 1). The extent of damage is easily spotted from the ground using binoculars, and the need for change-out is easily determined.

Vandal-damaged porcelain insulators also are easily spotted from the ground. Apart from extreme damage, vandal-damaged insulators do not impose immediate operational risks, either mechanically or electrically.

Field Inspection of NCIs

NCIs are more easily damaged than porcelain insulators, and the damage can easily occur during handling, shipping and construction. Vandal damage often requires inspection at close range to assess the extent of the damage because of the NCIs' smaller size. Insulators damaged by vandals may require change-out or monitoring.

Because of the smaller mass of the hardware, flashover (followed by power arc) often affects the insulator attachment hardware or corona ring, requiring change-out. Whether change-out is needed immediately or can be deferred requires inspection of the damage from close range by knowledgeable personnel.

To inspect the insulator, an outage may be necessary to safely assess the damage at close range. Often, change-out can be deferred, but the insulator needs to be monitored.

A sustained fault may cause separation failure (Fig. 2). Sometimes, monitoring for corona on transmission insulators requires night-vision equipment or the use of expensive daytime monitoring equipment. Corona rings on transmission insulators are generally not interchangeable. Even though another ring may fit physically, there is always the uncertainty of whether the ring grades the electric field in the same way as the original ring. This means that corona rings and insulators of the type installed on the system must be kept in stock. For some systems with three or four manufacturers' types, the extra stock of winsulators and corona rings can lead to confusion and extra cost.

Working Live

When manufactured, porcelain suspension insulators are tested to confirm their electrical and mechanical strengths, whereas NCIs are only tested mechanically. Porcelain insulators can be installed live, while NCIs should not, unless they are tested separately and identified as suitable for live installation. Porcelain suspension insulators can be tested through various methods to determine their electrical integrity prior to installing them live.

What Constitutes Damage

Various tests can determine the electrical integrity of a porcelain insulator, while the mechanical integrity can be determined visually. Cracks in posts and severe erosion of hardware, particularly the pin on suspension insulators, will lead to a severe loss of mechanical strength. A complete loss of the porcelain shell of a suspension insulator will result in a reduced strength but not low enough to jeopardize the insulator's ability to support the line.

What constitutes damage to NCIs and whether change-out is required immediately or can be deferred is not always so clear-cut. Most often field personnel knowledgeable in NCI designs must examine the damage at close range. The ease of damage to the thin rubber sheath on suspension, post types and bushings, exposing the fiberglass core to moisture, is a major concern. It can lead to a tracking failure or fracture of the insulator core. This type of damage can result from installation, birds or vandals (Fig. 3). Flashover of NCIs causing rupture of the rubber end seals also clearly constitutes a potential failure mode (Fig. 4).

Damage to the insulator housing, either by corona cutting or dry band arcing, can present a serious failure mechanism. Still, uncertainty and confusion exists at this time as to whether a loss of hydrophobicity of the NCI housing constitutes failure.

Latent Defects

The use of unsuitable cement in the assembly of porcelain insulators, in particular, suspension, pin-type and some designs of line posts, can cause cracks in the shells of these insulators. This latent defect could take 10 or more years to manifest itself in the field (Fig. 5). This volume expansion mechanism, generally referred to as cement growth, will lead to catastrophic failures of pin-type and line post insulators.

However, in ceramic suspension insulators, the shells will crack causing dielectric failure, but the mechanical strength is hardly affected. Of course the ensuing arc of a flashover passing through the head of a suspension insulator may result in the head blowing apart, leading to string separation and line drop. This latter failure mechanism is a rare occurrence as more than one cracked insulator in a string must be present for the arc to penetrate an insulator.

Porcelain also contains micro-cracks, which sometimes are introduced into the body during manufacturing. These micro-cracks may lead to dielectric failure with time, a phenomenon called aging. No tests are performed after assembly to detect for possible cracks in the dielectric.

NCIs also may contain latent defects. When the hardware is swaged to the core or if the compression dies are worn (or when over-crimping happens), a crack may develop in the fiberglass rod that can lead to puncture under lightning (Fig. 6) or even brittle fracture failure. Another serious, possible latent defect in NCIs is the bonding between the rubber housing and the fiberglass core. A slight change in rubber housing injection machine parameters, such as temperature or time, may result in poor or no bonding between the fiberglass core and the rubber housing. As only a statistical sampling of the moulded housings are examined for bonding, and no in-process tests are performed, this type of defect manifests itself in service by dielectric failure along the interface because of moisture ingress. Brittle fracture of the fiberglass core also may occur.

Performance Under Contamination

The performance of porcelain insulators varies considerably under contamination depending on factors that include: insulator type, design and leakage distance; type and severity of the contaminant; nature and frequency of the precipitation; and the degree of natural cleaning. In all but a few locations, the contaminant simply overwhelms the insulators and develops leakage current and channelled dry band arcing. This leads to porcelain dielectric shattering. Porcelain can withstand the heat produced by leakage current, dry band arcing, and flashover without damage. Change-out is not necessary, and the insulators can be restored to service by cleaning.

Routine maintenance, such as water washing or dry cleaning, removes contamination and restores insulators to their original insulation strength, thereby preventing flashover. Greasing and silicone-rubber coatings will reduce the required maintenance, and in many instances, particularly silicone-rubber-coated insulators, maintenance cleaning may be delayed for more than 10 years. The maintenance methods for porcelain insulators are well developed, and various industry application guides are available.

NCIs' flashover performance is considerably better than porcelain insulators, as confirmed through various laboratory tests. However, they cannot withstand the heat produced from leakage current and dry band arcing as well as porcelain. So the rubber housing erodes, exposing the fiberglass core to moisture and voltage, leading to tracking of the core and insulator failure.

Although NCIs can be routinely cleaned using the methods developed for porcelain, damage will occur if, for example, the water pressure is too high or if abrasive dry cleaning techniques are used. Both cleaning methods are still under development for NCI's. The same techniques should not be used for all NCIs because of their different materials and constructions. Any one method might effectively clean some insulators while damaging others.

After monitoring the erosion of NCI housings, or after experiencing flashovers in severe contamination, a few utilities have returned to porcelain, along with their required maintenance, to obtain greater reliability.

Conductor Temperature

The fiberglass core in NCIs is subject to creep while under tension, a phenomenon of plastic flow that occurs at elevated temperatures. In addition, the chemical bond of the primer layer between the rubber housing and the metal hardware that forms the end seals in NCIs may not be stable under elevated hardware temperatures.

Today's conductors have emergency ratings of 200°C (392°F), thereby producing hardware temperatures in excess of 100°C (212°F). This is a concern because the effects of high temperature on the compression attachment of the hardware to the core and the long-term stability of the end seals are unknown.

Final Evaluation

As with any new technology, service experience is often needed to uncover problems and sometimes it takes a long time to uncover the weaknesses. NCIs provide significant advantages because they are lightweight, easier to install and lower in cost.

Possible Sustained Damage to Porcelain and Non-Ceramic nsulators

Condition	Porcelain	Nonceramic
Handling &Shipping	Possible damage	Easily damaged
Storage	Damage unlikely	Damage possible
Construction	Possible damage	Easily damaged
Lightning	Possible puncture Unlikely housing damage No hardware damage Change-out not required	Possible puncture Unlikely housing damage Possible hardware damage Change-out may be required
Sustained fault	Separation unlikely	Separation likely
Maintenance procedures	Live methods	De-energized
High conductor temperature	Unknown	Unknown
Monitoring	Not required	Required
Contamination	Cleaning, grease, RTV coating methods standardized	Damage during cleaning possible, failure likely
Latent defects	Cement growth Micro-cracks in porcelain	Swaging damage to core Bonding of housing to core
Vandalism	Easily spotted from the ground	Close-up inspection required

NCIs can provide utilities real benefits over porcelain. They are initially lower in cost and easier to install. However, it is likely that NCIs may ultimately cost more to maintain, resulting in a higher life-cycle cost. Expenses related to monitoring, de-energized maintenance, and more frequent change-outs in problem areas must be taken into account when comparing the true cost and reliability of an insulator strategy.

Although NCIs have been on the marketplace for decades and the insulating compounds and end fitting methods have improved dramatically, we still have more to learn. The key to a successful insulator strategy requires a good grasp of the advantages and disadvantages for both porcelain and NCIs for utility-specific conditions and environment. Utilities now have two viable choices in insulator types, and sound engineering and business decisions will ensure the utility obtains the desired service life.

Edward A. Cherney received a BS degree in physics and chemistry from the University of Waterloo in 1967; an MS degree in physics from McMaster University in 1969; and a Ph.D. in electrical engineering from the University of Waterloo in 1974. In 1968, he began his career in the electrical insulation field working in the research division of Ontario Hydro. Cherney later worked for a manufacturer of insulators and then with a manufacturer of silicone materials. He is an adjunct professor at the University of Waterloo. He is involved in several IEEE working groups on insulators, is a registered engineer in the province of Ontario, and is a Fellow of the IEEE.
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Find this article at:
http://www.tdworld.com/mag/power_insulator_selection_complex/index.html

☐ Check the box to include the list of links referenced in the article.

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CI Number: 43293

Title: **Brushy Hill Protection Upgrades**

Start Date: 2012/09
Final Cost Date: 2013/09
Function: Transmission
Forecast Amount: 2,788,064

DESCRIPTION:

This project provides for the costs to upgrade the protections system at 210H Brushy Hill to comply with Northeast Power Coordinating Council (NPCC) reliability criteria for bulk power systems. The estimated useful life for protection systems is approximately 40 years.

Depreciation Class: Transmission Station Equipment

Summary of Related CIs +/- 2 years:
2011 CI 40231 Protection Upgrades Lakeside $1,609,905
2011 CI 40233 2011 Protection Upgrades TUC $3,928,932

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: System Protection

Why do this project?

In 2008, NPCC approved new criteria (Criteria Document A-10 – Attachment #2) for determining whether a substation bus is categorized as bulk power. The criterion is used to identify substation busses that, if a fault was not successfully cleared by protection, the situation could result in disturbances outside the local operating area.

Stations identified through this criterion are required to have fully redundant protection, control and communication schemes as defined in NPCC Directory #4 – Bulk Power System Protection Criteria (Attachment#3). The 120H Brushy Hill substation bus meets the criteria for a bulk power element and currently does not have fully redundant protection, control, and communication schemes in place.

Why do this project now?

Implementation of the redundant protection schemes are based on agreement with NPCC which requires completion by the end of 2013. Because this work is technically complex and involves modifications to energized equipment, NS Power developed a plan to complete the modifications to the five stations requiring this upgrade over a four year period. A portion of 79N-Hopewell was completed in 2010 and was finished in 2011. 91H-Tufts Cove was completed in 2012 and the 138kV portion of 103H-Lakeside will be completed in 2013. The last substation to be addressed is 120H-Brushy Hill.

Why do this project this way?

To comply with the updated NPCC standards, fully redundant protection, control and communication systems must be installed for all bulk power elements identified under the A-10 Criteria.

NS Power personnel will be completing the work associated with this project.

CI Number : 43293 - Protection Upgrade Brushy Hill (138KV) **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		126,345	0	126,345
094		094 - Interest Capitalized		49,932	0	49,932
095		095 - T&CS Regular Labour AO		52,300	0	52,300
095		095-COPS Contracts AO		118,051	0	118,051
095		095-COPS Regular Labour AO		223,853	0	223,853
012	003	012 - Materials	003 - TP - Bldg.,Struct.Grnd.	1,025	0	1,025
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	59,796	0	59,796
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	642,900	0	642,900
013	022	013 - COPS Contracts	022 - TP - Elec Contr.Equip.	[redacted]	0	[redacted]
066	022	066 - Other Goods & Services	022 - TP - Elec Contr.Equip.	120,000	0	120,000
001	023	001 - T&D Regular Labour	023 - TP - Power Equip.-Station S	10,107	0	10,107
012	023	012 - Materials	023 - TP - Power Equip.-Station S	84,200	0	84,200
013	023	013 - COPS Contracts	023 - TP - Power Equip.-Station S	[redacted]	0	[redacted]
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	58,112	0	58,112
012	043	012 - Materials	043 - TP - Substn Dev.	162,000	0	162,000
001	061	001 - T&D Regular Labour	061 - TP - Switched Telecomm. Sys	5,895	0	5,895
012	061	012 - Materials	061 - TP - Switched Telecomm. Sys	46,400	0	46,400
013	061	013 - COPS Contracts	061 - TP - Switched Telecomm. Sys	[redacted]	0	[redacted]
001	085	001 - Regular Labour (No AO)	085 Design	9,000	0	9,000
001	085	001 - T&CS Regular Labour	085 Design	182,168	0	182,168
011	085	011 - Travel Expense	085 Design	2,220	0	2,220
028	085	028 - Consulting	085 Design	76,800	0	76,800
041	085	041 - Meals & Entertainment	085 Design	2,250	0	2,250
066	085	066 - Other Goods & Services	085 Design	224,341	0	224,341
001	086	001 - T&D Regular Labour	086 Commissioning	172,528	0	172,528
013	087	013 - COPS Contracts	087 Field Super.& Ops.	[redacted]	0	[redacted]
			Total Cost:	2,788,064	0	2,788,064
			Original Cost:			

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 43293
Title: 120H-Brushy Hill BPS Upgrades 138KV- A-10
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician/ Technician	Person Day	[redacted]	[redacted]	$ 264,795.54		
1.2	Engineering (P.Eng)	Hour	[redacted]	[redacted]	$ 182,168.00		
1.3	Project Support Labour (No AO)	Hour	[redacted]	[redacted]	$ 9,000.00		
1.4	Technologist	Hour	[redacted]	[redacted]	$ 22,866.00		
1.5	CADD	Hour	[redacted]	[redacted]	$ 18,777.00		
1.6					$ -		
				Sub-Total	$ 497,606.54		
2	**012 Materials**						
2.1	Battery Charger	Item	1	10,000.00	$ 10,000.00		41348
2.2	Battery Bank	Item	1	35,000.00	$ 35,000.00		41348
2.3	Protection Panel	Item	12	40,000.00	$ 480,000.00		40233
2.4	Primary Equipment Modification	Lot	1	162,000.00	$ 162,000.00		
2.5	Communications Panel & Material	Lot	1	46,400.00	$ 46,400.00		
2.6	Misc Substation Equip & Materials	Lot	1	203,125.00	$ 203,125.00		
2.7							
2.8							
				Sub-Total	$ 936,525.00		
3	**013 T&D Contracts**						
3.1	Control Building & Trench	Contract	[redacted]	[redacted]	[redacted]		41348, 40233
3.2	Site Supervisor	Hour	[redacted]	[redacted]	[redacted]		
3.3	Lift Equipment/ Metal Fabrication	Contract	[redacted]	[redacted]	[redacted]		
				Sub-Total	$ 357,840.00		
4	**028 Consulting**						
4.1	Design Consultants	Hours	[redacted]	[redacted]	$ 76,800.00	[redacted]	
4.2							
4.3							
				Sub-Total	$ 76,800.00		
5	**011 & 041 Travel and Meal Expenses**						
5.1	Travel	Lot	1	2220	$ 2,220.00		
5.2	Meals	Lot	1	2250	$ 2,250.00		
5.3							
				Sub-Total	$ 4,470.00		
6	**066 Other Goods and Services**						
6.1	Project Contingency	Lot	1	224,341.00	$ 224,341.00		
6.2	Miscellaneous for Control Building & Breakers	Lot	1	120,000.00	$ 120,000.00		
6.3					$ -		
6.4					$ -		
				Sub-Total	$ 344,341.00		
7	**094 Interest Capitalized**						
7.1	Interest		1	49,932.16	$ 49,932.16		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 49,932.16		
8	**095 Administrative Overhead**						
8.1	Contracts AO		1	118,051.40	$ 118,051.40		
8.2	Labour AO		1	276,153.28	$ 276,153.28		
8.3	Vehicle AO		1	126,344.65	$ 126,344.65		
				Sub-Total	$ 520,549.33		
Cost Estimate				**Total**	$ 2,788,064.03		
9	**Original Cost**						
9.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

NPCC, Inc.

NORTHEAST POWER COORDINATING COUNCIL, INC.
1040 AVE OF THE AMERICAS, NEW YORK, NY 10018 TELEPHONE (212) 840-1070 FAX (212) 302-2782

Implementation Plan for Revised NPCC Document A-10

Approved by Full Member Ballot – December 01, 2009

This Implementation Plan provides for testing in accordance with the revised NPCC *Classification of Bulk Power System Elements*, Document A-10, to be completed as follows:

- Testing in accordance with the revised A-10 methodology shall be performed on all facilities that have not been evaluated under the existing A-10 methodology as of the date the revised A-10 is approved.
- Testing in accordance with the revised A-10 methodology shall be performed on all facilities within five years from the date the revised A-10 is approved.

Each **Area** shall ensure that this Implementation Plan is followed within its **Area**.

NPCC, Inc.

NORTHEAST POWER COORDINATING COUNCIL, INC.
1040 AVE OF THE AMERICAS, NEW YORK, NY 10018 TELEPHONE (212) 840-1070 FAX (212) 302-2782

Classification of Bulk Power System Elements

Adopted by the Members of the Northeast Power Coordinating Council Inc., this April 28, 2007 based on recommendation by the Reliability Coordinating Committee, in accordance with Section VIII of the NPCC Inc. Bylaws dated May 18, 2006 as amended to date.

1.0 Introduction

NPCC defines specific requirements applicable to design, operation, and **protection** of the **bulk power system**. The object of this *Classification of **Bulk Power System Elements*** (Document A-10) is to provide the methodology to identify the **bulk power system elements**, or parts thereof, of the interconnected NPCC Region.

The methodology in this document is used to classify **elements** of the **bulk power system** and may result in **elements** being added to or removed from the NPCC **Bulk Power System** List. The methodology in this document is based on the following:

- Results of an analysis done on a bus basis can be applied to identify which **elements,** or portions thereof, connected to the bus are part of the **bulk power system**.

- **Elements** shall not automatically be included or excluded from the **bulk power system** based on voltage class. Application of this methodology may be omitted at buses that can be logically excluded from the **bulk power system** based on study results at other buses tested using this methodology. If a bus is determined to be **bulk power system**, all other buses with elements connected to that bus must be tested.

- **Elements** shall be evaluated based on this methodology when significant changes occur on the system that could change an **element**'s **bulk power system** status; the evaluation may be limited to the affected part of the system.

- **Areas** and facility owners may adopt methodologies that exceed the requirements set forth in this document for their own purposes. However, only **elements** classified as **bulk power system** as a result of testing described in this document shall be included on the NPCC's list of **bulk power system elements**. NPCC criteria and compliance monitoring shall consider only the system **elements** listed on NPCC's list of **bulk power system elements**.

The Classification of **Bulk Power System Elements** is based on three defined terms: **bulk power system**, **local area** and **significant adverse impact**.

2.0 Definitions

Terms in italics in this document are defined in this section.

Terms in bold are defined in the *NPCC Glossary of Terms* (Document A-7).

2.1 *Bus*

Within this document the term *bus* refers to a junction with sensing or **protection** equipment within a substation or switching station at which the terminals of two or more **elements** are connected, regardless of whether circuit breakers are provided. In this context, *bus* may not have a direct correlation to the use of this term in substation design or a power flow data set.

In some configurations a *bus* may include more than one physical *bus*, such as in a breaker-and-a-half arrangement or a single-line-single-breaker arrangement in which two physical *buses* are connected through a *bus*-tie breaker. The examples in Figure 1 depict two of many possible configurations where two physical *buses* are tested as a single *bus*. *Buses* that are separated by normally open *bus*-tie breakers are considered as separate *buses*. The termination of line sections through switches should not be considered as a *bus* requiring testing unless the switches are activated as part of a **protection system** for the line which they sectionalize as part of normal **protection system** actions.

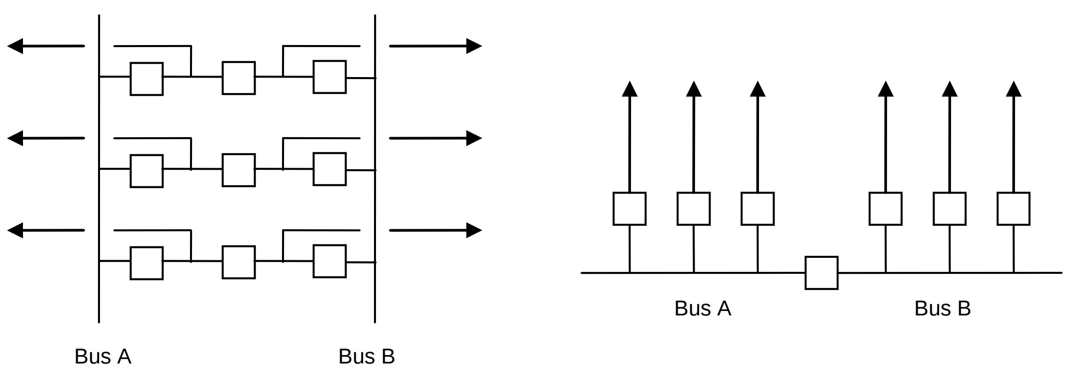

Figure 1 – Configurations where *Bus* A and *Bus* B are tested as one *bus*.

In some configurations **elements** may not be terminated to the *bus* through circuit breakers, such as the generator *bus* for a unit connected generator or a *bus* between a transmission line and transformer that are switched as a single circuit. The examples in Figure 2 depict two of many configurations where two physical *buses* are tested as separate *buses*.

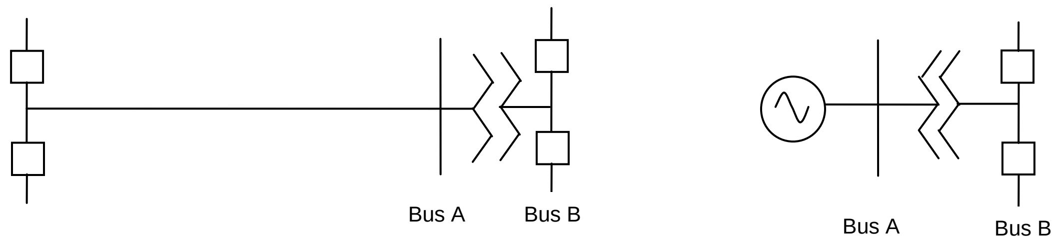

Figure 2 – Configurations where *Bus* A and *Bus* B are tested as two separate *buses*.

2.2 *Uncleared Locally*

Within this document the phrase *uncleared locally* is used to denote failure of the **protection** including **Special Protection Systems** for the *bus* under test to initiate tripping of all associated interrupting devices regardless of their location.

Protection located at other *buses* is assumed to operate as designed when that **protection** cannot be disabled by failure of a single component in common with the **protection** at the *bus* under test. For example, consider the case where the **protection** for **elements** connected to higher voltage level and lower voltage level *buses* in the same station share a dc source, and an independent dc source is provided for second **protection groups** associated with **elements** connected to the higher voltage level *bus*. In this case, it is acceptable when testing the lower voltage level *bus* to assume correct operation of any **protection groups** associated with **elements** connected to the higher voltage level *bus* capable of detecting the **fault** and supplied by the independent dc source.

In cases where circuit breakers are not provided at the terminals of the **element** at the *bus* under test (as shown in Figure 2, *bus* A), *uncleared locally* includes a failure to clear a **fault** by circuit breakers located at another *bus* within the same substation, unless back-up **protection** at that other *bus* using an independent dc source would detect the **fault** and initiate clearing.

3.0 Classification of Bulk Power System Elements

3.1 Testing Conditions and Assumptions

Studies conducted for the purpose of determining the **elements** of the **bulk power system** shall assume the following conditions:

3.1.1. Power flow transfers, **load** and **generation** patterns expected to exist for the period under study which stress the system in a manner critical to the classification of the *bus* to be tested. All **reclosing** facilities rendered inoperative.

3.1.2. Operation of **Special Protection Systems**, undervoltage **load shedding** and underfrequency **load shedding** modeled as designed.

3.1.3. Load models used in the **Transient Stability** Test are consistent with **Area** practices for the studies of rotor angle stability.

3.1.4. Load models used for steady state testing are either constant MVA or are based on actual system testing with LTC movement.

3.1.5. Stability simulation runs until the system response can be clearly determined.

3.1.6. Generic or detailed relay models to monitor, after tripping of remote terminals, the potential for tripping of un-faulted **elements**.

3.2 <u>Test Methodology</u>

Both **transient stability** and steady-state tests are used to determine the impact on system performance resulting from power system **faults**.

Testing is based on application of a *bus* **fault** at a single voltage level that is *uncleared locally*. Tripping of un-faulted **elements** associated with clearing the test **fault** does not constitute a **significant adverse impact**.

Depending on system configuration or topology, testing only **faults** at *buses* can fail to uncover **significant adverse impacts** arising <u>from a design criteria contingency involving the loss of two adjacent transmission circuits on a common tower.</u> Hence, specific tests in 1c and 2c below are designed to assess this contingency for its potential **significant adverse impact** outside of the **local area**.

A **transient stability** test may be done first to identify *buses* at which **faults** may cause a **significant adverse impact** outside of the **local area**.

For those *buses* which are not classified as **bulk power system** in the **transient stability** test, a steady-state test is used to identify *buses* at which **faults** may cause a **significant adverse impact** outside of the **local area**.

Step 1 - Transient Stability Test

Simulate the **transient stability** condition of a three-phase **fault** with delayed clearing at the *bus* under test (step 1a). If the test results in a positive **bulk power system** determination, more detailed testing (step 1b) may be applied to obtain a more precise determination.

1a. Apply a three-phase **fault** for at least 10 seconds at the *bus* that is being tested. Do not open any of the **elements** connected to the *bus* for the duration of the **fault**. After 10 seconds, simulate tripping of all terminals of each **element** connected to the *bus* under test. In cases where there is no **fault** interrupting device at the remote terminal of an **element**, open all terminals of all **elements** between the *bus* under test and the interrupting device(s) that will open to clear the **fault**. This test is performed as an efficient, but conservative method for evaluating the impacts of:

- *bus* **faults** which would result in faster clearing time, and
- **faults** off the *bus*.

It is recognized that due to the conservative nature of this test some **elements** could be classified unnecessarily as part of the **bulk power system**. If the above test results in a positive **bulk power system** determination, the following additional testing may be utilized to obtain a more precise determination. Subsequent testing utilizes design clearing times for the conditions being tested, as stated below.

1b. Apply a three-phase **fault** at the *bus*, which is *uncleared locally* and trip the remote terminals of all **elements** that will open to clear the **fault**. Remote clearing times shall be based on design **fault clearing** times, assuming no communications from the station under test to the remote terminals.

Transformers and other **elements** connected to the *bus* shall only be tripped by operation of independent remote **protection groups** capable of clearing a **fault** on the *bus* under test.

Some **protection groups** (e.g. directional comparison blocking) at remote terminals may provide high-speed **fault clearing** for faults at the bus under test. In order to test the effects of longer **fault clearing** times for fault conditions when these remote **protection**

groups would not provide high speed **fault clearing**, for either test (1a) or (1b) above:

- High-speed **fault clearing** at remote terminals must be ignored; or
- Testing must vary the placement of the 3-phase **fault** on the elements connected to the bus under test to include locations beyond the reach of the high-speed tripping relay element at the remote terminal.

However, the **protective relay** settings may be reviewed to determine whether the *bus* could be classified as not part of the **bulk power system** if faster remote **fault** clearing can be achieved. If **protective relay** settings are modified, an assessment shall be conducted to ensure that the faster clearing time does not compromise the security of the **protection system**. Until the **protective relay** settings are modified, the *bus* must be classified as **bulk power system**.

1c. The test above is meant to cover the majority of design criteria contingencies. However, the **elements** associated with the *bus* under test must be reviewed to ensure adverse consequences resulting from a design criteria contingency involving the loss of two adjacent transmission circuits on a common tower are not overlooked.

If a circuit terminating at the *bus* under test shares a multiple circuit tower with an adjacent circuit that does not terminate at the *bus* under test, the adjacent circuit design contingency must also be assessed. In such cases, simultaneous permanent phase to ground **faults** on different phases of each of two adjacent transmission circuits shall be applied at critical common tower locations. The **fault** on the circuit associated with the *bus* under test which is *uncleared locally*, shall be simulated with **normal fault clearing** at the remote terminal and on the adjacent circuit.

If the **fault** has a **significant adverse impact** outside of the **local area**, the *bus* is classified as part of the **bulk power system**.

For *buses* not classified as part of **bulk power system** in Step 1, continue with the Steady State Test in step 2.

Step 2 - Steady State Test

Simulate the post-**contingency** steady-state conditions based on one of the following outcomes of the **fault** applied to the *bus* under test:

2a. If the **fault** was cleared based on design **fault clearing** times in the **Transient Stability** Test, open the same **elements** that were opened to clear the **fault** in the Transient Test. Post-**contingency** conditions shall reflect operation of all automatic devices.

2b. If the **fault** was not cleared based on design **fault clearing** times in the **Transient Stability** Test, assume that the **fault** propagates to the nearest location where it can be detected by independent **protection groups** and open the **elements** that would be opened by the **protection groups** to clear the **fault**. Note that because **fault clearing** will occur at interrupting devices capable of clearing the **fault**, it may be necessary to open multiple **elements** between the *bus* under test and the relevant interrupting devices, for example, a transmission line and transformer in series as shown in Figure 2.

2c. As in Step 1, the steady state test above is meant to cover the majority of design criteria contingencies. However, the **elements** associated with the *bus* under test must be reviewed to ensure adverse consequences resulting from a design criteria contingency involving the loss of two adjacent transmission circuits on a common tower are not overlooked. The post-contingency analysis must assess the loss of any adjacent circuit on common towers with a circuit terminating at the *bus* under test in addition to the **elements** associated with the *bus* under test.

Voltages and thermal loading will be assessed for **significant adverse impact** outside of the **local area** following automatic actions. In cases where a power flow solution is not obtained, other techniques shall be used to assess the impact of the event on the power system.

If the **fault** has a **significant adverse impact** outside of the **local area**, the *bus* is classified as part of the **bulk power system**.

Note that Step 2 can be done prior to Step 1. If a *bus* is classified as part of the **bulk power system** by the Steady State Test (Step 2), the **Transient Stability** Test (Step 1) need not be done for that *bus*.

3.3 Utilization of Test Results to Classify on an **Element**-by-**Element** Basis**.**

Classification of **bulk power system elements** is achieved by applying the results of the above tests to the **elements** connected to the tested *bus*.

An **element** with only one terminal such as a generator, shunt reactor, or capacitor bank, is classified as part of the **bulk power system** if the *bus* at which it is connected is classified as part of the **bulk power system**.

An **element** with multiple terminals such as a transformer or transmission line is classified as part of the **bulk power system** if any terminal of the **element** is connected to a *bus* that is classified as part of the **bulk power system**. The **bulk power system** classification may be limited to only a portion of the **element** if all of the following conditions are met:

- At least one terminal is connected to a *bus* that is not part of the **bulk power system**.

- The Steady State Test has been applied at the *buses* connected to all terminals of the **element** and none of these *buses* have been classified as part of the **bulk power system** based on results of the Steady State Test.

- The **Transient Stability** Test has been applied between the terminals of the **element** to identify those portions of the **element** for which the **Transient Stability** Test will not result in a **significant adverse impact** outside of the **local area**.

3.4 Documentation

Documentation for **Bulk Power System** classification shall include:

3.4.1 The rationale for the test conditions and assumptions used that are not listed above in 3.1.

3.4.2 The criteria used in evaluating the result of the testing including but not limited to stability, voltage, and thermal performance.

3.4.3 Detailed result of the testing shall be provided upon request.

4.0 Application and List Maintenance

Each **Area** shall be responsible for the application of the *Classification of* **Bulk Power System** *Elements* as described in this document and shall submit proposed changes and supporting documentation to the Task Force on System Studies (TFSS).

The "NPCC **Bulk Power System** List" will be maintained by the TFSS. Additions to and removals from the NPCC **Bulk Power System** List will be submitted by TFSS to the Reliability Coordinating Committee (RCC) for approval.

4.1 Addition of **Elements** to the **Bulk Power System** List

When application of this methodology identifies an **element** that was not part of the **bulk power system** should be classified as a **bulk power system element**, documentation of the analysis shall be presented to the TFSS. Once classification of the **element** is recommended by TFSS and approved by the RCC the **element** will be added to the NPCC **Bulk Power System** List with the appropriate comments and information. All task forces and the Compliance Committee will be notified once an **element** is approved by the RCC to be added to the **Bulk Power System List**. Within three months of an element being added to the **Bulk Power System** List, a plan and schedule for achieving compliance shall be provided to TFSP for review and acceptance. TFSP may require modifications to the proposed plan and schedule.

4.2 Removal of **Elements** from the **Bulk Power System** List

When application of this methodology identifies a **bulk power system element** that no longer should be classified as a **bulk power system element**, documentation of the analysis shall be submitted to the TFSS. If reclassification of the **element** is recommended by TFSS and approved by the RCC, the **element** will be removed from the NPCC **Bulk Power System** List.

Lead Task Force:	Task Force on Coordination of Planning
Reviewed for concurrence by:	TFSS, TFCO, TFSP, and TFIST
Review frequency:	4 years
References:	*Basic Criteria for Design and Operation of Interconnected Power Systems* (Document A-2)
	NPCC Glossary of Terms (Document A-7)

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NPCC
Regional Reliability Reference Directory # 4
Bulk Power System Protection Criteria

Task Force on System Protection Revision Review Record:
December 01, 2009

Adopted by the Members of the Northeast Power Coordinating Council, Inc. December 01, 2009 based on recommendation by the Reliability Coordinating Committee, in accordance with Section VIII of the NPCC Amended and Restated Bylaws dated July 24, 2007 as amended to date.

Revision History

Version	Date	Action	Change Tracking (New, Errata or Revisions)

Table of Content

1.0 Introduction

1.1 Title — Protection Criteria

1.2 Directory Number — 4

1.3 Objective

The purpose of this Directory is to provide the **protection** criteria, for **protection** of the NPCC **bulk power system**. It is not a design specification.

1.4 Effective Date — December 01, 2009

1.5 Background

This Directory was developed from the draft NPCC A-05 Bulk Power Protection Criteria document dated December 4, 2008 and approved B-05, B-07, B-24 and C-22 documents. Guidelines and procedures for consideration in the implementation of this Directory are provided in Appendix A.

1.6 Applicability

1.6.1 Functional Entities

Transmission Owners
Generator Owners

1.6.2 Facilities

1.6.2.1 New Facilities

These criteria shall apply to all new Bulk Power System (BPS) facilities.

1.6.2.2 Existing Facilities

It is the responsibility of individual companies to assess the **protection systems** at existing facilities and to make modifications which are required to meet the intent of these criteria as follows.

1.6.2.2.1 Planned Renewal or Upgrade to Existing BPS Facilities

It is recognized that there may be portions of the **bulk power system,** which existed prior to each member's adoption of the *Bulk Power System Protection Criteria* (Document A-5) that do not meet these criteria. However, if **protection systems** or sub-systems of these facilities are replaced as part of a planned renewal or upgrade to the facility and do not meet all of these criteria, then an assessment shall be conducted for those criteria that are not met.

The result of this assessment shall be reported, It is recommended this reporting be in accordance with the procedure stipulated in Section 4.0 of Appendix A of this Directory and using the appropriate portion of the "Protection System Review forms" (formerly C-22 forms), for review and disposition by the TFSP, or in a form consistent with the intent of the procedure.

1.6.2.2.2 Facility Classification Upgraded to **Bulk Power System**.

These criteria apply to all existing facilities which become classified as **bulk power system**. A mitigation plan shall be required to bring such a facility into compliance with these criteria.

Where the owner of the **protection system** has determined that the cost and risks involved to implement physical separation, as per Section 5.12, cannot be justified, the reason for this determination and an assessment shall be reported to the TFSP.

It is recommended this reporting be in accordance with the procedure stipulated in Section 4.0 of Appendix A of this Directory and using the appropriate portion of the "Protection System Review forms" (formerly C-22 forms), for review and disposition by the TFSP, or in a form consistent with the intent of the procedure.

1.6.2.2.3 Additions to **Bulk Power System** Facilities

If a **bulk power system element** is added to an existing **bulk power system** facility that is recognized under Section 1.6.2.2.1, Planned Renewal or Upgrade to Existing Facilities, these criteria apply to the **protection systems** for the new **element**.

1.6.2.2.4 "In-Kind" Replacement of **Bulk Power System** Equipment

If a **bulk power system element** (e.g., breaker, transformer, capacitor bank, reactor, etc.) or a **protective relay** is replaced "in kind" as a result of an unplanned event, then it is not required to upgrade the associated **protection system** to comply with these criteria.

1.6.2.2.5 Change in **Bulk Power System** Facility Status

When a facility was originally on the BPS list of April 2007 and has been shown to be non-BPS but later was determined to be BPS again, Section 1.6.2.2.1 would apply. When the facility returns to BPS status, it shall be maintained in accordance with Directory #3 within two years timeframe.

1.6.3 Responsibility

Whenever changes are anticipated in generating sources, transmission facilities, or operating conditions, Generator Owners and Transmission Owners shall review those **protection system** applications (i.e., settings, ac and dc supplies) which can reasonably be expected to be impacted by those changes.

2.0 Terms Defined in this Directory

The definitions of terms found in this Directory appearing in bold typeface, can be found in Document A-07, NPCC *Glossary of Terms*.

3.0 NERC ERO Reliability Standard Requirements

The NERC ERO Reliability Standards containing requirements that are associated with this Directory include, but may not be limited to:

3.1 PRC-001
3.2 PRC-002
3.3 PRC-012

4.0 NPCC Regional Reliability Standard Requirements

None.

5.0 NPCC Full Member, More Stringent Criteria

These Criteria are in addition, more stringent or more specific than the NERC or any Regional Reliability standard requirements.

5.1 General Criteria

The intent of the criteria established in this Directory is to ensure dependable and secure operation of the **protection systems** for **Bulk Power System** facilities. For those **protective relays** intended for removal of **faults** from the **bulk power system**, dependability is paramount, and the redundancy provisions of the criteria shall apply. For **Protective relays** installed for reasons other than **fault** sensing such as overload, etc., security is paramount, and the redundancy provisions of the criteria do not apply. The relative effect on the **bulk power system** of a failure of a **protection system** to operate when desired versus an unintended operation shall be weighed carefully in selecting design parameters as follows.

5.2 Criteria for Dependability

5.2.1 Except as identified otherwise in these criteria, all elements of the **bulk power system** shall be protected by two protection **groups**, each of which is independently capable of performing the specified protective function for that **element.** This requirement also applies during energization of the **element.**

5.2.2 Except as identified otherwise in these criteria, the two **protection groups** shall not share the same component**.**

5.2.3 Means shall be provided to trip all necessary local and remote breakers in the event that a breaker fails to clear a fault. This **protection** need not be duplicated.

5.3 Criteria for Security

Protection systems shall be designed to isolate only the faulted **element**, except in those circumstances where additional **elements** are tripped intentionally to preserve system integrity, or where isolating additional **elements** has no impact outside the local area.

5.4 Criteria for Dependability and Security

5.4.1 The thermal capability of all **protection system** components shall be adequate to withstand rated maximum short time and continuous loading of the associated **protected elements**.

5.4.2 Communication link availability, critical switch positions, and trip circuit integrity, shall be monitored to allow prompt attention by appropriate operating authorities.

5.4.3 When remote access to **protection systems** is possible, the design shall include security measures to minimize the probability of unauthorized access to the protection systems.

5.4.4 Short Circuit Models used to assess **protection** scheme design and to develop **protection** settings shall take into account minimum and maximum fault levels and mutual effects of parallel transmission lines. Details of neighboring systems shall be modeled wherever they can affect results significantly.

5.5 Operating Time Criteria

Bulk power system protection shall take corrective action within times determined by studies with due regard to security, dependability and selectivity.

5.6 Current Transformer Criteria

Current transformers (CTs) associated with **protection systems** shall have adequate steady-state and transient characteristics for their intended function as follows:

5.6.1 The output of each current transformer secondary winding shall be designed to remain within acceptable limits for the connected burdens under all anticipated **fault** currents to ensure correct operation of the **protection system**.

5.6.2 The thermal and mechanical capabilities of the CT at the operating tap shall be adequate to prevent damage under maximum **fault** conditions and normal or **emergency** system loading conditions.

5.6.3 For **protection groups** to be independent, they shall be supplied from separate current transformer secondary windings.

5.6.4 Interconnected current transformer secondary wiring shall be grounded at only one point.

5.6.5 Current transformers shall be connected so that adjacent **protection** zones overlap.

5.7 Voltage Transformer and Potential Devices Criteria

Voltage transformers and potential devices associated with **protection systems** shall have adequate steady-state and transient characteristics for their intended functions as follows:

5.7.1 Voltage transformers and potential devices shall have adequate volt-ampere capacity to supply the connected burden while maintaining their **relay** accuracy over their specified primary voltage range.

5.7.2 The two **protection groups** protecting an element shall be supplied from separate voltage sources. The two protection groups may be supplied from separate secondary windings on one transformer or potential device, provided all of the following requirements are met:

5.7.2.1 Complete loss of one or more phase voltages does not prevent all tripping of the protected **element**;

5.7.2.2 Each secondary winding has sufficient capacity to permit fuse **protection** of the circuit;

5.7.2.3 Each secondary winding circuit is adequately fuse protected.

5.7.3 The wiring from each voltage transformer secondary winding shall not be grounded at more than one point.

5.8 Batteries and Direct Current (DC) Supply Criteria

DC supplies associated with **protection** shall be designed to have a high degree of dependability as follows:

5.8.1 No single battery or dc power supply failure shall prevent both independent **protection groups** from performing the intended function. Each battery shall be provided with its own charger. Physical separation shall be maintained between the two station batteries or dc power supplies used to supply the independent **protection groups**.

5.8.2 Each station battery shall have sufficient capacity to permit operation of the station, in the event of a loss of its battery charger or the ac supply source, for the period of time necessary to transfer the **load** to the other station battery or re-establish the supply source. Each station battery and its associated charger shall have sufficient capacity to supply the total dc **load** of the station.

5.8.3 A transfer arrangement shall be provided to permit connecting the total **load** to either station battery without creating areas where, prior to failure of either a station battery or a charger, a single event can disable both dc supplies.

5.8.4 The battery chargers and all dc circuits shall be protected against short circuits. All protective devices shall be coordinated to minimize the number of dc circuits interrupted.

5.8.5 Dc systems shall be continuously monitored or annunciated to detect abnormal voltage levels (both high and low), dc grounds, and loss of ac to the battery chargers, in order to allow prompt attention by the appropriate operating authorities.

5.8.6 **Protection group** dc sources shall be continuously monitored to detect loss of voltage in order to allow prompt attention by the appropriate operating authorities.

5.9 Station Service ac Supply Criteria

On **bulk power system** facilities there shall be two sources of station service ac supply, each capable of carrying at least all the critical **loads** associated with **protection systems**.

5.10 Circuit Breaker

No single trip coil failure shall prevent both independent **protection groups** from performing the intended function. The design of a breaker with two trip coils shall be such that the breaker will operate if both trip coils are energized simultaneously. The correct operation of this design shall be verified by tests.

5.11 Teleprotection Criteria

5.11.1 Communication facilities required for **teleprotection** shall be designed to have a level of performance consistent with that required of the **protection system**, and shall meet the following:

5.11.1.1 Where each of the two **protection groups** protecting the same **bulk power system element** requires a communication channel, the equipment and channel for each **protection group** shall be separated physically and designed to minimize the risk of both **protection groups** being disabled simultaneously by a single event or condition.

5.11.1.2 **Teleprotection** equipment shall be monitored to detect loss of equipment and/or channels to allow prompt attention by the appropriate operating authorities.

5.11.1.3 **Teleprotection** equipment shall be provided with means to test for proper signal adequacy.

5.11.1.4 **Teleprotection** equipment shall be powered by the substation batteries or other sources independent from the power system.

5.11.1.5 Except as identified otherwise in these criteria, the two **teleprotection** groups shall not share the same component.

5.11.1.5.1 The use of a single communication tower for the radio communication systems used by two **protection groups** protecting a single **element** is permitted as long as directional diversity of the communication signals is achieved.

5.12 Environment

5.12.1 Each separate **protection group** and **teleprotection** protecting the same system **element** shall be on different non-adjacent vertical mounting assemblies or enclosures.

5.12.2 Wiring for separate **protection groups** and **teleprotections** protecting the same system **element** shall not be in the same cable.

5.12.3 Cabling for separate **protection groups** and **teleprotections** protecting the same system **element** shall be physically separated. This can be accomplished by being in different raceways, trays, trenches, etc.

5.12.4 In the event a common raceway is used, cabling for separate **protection groups** protecting the same system **element** shall be separated by a fire barrier.

5.13 Grounding Criteria

Station grounding is critical to the correct operation of **protection systems**. The design of the ground grid directly impacts proper **protection system** operation and the probability of false operation from **fault** currents or transient voltages. Each member shall have established as part of its substation design procedures or specifications, a mandatory method of designing the substation ground grid, which:

5.13.1 Can be traced to a recognized calculation methodology

5.13.2 Considers cable shielding

5.13.3 Considers equipment grounding

5.14 Transmission Line Protection Criteria

5.14.1 **Protection system** settings shall not constitute a loading limitation as per NERC requirement/standard. In cases where NERC approved exceptions are used the limits thus imposed shall be adhered to as system operating constraints.

5.14.2 A **pilot protection** shall be so designed that its failure or misoperation will not affect the operation of any other **pilot protection** on that same **element**.

5.15 Breaker Failure Protection Criteria

Means shall be provided to trip all necessary local and remote breakers in the event that a breaker fails to clear a **fault**, as follows.

5.15.1 Breaker failure **protection** shall be initiated by each of the **protection groups** which trip the breaker, with the optional exception of a breaker failure **protection** in an adjacent zone.

5.15.2 Fault current detectors shall be used to determine if a breaker has failed to interrupt a **fault.**

5.16 Generating Station Protection Criteria

All under- and over-frequency **protection systems** designed to disconnect generators from the power system shall be coordinated with automatic under frequency **load shedding** programs, in accordance with the *Emergency Operation Criteria* (Directory #2).

5.17 Automatic Under frequency Load Shedding Protection System Criteria

5.17.1 The requirements and guides for the operation of these **Protection Systems** are detailed in the *Emergency Operation Criteria* (Directory #2). The guideline for automatic under frequency **load shedding protective relaying** design is provided in Appendix A of this Directory.

5.18 HVdc System Protection Criteria

5.18.1 The ac portion of an HVdc converter station, up to the valve-side terminals of the converter transformers, shall be protected in accordance with these criteria.

5.18.2 Multiple commutation failures, unordered power reversals, and **faults** in the converter bridges and the dc portion of the HVdc link which are severe enough to disturb the **bulk power system** shall be detected by more than one independent control or **protection group** and appropriate corrective action shall be taken, in accordance with the considerations in these criteria.

5.19 Protection System Testing and Maintenance Criteria

5.19.1 **Protection systems** shall be maintained in accordance with the *Maintenance Criteria for Bulk Power System Protection* (Directory #3).

5.19.2 The design of **protection systems** both in terms of circuitry and physical arrangement shall facilitate periodic testing and maintenance.

5.19.3 Each **protection group** shall be functionally tested to verify the dependability and security aspects of the design, when initially placed in service and when modifications are made.

5.20 Analysis of Protection Performance Requirements

5.20.1 **Bulk power system** automatic operations shall be analyzed to determine proper **protection system** performance. Corrective measures shall be taken promptly if a **protection group** fails to operate or operates incorrectly.

5.20.2 Event and fault recording capability shall be provided to the extent required to permit analysis of **system disturbances** and **protection system** performance.

5.20.3 Internal clocks in event and **fault** recording equipment shall be time synchronized to within 2 milliseconds or less of Universal Coordinated Time scale. The time zone shall be clearly identified as either universal time zone or local time zone.

5.20.4 Each **protective relay** which trips **Bulk Power System** equipment shall provide separate target indication.

6.0 Measures and Assessments

None developed at this time.

7.0 Compliance Monitoring

7.1 Each member shall provide the Task Force on System Protection (TFSP) with advance notification of any of the member's new **bulk power system protection systems**, or significant changes in the member's existing **bulk power system protection systems**.

7.2 Each member shall also provide the TFSP with advance notification of non-member **protection** facilities as required per *NPCC Bylaws*.

7.3 Each new or revised **protection system** shall be reported to the TFSP. It is recommended this reporting be in accordance with the procedure detailed in Section 4.0 of Appendix A of this Directory, or in a form consistent with the intent of the procedure.

7.4 Adherence to these Criteria shall be reported by the responsible entity in a manner and form designated by the Compliance Committee.

Prepared by: Task Force on System Protection

Review and Approval: Revision to any portion of this Directory will be posted by the lead Task Force in the NPCC Open Process for a 45 day review and comment period. Upon satisfactorily addressing all the comments in this forum, the Directory document will be sent to the remaining Task Forces for their recommendation to seek RCC approval.

Upon approval of the RCC, this Directory will be sent to the Full Member Representatives for their final approval if sections pertaining to the Requirements and Criteria portion have been revised. All voting and approvals will be conducted according to the most current "NPCC. Bylaws" in effect at the time the ballots are cast.

Revisions pertaining to the Appendices or any other portion of the document such as Links glossary terms, etc., only RCC Members will need to conduct the final approval ballot of the document.

This Directory will be updated at least once every three years and as often as necessary to keep it current and consistent with NERC, Regional Reliability Standards and other NPCC documents.

Appendix A
Guideline and Procedure for Bulk Power System Protection

1.0 Introduction

This Appendix provides the guidance for consideration in the implementation of the **bulk power system Protection** criteria stipulated in this Directory, and the procedure on reporting new and revised **bulks power system protection** facilities.

2.0 Design Considerations

2.1 General Considerations

In general, the function of a **protection system** is to limit the severity and extent of **system disturbances** and possible damage to system equipment.

The Directory's criteria objectives can be met only if **protection systems** have a high degree of dependability and security. In this context dependability relates to the degree of certainty that a **protection system** will operate correctly when required to operate. Security relates to the degree of certainty that a **protection system** will not operate when not required to operate.

Often increased security (fewer unintended operations) results in decreased dependability (more failures to operate), and vice versa. As an example, consideration is given to the consequence of applying permissive line **protection** schemes, which often are more secure, but less dependable, than blocking line protection schemes. The relative effect on the **bulk power system** of a failure of a **protection system** to operate when desired versus an unintended operation should be weighed carefully in selecting design parameters. Considerations for specific aspects of **protection** design are provided below.

2.2 Issues Affecting Dependability

2.2.1 Some portions of **elements** may not in themselves be part of the **bulk power system**. Those portions do not require two **protection groups**.

2.2.2 Two identical measuring **relays** should not be used in independent **protection groups** due to the risk of simultaneous failure of both groups because of design deficiencies or equipment problems.

2.2.3 In addition to the separation requirements in the criteria, areas of common exposure should be kept to a minimum to reduce the possibility of both **protection groups** being disabled by a single event such as fire, excavation, water leakage, and other such incidents.

2.2.4 On installations where free-standing or column-type current transformers are provided on one side of the breaker only, resulting in a **protection** blind spot, **protection** should be provided to detect a **fault** to ground on the primaries of such current transformers. When frame ground **protection** is used, then frame ground and breaker failure **protections** are the two local independent **protections** for the blind spot between the current transformer and the circuit breaker. Neither of these **protections** need be duplicated. Both of these **protections** should be designed so as to not be disabled by the same failure. The frame ground **protection** and breaker failure **protection** will in fact provide independent **protections** for the blind spot.

2.3 Issues Affecting Security

2.3.1 For **faults** external to the protected zone, each **protection group** should be designed either to not operate, or to operate selectively with other groups and with breaker failure **protection**.

2.3.2 For planned system conditions, **protection systems** should not operate to trip for stable power swings.

2.4 Issues Affecting Dependability and Security

2.4.1 **Protection systems** should be no more complex than required for any given application.

2.4.2 The components and software used in **protection systems** should be of proven quality, as demonstrated either by actual experience or by stringent tests under simulated operating conditions.

2.4.3 **Protection systems** should be designed to minimize the possibility of component failure or malfunction due to electrical transients and interference or external effects such as vibration, shock and temperature.

2.4.4 **Protection system** circuitry and physical arrangements should be designed so as to minimize the possibility of incorrect operations due to personnel error.

2.4.5 **Protection system** automatic self-checking facilities should be designed so as to not degrade the performance of the **protection**

system.

2.4.6 Consideration should be given to the consequences of loss of instrument transformer voltage inputs to **protection systems**.

2.4.7 **Protection systems**, including intelligent electronic devices (IEDs) and communication systems used for **protection**, should comply with applicable industry standards for utility grade **protection** service. Utility Grade **Protection System** Equipment are equipment that are suitable for protecting transmission power system elements, that are required to operate reliably, under harsh environments normally found at substations. Utility grade equipment should meet the applicable sections of all or some of the following types of industry standards, to ensure their suitability for such applications:

- IEEE C37.90.1-2002 (oscillatory surge and fast transient)
- IEEE C37.90.1-2002 (service conditions)
- IEC 60255-22-1, 2005 (1 MHz burst, i.e. oscillatory)
- IEC 61000-4-12, 2001 (oscillatory surge)
- IEC 61000-4-4, 2004 (EFT)
- IEC 60255-22-4, 2002 (EFT)
- IEEE C37.90.2-2004 (narrow-band radiation)
- IEC 60255-22-3, 2000 (narrow-band radiation)
- IEC 61000-4-3, 2002 (narrow-band radiation)
- IEEE 1613 (communications networking devices in Electric power Substations)

2.5 Operating Time

Adequate time margin should be provided taking into account study inaccuracies, differences in equipment, and **protection** operating times. In cases where clearing times are deliberately extended, consideration should be given to the following:

- Effect on system **stability** or reduction of **stability** margins.
- Possibility of causing or increasing damage to equipment and subsequent extended repair and/or outage time.
- Effect of **disturbances** on service to customers.

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2.6 Current Transformer

None.

2.7 Voltage Transformers and Potential Devices

Voltage transformer installations should be designed with due regard to ferroresonance.

2.7.1 Special attention should be given to the physical properties (e.g. resistance to corrosion, moisture, fatigue) of the fuses used in **protection** voltage circuits.

2.8 Batteries and Direct Current (dc) Supply

2.8.1 The circuitry between each battery and its first protective device cannot be protected and therefore should be designed so as to minimize the possibility of electrical short circuit.

2.8.2 The design for the regulation of the dc voltage should be such that, under all anticipated charging and loading conditions, voltage within acceptable limits will be supplied to all devices, while minimizing ac ripple and voltage transients.

2.9 Station Service ac Supply

None.

2.10 Circuit Breakers

The indication of the circuit breaker position in **protection systems** should be designed to reliably mimic the main contact position.

2.11 Teleprotection

2.11.1 **Teleprotection** systems should be designed to prevent unwanted operations such as those caused by equipment or personnel.

2.11.2 Two identical **teleprotection** equipments should not be used in independent **protection groups**, due to the risk of simultaneous failure of both groups because of design deficiencies or equipment problems.

2.11.3 Areas of common exposure should be kept to a minimum to reduce the possibility of both groups being disabled by a single event such as fire, excavation, water leakage, and other such incidents.

2.11.4 **Teleprotection** systems should be designed to mitigate the effects of signal interference from other communication sources and to assure adequate signal transmission during **bulk power system disturbances**.

2.12 Environment

Means should be employed to maintain environmental conditions that are favorable to the correct performance of **protection systems.**

2.13 Grounding

None.

2.14 Transmission Lines Protection

For planned system conditions, line **protection systems** associated with transmission facilities should not operate to trip for stable **power swings**.

2.15 Breaker Failure Protection

2.15.1 It is not necessary to duplicate the breaker failure **protection** itself.

2.15.2 Auxiliary switches may also be required in instances where the **fault** currents are not large enough to operate the **fault** current detectors. In addition, auxiliary switches may be necessary for high-speed detection of a breaker failure condition.

2.16 Generating Station Protection

2.16.1 Each **protection system** should be designed to minimize the effects to **the bulk power system** of **faults** and **disturbances**, while itself experiencing a single failure.

2.16.2 Generators should be protected to limit possible damage to the equipment. The following are some of the abnormal (not necessarily **fault**) conditions that should be detected:

- Unbalanced phase currents, loss of excitation
- Overexcitation, generator out of step, field ground
- inadvertent energization.

2.16.2.1 **Protections** for the above conditions, which are applied for equipment **protection**, need not be duplicated.

2.16.2.2 When a directional over current or distance **relay** is applied to remove the generator for slowly cleared **faults** on the external system, such **protection** is a backup and need not be duplicated.

2.16.2.3 The apparatus should be protected when the generator is starting up or shutting down as well as running at normal speed; this may require additional **relays** as the normal **relays** may not function satisfactorily at low frequencies.

2.16.2.4 Generator **protection systems** should not operate for stable **power swings** except when that particular generator is out of step with the remainder of the system. This does not apply to **Special Protection Systems** designed to trip the generator as part of an overall plan to maintain **stability** of the power system.

2.16.2.5 Loss of excitation and out of step **relays** should be set with due regard to the performance of the excitation system.

2.16.2.6 It is recognized that the overall **protection** of a generator involves non-electrical considerations that have not been included as a part of the criteria in this Directory.

2.16.2.7 All over frequency, overvoltage and under voltage **protection systems** designed to disconnect generators from the power system should be coordinated with automatic under frequency **load shedding** programs.

2.17 Automatic Under frequency Load Shedding Protection Systems

2.17.1 Automatic under frequency **load shedding protection systems** are not generally located at **bulk power system** stations; however, they have a direct effect on the operation of the **bulk power system** during major **emergencies**.

2.17.2 Automatic under frequency **load shedding protection** need not be duplicated.

2.17.3 Under frequency **relays** which operate at a discrete frequency value are called “under frequency threshold **relays**.” Selection of under frequency sensing devices should be on a threshold basis. Alternatively, rate of change of frequency **load shedding** may be used when the requirements of the Balancing Authority indicate that this method will achieve the intent of the **load shedding** program.

Appropriate studies are necessary to determine the application and settings of the rate of change of frequency **relays** for a particular Balancing Authority area.

2.17.4 In order for each Balancing Authority within NPCC to **shed** approximately the same proportion of **load**, given the same frequency condition, all styles and manufacture of under frequency **relays** should trip at essentially the same time. For electromechanical **relays**, time delay depends on rate of frequency decline, and it is not possible to achieve uniform response for different rates of decline. The recommendations in this guideline are based on the goal of a uniform response at a rate of frequency decline of 0.2 Hz per second.

2.17.5 Additional Application Considerations

2.17.5.1 Where undesired under frequency **relay** operation can be caused by decaying frequency due to isolated generation or motor load, additional supervising undercurrent or voltage **relays** may be used to prevent misoperation.

2.17.5.2 Where the AC voltage source for an under frequency **relay** is derived from a potential device connected to a cable circuit, care should be taken to estimate the voltage present during deenergization of the circuit. The natural frequency of the decaying cable voltage may be less than 60 Hz, and thus cause an incorrect **relay** operation.

2.17.5.3 The AC Voltage Inhibit feature available on some relays may be useful as a security tool to restrain operation during cable deenergization, depending on the voltage decay time constant

2.17.5.4 Due regard should be given to the expected power system voltage during events for which the underfrequency **relays** are expected to operate. The **relay's** minimum AC voltage operating characteristic should not inhibit proper **relay** operation, nor should the Voltage Inhibit feature, where it exists, be set to prevent proper operation.

2.17.6 Settings and Maintenance Recommendations

2.17.6.1 Pickup Time Delay Settings

Pickup and time delay settings of underfrequency threshold **relays** should be applied in accordance with the requirements specified in Section 5.2 and Section 5.4 of *Emergency Operation Criteria* (Directory #2).

2.17.6.2 Relay Performance Considerations

Any underfrequency **relay** which has been found to have drifted more than ±0.2 Hz from its set point or ±0.1 seconds from its time delay should be recalibrated and then retested in six months. If, at that time, the **relay** has drifted ±0.2 Hz or more from its set point or ±0.1 seconds or more from its fixed time delay, the cause of the drift should be corrected or the **relay** should be replaced.

2.17.6.3 Maintenance

Underfrequency **load shedding relays** have a direct effect on the operation of the **bulk power system** during major **emergencies**. These **relays** should be maintained in accordance with requirements stipulated in *Maintenance Criteria for Bulk Power System Protection* (Directory 3), even though they are usually located in non-**bulk power system** stations**.**

2.18 HVdc Systems Protection

2.18.1 Converter terminals should be protected to avoid excessive equipment stresses and to minimize equipment damage and outage time. These **protections** are usually specific to the design of the converter station(s) and are determined by the manufacturer to comply with availability guarantees. The followings are some conditions which should be detected:

- ac and dc undervoltage,
- ac and dc overvoltage,
- valve misfire,
- excessive harmonics on the dc,
- dc ground **faults** and open circuits,
- dc switching device failures,
- thyristor failures,
- valve and snubber circuit overloads.

2.18.2 The overall **protection** and control of an HVdc link may also involve the initiation of actions in response to abnormal conditions on the ac interconnected system. The control and **protection systems** associated with such conditions are not considered part of the HVdc systems **protection**.

2.19 Protection System Testing and Maintenance

Test facilities and test procedures should be designed such that they do not compromise the independence of **protection groups** protecting the same **bulk power system element**. Test devices or switches should be used to eliminate the necessity for removing or disconnecting wires during testing.

2.20 Analysis of Protection System

Insofar as possible, each active protective function within a **protective relay** should provide separate target information.

2.21 Transmission Station Protection

2.21.1 The **protection systems** should operate properly for the anticipated range of currents.

2.21.2 For planned system conditions, all station **protection systems** should not operate for **load** current or stable **power swings.**

2.21.3 **Load** responsive **protection relays** applied to transmission autotransformers should allow all possible load ability, consistent with equipment **protection** requirements.

2.21.4 Fault pressure or Buchholz **relays** used on transformers, phase shifters or regulators should be applied so as to minimize the likelihood of their misoperation due to through **faults**.

2.22 Capacitor Banks

2.22.1 Each **protection system** should be designed to minimize the effects to the **bulk power system** of **faults** and **disturbances**, while itself experiencing a single failure.

2.22.2 Capacitor bank **protection** should be applied with due consideration for capacitor bank transients, power system voltage unbalance, and system harmonics.

2.22.3 Protection may be provided to minimize the impact of failures of individual capacitor units on the remaining capacitor units, however, these types of **protections** do not need to be duplicated:

a. Overvoltage Protection
b. Individual fuses for each capacitor unit
c. Overvoltage Protection for each capacitor units

2.23 Static Var Compensation (SVC) Protection

2.23.1 The low voltage branch circuits contain the reactive controlling equipment, filters, etc. These may include all or some of the following:

a. Thyristor Controlled Reactors (TCR)
b. Thyristor Switched Capacitors (TSC)
c. Switched or Fixed Capacitors
d. Harmonic Filters

2.23.2 **Protection** for the branch circuits that are not part of the **bulk power system** need not be duplicated. **Protection** for these branch circuits should be applied with due consideration for capacitor bank transients, power system voltage unbalance, and system harmonics.

2.23.3 **Protection** against abnormal non-**fault** conditions within the SVC via control of the TSC and TCR valves should be designed so as to not interfere with the proper operation of the SVC.

2.24 Logic System

The design should recognize the effects of contact races, spurious operation due to battery grounds, dc transients, radio frequency interference or other such influences.

It is recognized that timing is often critical in logic schemes. Operating times of different devices vary. Known timing differences should be accounted for in the overall design.

2.25 Microprocessor-Based Equipment and Software

A **protection system** may incorporate microprocessor-based equipment. Information from this equipment may support other functions such as power system operations. In such cases, the software and the interface should be designed so as to not degrade the **protection system** functions.

2.26 Control Cable, Wiring and Ancillary Control Devices

Control cables and wiring and ancillary control devices should be highly dependable and secure. Due consideration should be given to published codes and standards, fire hazards, current-carrying capacity, voltage drop, insulation level, mechanical strength, routing, shielding, grounding and environment.

2.27 Environment

Means should be employed to maintain environmental conditions that are favorable to the correct performance of **protection systems**.

3.0 Guideline for Application of Remote Access to Protection System

The following guideline is established for the application of remote access to **protection system** Intelligent Electronic Devices (IEDs), such as relays, programmable logic controllers (PLC), and teleprotection equipment that have remote access capabilities, and are designed and configured for remote access applications. It is intended to assist in meeting the requirement stipulated in Section 5.1.3.3 of this Directory, and Section 3.3.1.6 of the *Special Protection System Criteria* (Directory 7).

This guideline assumes that appropriate physical measures are in place, and that they meet all applicable standards.

3.1 Definitions for Use in this Guideline Only

The flowing defined terms are used for illustration of the guideline presented in this Section only. These terms are not defined in Appendix A of this Directory, or any other NPCC documents.

IED - Intelligent Electronic Device, normally computer based, equipped with digital communication abilities, some examples are **protective relays**, RTUs, SERs, DFRs, PLCs, data concentrators, telecommunications equipment, and general monitoring equipment.

PLC - Programmable Logic Controller, used to create and implement logical actions and automation.

Remote Access - accessing a device from a remote geographical area via a communications link; once accessed, provides similar local device functionality, at a distance.

Authenticate - to prove to be genuine or is an approved user.

Intrusion - An unauthorized electronic entry into an IED. Access normally provides user access to the functionality of the device.

Cryptography – is the study and application of codes and ciphers. Codes or encryption is used to transform data into a form that is not directly usable. Decryption transforms encrypted data using a decryption key back into the original useful form.

VPN – Virtual Private Network. It uses encryption to provide a private channel between private networks using a public network as its carrier i.e., two users using the Internet to provide confidentiality, integrity, and authentication.

3.2 Governing Principles

The industry has become more reliant on computer technology for power **system protection**, control, communications, and automation of its power system. Electromechanical and solid-state technologies are being replaced with microprocessor devices, offering, among other functions, local and remote communications access. **Protection system** IEDs are employed to protect, and or operate power system elements. Unauthorized access to an IED could result in interruption of electric service, damage to the power system equipment, major **disturbances**, or a danger to life and property. **Protection system** IEDs also contain a large amount of information that utility personnel have come to rely on, including telemetry, power system **disturbance** analysis, fault location, preventive maintenance information, as well as asset condition and optimization data. However, this technology has also created vulnerabilities that are similar to those seen in traditional computer networks. Therefore, the following should be the governing principles of any cyber security program:

- Prevent penetration from cyber attacks.
- Prevent local and remote access to critical cyber assets by non-authorized personnel.
- Monitor cyber assets to detect unauthorized access or attempts to access.
- Limit exposure.

3.3 Guideline

3.3.1 Authentication

One of the foundations of the cyber security program is controlled, or secure, access. This dictates that some form of user authentication be used. Three common means of authenticating a user's identity are:

3.3.1.1 Something the user knows, such as passwords, or IP addresses.

3.3.1.2 Something the user has, such as a key, or cryptographic token.

3.3.1.3 Something the user is, such as fingerprints and voiceprints

At minimum, at least two factors of authentication should be used, e.g., passwords, and a destination – telephone number, or an IP address. The use of more factors such as encryption, etc. will result in providing more secure authentication. However, most present day and legacy **protection system** IEDs do not yet support this technology. Existing equipment often contains some level of security features. At a minimum, they usually provide multi-level passwords. These features should be activated as a first step in security implementation

3.3.2 Substation IED Access Point

A list of all substation IEDs that have remote electronic access configured should be compiled and maintained. This list should also include the access method(s) (e.g., dial-in, WAN, etc), the associated phone numbers and/or IP address, passwords, and other pertinent data.

3.3.3 Approved Remote Access Authorization List

A list of approved users, and the station IEDs they are authorized to access, should be established and maintained. It is vital that all such access information be classified as confidential, and managed as such.

3.3.4 Remote Access Configuration

Protection system IEDs should be configured to afford remote access only where needed and approved, and then, only when proper authentication is provided.

3.3.5 Password

Most **protection system** IEDs offer multiple access levels, each with separate passwords. Normally, a “view” only level is provided which allows a user to extract and or view information only. An alternate access level is provided to allow trained and authorized users to “make” settings and configuration changes, and initiate breaker operations. It is this level of access that is susceptible to an intrusion which could cause the most damage to the power system. Only limited users should have access to this level by considering the followings:

3.3.5.1 Establish multi-tiered passwords with different privileges for different classes of users.

3.3.5.2 Default passwords should be changed when remote access is configured.

3.3.5.3 Make sure that all IEDs have "strong" passwords, i.e., passwords that are not dictionary words, not easily guessable, not blank, or have no password at all. It is recommended that all passwords contain a combination of letters and numbers, and should be at least six characters long.

3.3.6 Logging/Alarming

When remote connections are used to access the relay beyond “view-only” mode, this should be alarmed and/or logged where possible.

3.3.7 Controlling Authority Approval

For both local and remote communications, excluding viewing, notification and approval of the Controlling Authority should be required to access in-service **protection system** IEDs. Only authorized users, as per Sections 3.3.3 and 3.3.5 above, should have remote access capabilities.

3.3.8 Disable User Function

Often, **protection system** IEDs are put into service with functions that are not used. These functions can create vulnerabilities, and therefore, should be disabled if possible.

3.4 Other Available Higher Level Authentication Factors and Some General Good Practices

As stated in Section 3.3.1, a minimum of two factors of authentication should be used. However, the use of more factors will result in providing more secure authentication. This Section is intended to provide additional factors and practices that could be implemented where warranted, and where the technology allows.

3.4.1 For WAN based access systems, implement Virtual Private Network (VPN) technology. VPN technology is also applicable when using ISDN, DSL, and cable.

3.4.2 Limit, as far as possible, dependence on the public telephone network for substation communications to IEDs. Instead, use secure communications facilities whenever possible.

3.4.3 Call back (where the IED device or modem hangs up on the original caller and calls back on a second line to a preconfigured phone number) may be utilized as a portion of an IED's security to prevent unauthorized access. This security measure added to other security measures will improve the IEDs security. Security can be further enhanced by using a different telephone line for the return call.

3.4.4 For dial-up modem access, use a hardware lock and key dongle on the analog phone line at each modem and the lock and key combination will act as a gatekeeper. When a call is initiated, the lock at the called modem will verify the existence of a valid key at the calling modem Time.

3.4.5 Isolation from the Business/Corporate Network

Isolation of the substation **protection system** IEDs from the Corporate Network should be provided where possible. Data can be transferred from the substation IEDs to a server connected to a Corporate Network via appropriate firewalls. This practice is warranted because most Corporate Networks are Internet connected and therefore are exposed to external users.

4.0 Procedure for Reporting New and Revised **Protection Systems**

Paragraph 7.1 of this criteria states that **Protection system** owners shall provide the Task Force on System Protection (TFSP) with advance notification of any of their new **bulk power system protection** facilities, or significant changes in their existing **bulk power system protection** facilities. Paragraph 7.2 of this criteria states that **Protection system** owners shall also provide the TFSP with advance notification of non-member **protection** facilities as required per NPCC Bylaws . Notification will be made to the TFSP early in the engineering design stage.

4.1 Additional Requirements for Presentation and Review

4.1.1 A presentation will be made to the TFSP on new facilities or a modification to an existing facility when requested by either a member entity or the TFSP.

4.1.2 A presentation will be made to the TFSP when the design of the **protection** facility deviates from the criteria set forth in this Directory.

4.1.3 A presentation will be made to the TFSP when a member entity is in doubt as to whether a design meets the **protection** criteria set forth in this Directory.

4.2 Data Required for Presentation and Review of Proposed Protection Facilities

4.2.1 The **protection system** owner will advise the TFSP of the basic design of the proposed system. The data will be supplied on the "Protection System Review Forms" (formerly C-22 forms) as listed below, accompanied by a geographical map, a one-line diagram of all affected areas, and the associated **protection** and control function diagrams. A physical layout of **protection** panels and batteries for the purpose of illustrating physical separation will also be included.

Protection System Details
Line Relaying (Phase)
Line Relaying (Ground)
Transformer/Reactor Relaying
Generator Relaying
Bus Relaying
Shunt Capacitors and Filters Relaying
HVdc Converter Relaying
Special Protection Systems
Communication links
Equipment Details
Current Transformers
Voltage Transformers
Station Battery
Physical Separation
Breakers
Disturbance Monitoring Equipment
Transmission Relay Loadability
Exception Request

4.2.2 The proposed **protection system** will be explained with due emphasis on any special conditions or design restrictions existing on the particular power system.

4.3 Procedure for Presentation

4.3.1 The **protection system** owner will arrange to have a technical presentation made to the TFSP

4.3.2 To facilitate scheduling, the chairman of the TFSP will be notified approximately four months prior to the desired date of presentation.

4.3.3 Copies of materials to be presented will be distributed to TFSP members 30 days prior to the date of the presentation.

4.4 TFSP Procedures

4.4.1 The TFSP will review the material presented and develop a position statement concerning the proposed **protection system**. This statement will indicate one of the following:

4.4.1.1 The need for additional information to enable the TFSP to reach a decision.

4.4.1.2 Acceptance of the member statement of conformance to the Protection Criteria.

4.4.1.3 Acceptance of the submitted proposal

4.4.1.4 Conditional acceptance of the submitted proposal*.

4.4.1.5 Rejection of the submitted proposal*.

* Position Statements 4.4.1.4 and 4.4.1.5 will include an indication of areas of departure from the intent of the **protection** criteria and suggestions for modifications to bring the **protection system** into conformance with the NPCC criteria.

4.4.2 The results of the TFSP review will be documented in the following manner:

4.4.2.1 A position statement will be included in the minutes of the meeting at which the proposed **protection system** was reviewed.

4.4.2.2 If necessary, a letter outlining areas of nonconformance with the **protection** criteria stipulated in this Directory and recommendations for correction will be submitted to the **protection system** owner. If necessary, the matter will be brought to the attention of the RCC.

4.4.2.3 The Task Force will maintain a record of all the reviews it has conducted.

Attachment 4

Removed due to confidentiality

CI Number: 43260

Title: **2013 Transmission Line Insulator Replacements**

Start Date: 2012/09
Final Cost Date: 2013/03
Function: Transmission
Forecast Amount: $2,472,103

DESCRIPTION:

This project provides for the replacement of insulators on four transmission circuits in 2013. Insulators targeted for replacement have a known failure mechanism resulting from cement growth, which lead to unplanned transmission outages and customer outages. This CI only covers the replacement of insulators in 2013. NSPI intends to submit a separate CI for insulator replacements in future years.

Replacement of insulators will occur on the following four lines:
L5016 St Croix to Five Points - 1455 insulators
L5017 Five Points to Canaan Road - 1812 insulators
L5500 Trenton to Bridge Ave - 450 insulators
L5506 Abercrombie Point to Pictou - 146 insulators

The expected life of this project is 30 to 40 years.

This project will be depreciated according to the following depreciation classes:

- Transmission Plant Station Equipment
- Transmission Plant Poles and Fixtures
- Transmission Plant Overhead Conductors and Devices

Summary of Related CIs +/- 2 years:
2010 CI 38110 2010 Transmission Line Insulator Replacement $2,236,168
2011 CI 40281 2011 Transmission Line Insulator Replacement $3,018,100
2012 CI 41517 L6535 Lidar Upgrades & Maintenance $2,361,250
2012 CI41387 Transmission Line Insulator Replacements $3,619,166
2014 CI TBD 2014 Transmission Line Insulator Replacements $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Outage Performance

Why do this project?

This work is being undertaken as part of the overall customer reliability improvement investment. This year is year four of a five year (2010-2014) plan to improve reliability to NSPI's customers. The insulator failure mechanism is well known and previously replaced insulators have been performing well.

Why do this project now?

This project is required because throughout NS Power's system, the type of insulator on these circuits has failed due to an industry known cement growth failure mechanism.

Why do this project this way?

Replacing the existing defective insulators with a new type of improved insulator is the only option.

Based on the scope of the work and availability of NS Power's Power Line Technician workforce, the Company plans to engage a contractor to perform this work. The labour for this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 43260-T746 - 2013 Transmission Line Insulator Replacements **Project Number** T746

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		4,566	0	4,566
094		094 - Interest Capitalized		82,607	0	82,607
095		095-COPS Regular Labour AO		8,089	0	8,089
095		095-COPS Contracts AO		567,432	0	567,432
013	007	013 - COPS Contracts	007 - TP - Environmental	[redacted]	0	[redacted]
012	035	012 - Materials	035 - TP - Wood Poles	7,882	0	7,882
013	035	013 - COPS Contracts	035 - TP - Wood Poles	[redacted]	0	[redacted]
012	038	012 - Materials	038 - TP - Insulators	68,738	0	68,738
013	038	013 - COPS Contracts	038 - TP - Insulators	670,150	0	670,150
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	3,001	0	3,001
002	039	002 - T&D Overtime Labour	039 - TP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - TP - O/H Cond.	168	0	168
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	997,024	0	997,024
001	085	001 - Regular Labour (No AO)	085 Design	1,536	0	1,536
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	8,073	0	8,073
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	2,472,103	0	2,472,103
			Original Cost:	337,368		

Location: Transmission
CI# / FP#: 43260
Title: 2013 Transmission Line Insulator Replacement
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (no AO)	Lot	1	$ 1,535.77	$ 1,535.77		
1.2	Site Supervision	Lot	1	$ 8,072.81	$ 8,072.81		
1.3	Line Switching	Person Day	[redacted]	[redacted]	$ 3,000.99		
1.4							
1.5							
1.6							
				Sub-Total	$ 12,609.57		
2	**012 Materials**						
2.1	Insulators and associated materials/ hardware	Lot	1	76788.67	$ 76,788.67		41387
2.2					$ -		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 76,788.67		
3	**013 T&D Contracts**						
3.1	Line Work	per recl.	[redacted]	[redacted]	$ 1,690,363.62		
3.2	Environment Bog Mats and Bridges	Lot	1	[redacted]	[redacted]		
3.3	Pole Haulage	Lot	1	[redacted]	[redacted]		
				Sub-Total	$ 1,720,010.62		
4	**011 Travel Expenses**						
4.1					$ -		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ -		
5	**041 Meals and Entertainment**						
5.1					$ -		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ -		
6							
6.1					$ -		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ -		
7							
7.1					$ -		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ -		
8	**094 Interest Capitalized**						
8.1	Interest	Lot	1	$82,607.18	$ 82,607.18		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 82,607.18		
9	**095 Administrative Overhead**						
9.1	COPS Regular Labour AO				$8,089.38		
9.2	Vehicle T&D Reg. Labour AO				$4,565.68		
9.3	COPS Contracts AO				$567,431.52		
				Sub-Total	$ 580,086.58		
Cost Estimate				**Total**	$ 2,472,102.62		
10	**Original Cost**				$ 333,368.00		
10.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43233

Title: **New Mobile Transformer 30+MVA (138-69kV -26,4-13_2kV)**

Start Date: 2012/12
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $2,152,435

DESCRIPTION:

The scope of this project is to procure a new, 30+ MVA mobile transformer. A new mobile transformer has an expected useful life of 40 years.

Depreciation Class: Transmission Station Equipment

Summary of Related CIs +/- 2 years:
No projects in 2011, 2012, 2013, 2014 and 2015

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Capacity

Why do this project?

NS Power has a requirement for an additional large mobile transformer in the fleet with a capacity greater than 25MVA. There is currently an operational need to restrict the in-service use of the two existing, largest mobiles to one at a time. This is so that one large mobile transformer is always available for reactionary use.

Why do this project now?

Due to the scope of NS Power's ongoing substation maintenance and capital programs, an additional large mobile transformer is required to ensure that these activities can proceed. This will allow two to be deployed at once and a third to be available for reactive / emergency use.

Why do this project this way?

NS Power did consider renting a mobile transformer however it was determined that purchasing a new 30MVA mobile transformer is the least cost option to fulfill the company's mobile transformer requirements both from a capacity and work execution perspective.

CI Number : 43233 - New Mobile Transformer -- 30+MVA (138-69kV -26,4-13_2kV) **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		5,556	0	5,556
094		094 - Interest Capitalized		59,562	0	59,562
095		095-COPS Regular Labour AO		9,844	0	9,844
095		095 - T&CS Regular Labour AO		2,519	0	2,519
012	044	012 - Materials	044 - DP - Substn.Transf.	[redacted]	0	[redacted]
066	044	066 - Other Goods & Services	044 - DP - Substn.Transf.	[redacted]	0	[redacted]
001	085	001 - T&CS Regular Labour	085 Design	8,062	0	8,062
001	085	001 - Regular Labour (No AO)	085 Design	5,417	0	5,417
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
001	086	001 - T&D Regular Labour	086 Commissioning	13,476	0	13,476
002	086	002 - T&D Overtime Labour	086 Commissioning	0	0	0
			Total Cost:	2,152,435	0	2,152,435
			Original Cost:			

Location: Transmission
CI# / FP#: 43233
Title: New Mobile Transformer 30 MVA
Execution Year: 2013

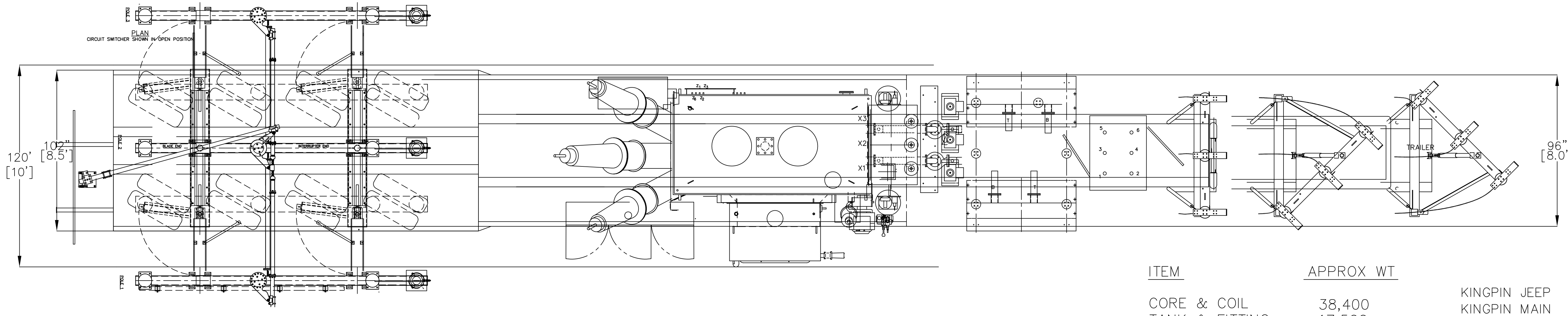
Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	001 Regular Labour						
1.1	Project Support Labour (No AO)	Lot	1	$ 5,417	$ 5,417		
1.2	Design Labour	Lot	1	$ 8,062	$ 8,062		
1.3	Commissioning Labour	Person Day	[redacted]		$ 13,475.60		
						`	
				Sub-Total	$ 26,955		
2	012 Materials						
2.1	New Mobile Transformer 30MVA	Lot	1	[redacted]			
2.2					$ -		
2.3					$ -		
2.4					$ -		
2.5					$ -		
				Sub-Total	[redacted]		
3	066 - Other Goods and Services						
3.1	Contingency	Lot	1	[redacted]			
3.2					$ -		
3.3					$ -		
				Sub-Total	[redacted]		
4	094 Interest Capitalized						
4.1	Interest			59562.28	$ 59,562.28		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 59,562.28		
5	095 Administrative Overhead						
5.1	Labour AO			12,362	$ 12,362.48		
5.2	Vehicle AO			5,556	$ 5,556.00		
5.3							
5.4							
				Sub-Total	$ 17,918.48		
Cost Estimate				**Total**	$ 2,152,435.36		
6	**Original Cost**						
6.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

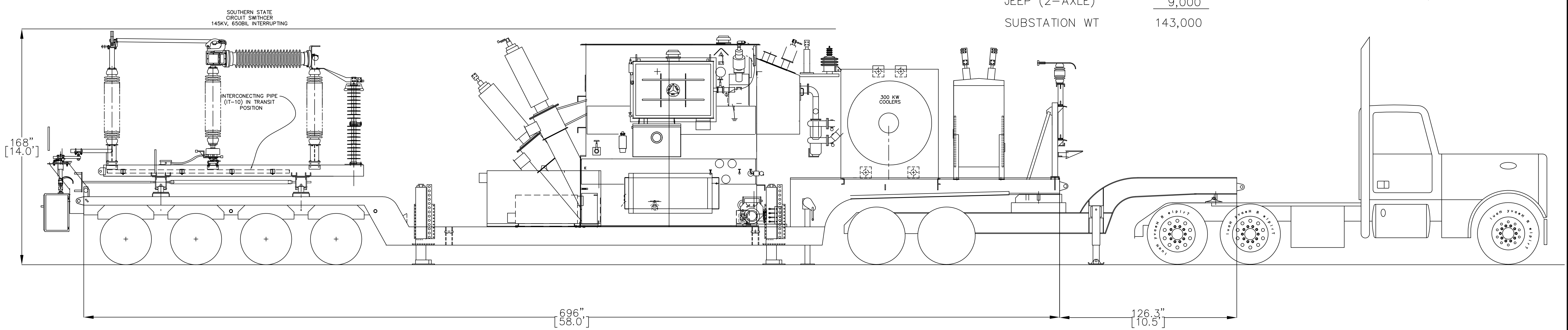
Removed due to confidentiality

NO.	REVISIONS	BY	DATE	APRV.



ITEM	APPROX WT
CORE & COIL	38,400
TANK & FITTING	17,500
OIL (3880 GAL.)	29,100
TRANSFORMER	85,000
ACCESSORIES	24,000
TRAILER (4-AXLE)	25000
JEEP (2-AXLE)	9,000
SUBSTATION WT	143,000

	COMPLETE	MAIN
KINGPIN JEEP	30,000	--
KINGPIN MAIN	--	65,000
JEEP AXLE	44,000	--
REAR AXLE	69,000	69,000
SUBSTATION	143,000	134,000
TRACTOR	20,000	20,000
TOTAL WT	163,000	154,000



69,000 LBS AXLE GROUP

102 INCHES WIDE TRAILER

(16) TIRES

44,000 LBS AXLE GROUP

96 INCHES WIDE JEEP

(4) TIRES

38,000 LBS AXLE GROUP

(4) TIRES

12,000 LBS

35 — 40 MVA UNIT

NOVIA SCOTIA

THIS OUTLINE IS NOT FOR CONSTRUCTION

PROPRIETARY
NOT FOR DISTRIBUTION EXCEPT AS AUTHORIZED BY DELTA STAR, INC

SCALE:
DFT: BY-DATE RM 12/21/10
CHK: BY-DATE RM 12/21/10

DELTA STAR, INC.
SAN CARLOS OPERATION (650) 508-2850
270 INDUSTRIAL ROAD, SAN CARLOS, CA 94070

TITLE MOBILE TRANSFORMER OUTLINE

SIZE	DRAWING NO.	SHEET	REV.
D	PG 105019-1B	1 OF 2	0

Delta Star, Inc.
270 Industrial Road, San Carlos, CA 94070-6212
Telephone: (650) 508-2850 · Fax (650) 593-0658

MOBILE SUBSTATION – PERFORMANCE GUARANTEE

PG #: 105019-1

FOR: NOVIA SCOTIA — DATE: 12/29/11

SPEC. #: ESTIMATE — INQ #: -- — ITEM # : 1

RATING:		3 PHASE 60 HERTZ		
CLASS	ODAF	HV - WDG (H)	LV - WDG (X)	LV - WDG (Y)
TEMP	-- ºC	-- MVA	-- MVA	-- MVA
TEMP	95 ºC	35 - 40 MVA	35 - 40 MVA	-- MVA
RATED VOLTAGE (kV)		69 X 138	13.09GrdY/7.56 X 26.18Grd/15.1	--
ADDITIONAL TAPS (kV) OR PERCENT TAPS		± (2) - 2.5% F.C.	@ 13.09 ± (8) - 1.25% R.C. @26.18 ± (16) - 0.625%	--
BIL (kV)	LINE	350 X 450	110 X 150	--
	NEUTRAL	--	110	--
DIELEC-TRIC TEST	APPLIED (kV)	185	34	--
	INDUCED (kV)	138 X 251	--	--
	RIV	--	--	--
% IZ @ RATED MVA		19 H - X	-- X - Y	-- H - Y

PERFORMANCE DATA NO LOAD @ 20 ºC & FULL LOAD @ 115 º C @ 138 - 26.18 KV CONNECTION												
MVA	%		LOSSES (kW)			PERCENT EFFICIENCY				% REGULATION		
	EXC VOLTS	EXC AMPS	NO LOAD	FULL LOAD	TOTAL	FULL	3/4	1/2	1/4	1.0	0.8	
40	100 110	1.3 4.5	17.4 38.3	533.4	550.8	98.63	98.94	99.25	99.49	3.2	13.6	

AUXILIARY LOSSES AND SOUND LEVEL				
CLASS	ONAN	ONAF	ONAF	ODAF
AUXILIARY LOSSES kW	--	--	--	25
SOUND LEVEL dB(A)	--	--	--	85@60Hz

APPROXIMATE DIMENSIONS AND WEIGHTS PER PAGE 2 OF 2

PREPARED BY: PAGE 1 OF 2

F-____ (D)

CI Number: 43226

Title: **2013 Transmission Switch & Breaker Replacements**

Start Date: 2013/01
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $1,969,767

DESCRIPTION:

This project provides for costs associated with reliability improvements on the NS Power transmission system. Included is the material for the replacement of 10 circuit breakers: 1 x 25kV breaker, 5 x 69kV breakers, and 4 x 138kV breakers.

This project also includes the replacement of 38 disconnect switches associated with breaker upgrade replacements. A combination of field-age, condition, and those that posed the greatest risk of failure was used to identify those circuit breakers and switches that are a priority for replacement. Depending on the type of circuit breaker, the expected useful life of the asset could be 25- 40 years.

Depreciation class: Transmission Station Equipment

Summary of Related CIs +/- 2 years:
2011 CI 40280 2011 Trans Switch & Breaker Upgrade $2,866,718
2012 CI 41426 2012 Transmission Switch & Breaker Upgrades $2,000,849
2014 CI TBD Transmission Switch & Breaker Upgrades $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

This work is being undertaken as part of the overall customer reliability improvement investment. This is year four of a five year (2010-2014) plan to improve reliability to NS Power's customers. This project will replace circuit breakers that are malfunctioning due to age. In addition, switch modifications/additions will result in improved customer reliability.

Why do this project now?

Completing this project now will result in mitigating transmission supply interruptions and provide reliability improvements for customers.

Why do this project this way?
In the majority of cases, the circuit breakers are being replaced for which spare parts are no longer available due to the age of the devices. Various switches are being modified or changed out due to either operational issues, or targeted at improving the capability of the switch. These modifications will result in improved customer reliability.

NS Power personnel will be completing the work associated with this project.

CI Number : 43226 - 2013 Transmission Switch & Breaker Replacements

Project Number

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin.

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		97,352	0	97,352
092		092-Vehicle T&D OT Labour AO		2,927	0	2,927
094		094 - Interest Capitalized		106,361	0	106,361
095		095-COPS Overtime Labour AO		5,186	0	5,186
095		095 - T&CS Regular Labour AO		11,712	0	11,712
095		095-COPS Contracts AO		17,815	0	17,815
095		095-COPS Regular Labour AO		172,486	0	172,486
001	043	001 - T&D Regular Labour	043 - DP - Substn Dev.	200,120	0	200,120
002	043	002 - T&D Overtime Labour	043 - DP - Substn Dev.	14,198	0	14,198
011	043	011 - Travel Expense	043 - DP - Substn Dev.	16,800	0	16,800
012	043	012 - Materials	043 - DP - Substn Dev.	1,163,550	0	1,163,550
013	043	013 - COPS Contracts	043 - DP - Substn Dev.	54,000	0	54,000
001	085	001 - Regular Labour (No AO)	085 Design	23,271	0	23,271
001	085	001 - T&CS Regular Labour	085 Design	37,490	0	37,490
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
041	085	041 - Meals & Entertainment	085 Design	500	0	500
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	36,000	0	36,000
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
011	087	011 - Travel Expense	087 Field Super.& Ops.	7,500	0	7,500
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	2,500	0	2,500
			Total Cost:	1,969,767	0	1,969,767
			Original Cost:	222,646		

Location: Transmission
CI# / FP#: 43226
Title: 2013 Transmission Switch and Breaker Replacements
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (no AO)	Lot	1	$ 23,271.00	$ 23,271.00		
1.2	Electrician Labour	Person Day	[redacted]		$ 161,707.20		
1.4	PLT Labour	Person Day			$ 38,412.64		
	Site Supervision	Lot	1	$ 36,000.00	$ 36,000.00		
1.7	Engineering (P.Eng)	Per Breaker	[redacted]		$ 23,340.00		
1.8	CADD Operators	Per Drawing			$ 14,150.00		
1.9							
1.1					$ -		
				Sub-Total	$ 296,880.84		
2	**002 Overtime Labour**						
2.1	OT Electrician Labour	Person Day	[redacted]		$ 11,454.26		
2.2	OT PLT Labour	Person Day			$ 2,743.76		
				Sub-Total	$ 14,198.02		
3	**012 Materials**						
3.1	25 kV Dead Tank Breaker (2013 Breaker)	Device	[redacted]		$ 47,250.00		41426
3.2	69kV Dead tank SF6 breaker (2013 Breakers)	Device			$ 275,000.00		
3.3	138kV Dead tank SF6 breaker (2013 Breakers)	Device			$ 300,000.00		
3.4	25kV Disconnect Switch (2013 Switches)	Switch + ins			$ 31,500.00		
3.5	69kV Disconnect Switch (2013 Switches)	Switch + ins			$ 64,800.00		
3.6	138 kV Disconnect Switch (2013 Switches)	Switch + ins			$ 130,000.00		
3.7	230 kV Disconnect Switch (2013 Switches)	Switch + ins			$ 270,000.00		
3.8	Misc materials wire and lugs	Per Breaker			$ 45,000.00		
3.9					$ -		
				Sub-Total	$ 1,163,550.00		
4	**013 T&D Contracts**						
4.1	Crane/Boom Truck Services	Per Breaker	[redacted]		$ 54,000.00		
4.2							
4.3							
				Sub-Total	$ 54,000.00		
5	**011 Travel Expenses**						
5.1	2- Work Site Truck Rentals	1 mth	12	1400	$ 16,800.00		
5.2	Travel	Lot	1	7500	$ 7,500.00		
5.3					$ -		
				Sub-Total	$ 24,300.00		
6	**041 Meals and Entertainment**						
6.1	Meals	lot	1	3000	$ 3,000.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 3,000.00		
7	**094 Interest Capitalized**						
7.1	Interest	lot	1	106,360.76	$ 106,360.76		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 106,360.76		
8	**095 Administrative Overhead**						
8.1	Labour AO		1	189,383.32	$ 189,383.32		
8.2	Vehicle AO		1	100,279.20	$ 100,279.20		
8.3	Contract AO		1	17,814.60	$ 17,814.60		
				Sub-Total	$ 307,477.12		
Cost Estimate				**Total**	$ 1,969,766.74		
9	**Original Cost**				$ 222,646.28		
9.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43237

Title: **2013 Substation Recloser Replacements**

Start Date: 2013/01
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $1,863,378

DESCRIPTION:

This capital item provides for reliability improvements for substation equipment by replacing 50 substation reclosers throughout the province. The estimated useful life of substation reclosers is approximately 30 years.

Depreciation Class: Transmission Station Equipment

Related Projects: 2 years previous and any planned for the future
2011 CI 40287 Substation Recloser Replacement $3,764,921
2012 CI 41430 Substation Recloser Replacements $2,120,686
2014 CI TBD Substation Recloser Replacements $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Outage Performance

Why do this project?

In late 2010 and 2011, a number of substation recloser failures identified that some substation reclosers are reaching the end of their useful life, causing a reliability and safety issue. In 2013, reclosers reaching the end of their useful life will be replaced based on their potential effects on reliability.

Why do this project now?

The average age of substation reclosers currently in operation is 33 years, corresponding to 1978 manufacture. Life expectancy is in the range of 30 to 35 years. Recently, failures of substation reclosers have occurred at the following locations: 113H Dartmouth East, 126H Porters Lake, 131H Lucasville, 129H Kearney Lake Road, and 101H Cobequid Road. The associated reliability imperatives make it necessary to mitigate the issues with this equipment through removal and replacement. Completing this project now will result in reliability improvements for customers.

Why do this project this way?

Replacement of recloser models and vintages of reclosers that have failed over the last few years, removal from service and replacement with new equipment ensures improved reliability of NS Power's system.

CI Number : 43237 - 2013 Substation Recloser Replacements

Project Number

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin.

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		55,600	0	55,600
092		092-Vehicle T&D OT Labour AO		9,167	0	9,167
094		094 - Interest Capitalized		62,446	0	62,446
095		095-COPS Regular Labour AO		98,510	0	98,510
095		095-COPS Overtime Labour AO		16,242	0	16,242
095		095-COPS Contracts AO		11,546	0	11,546
095		095 - T&CS Regular Labour AO		16,573	0	16,573
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	98,853	0	98,853
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	44,469	0	44,469
011	043	011 - Travel Expense	043 - TP - Substn Dev.	8,000	0	8,000
012	043	012 - Materials	043 - TP - Substn Dev.	1,283,500	0	1,283,500
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	35,000	0	35,000
001	085	001 - T&CS Regular Labour	085 Design	53,050	0	53,050
001	085	001 - Regular Labour (No AO)	085 Design	25,670	0	25,670
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	36,000	0	36,000
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
011	087	011 - Travel Expense	087 Field Super.& Ops.	7,500	0	7,500
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	1,250	0	1,250
			Total Cost:	1,863,378	0	1,863,378
			Original Cost:	477,707		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 43237
Title: 2013 Transmission Substation Recloser Replacement
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (no AO)	Lot	1	$ 25,670.00	$ 25,670.00		
1.2	Electrician Labour	Person Day	[redacted]		$ 33,689.00		
1.3	PLT Labour	Person Day			$ 65,164.30		
1.4	Site Supervision	Lot	1	$ 36,000.00	$ 36,000.00		
1.5	Engineering (P.Eng)	Lot	1		$ 38,900.00		
1.6	CADD	Lot	1		$ 14,150.00		
				Sub-Total	$ 213,573.30		
2	**002 Overtime Labour**						
2.1	Electrician Labour	Person Day	[redacted]		$ 44,469.48		
2.2							
2.3							
				Sub-Total	$ 44,469.48		
3	**012 Materials**						
3.1	3 Phase Solid Di-electric Recloser	Device	50	22500	$ 1,125,000.00	Costs Estimates for materials based on 2011 and 2012 work	40287, 41430
3.2	Recloser Stands	Device	50	720	$ 36,000.00		40287, 41430
3.3	"A" and "B" switch replacement w/required	Switch	25	2500	$ 62,500.00		40287, 41430
3.4	Misc materials conductor, lugs, and control wire	per recl.	50	1200	$ 60,000.00		40287, 41430
				Sub-Total	$ 1,283,500.00		
4	**013 T&D Contracts**						
4.1	Crane/Boom Truck Services	per recl.	[redacted]		$ 35,000.00		40287, 41430
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 35,000.00		
4	**011 Travel Expenses**						
4.1	Recloser Supplier Inspection	Lot	1	8000	$ 8,000.00		
4.2	Travel	days	50	150	$ 7,500.00		
4.3					$ -		
				Sub-Total	$ 15,500.00		
5	**041 Meals and Entertainment**						
5.1	Meals	lot	1	1250	$ 1,250.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 1,250.00		
8	**094 Interest Capitalized**						
8.1	Interest	Lot	1	62445.57	$ 62,445.57		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 62,445.57		
9	**095 Administrative Overhead**						
9.1	Labour AO		1	131325.66	$ 131,325.66		
9.2	Vehicle AO		1	64767.41	$ 64,767.41		
	Contract AO		1	11546.48	$ 11,546.48		
9.3							
				Sub-Total	$ 207,639.55		
Cost Estimate				**Total**	$ 1,863,377.90		
10	**Original Cost**				$ 477,707.00		
10.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

2013 Substation Recloser Replacements

Region	Device	Type
Cape Breton	87C-311	WVE
Cape Breton	103C-311	WVE
Cape Breton	103C-313	WVE
Cape Breton	103C-314	WVE
Cape Breton	9C-301	WVE
Cape Breton	9C-302	4H
Cape Breton	9C-303	4H
Cape Breton	9C-304	4H
Cape Breton	100C-421	WVE
Cape Breton	100C-422	WVE
Cape Breton	100C-423	CRVE
Metro	104H-420	MVE
Metro	104H-421	MVE
Metro	104H-422	MVE
Metro	104H-423	MVE
Metro	104H-430	MVE
Metro	104H-433	MVE
Metro	124H-301	CWE
Metro	124H-302	CWE
Metro	126H-311	CWVE
Metro	126H-312	CWVE
Metro	126H-313	WE
Northeast	50N-411	MVE
Northeast	50N-412	MVE
Northeast	4N-311	WVE
Northeast	4N-312	WVE
Northeast	4N-313	CWVE
Northeast	16N-301	CRVE
Northeast	16N-302	WVE
Northeast	8C-221	WVE
West	55V-313	WE
West	55V-314	WE
West	55V-322	WE
West	55V-323	WE
West	63V-311	WE
West	63V-312	WVE
West	63V-313	WE
West	65V-301	CWE
West	65V-302	WVE
West	65V-303	CWE
West	46W-301	WVE
West	46W-303	CWE
West	77V-301	CRE
West	77V-302	CRE
West	77V-303	WVE
West	21W-311	WVE
West	21W-312	WVE
West	57W-401	WVE
West	57W-402	WVE
West	1V-442	WVE

Downlines

Region	Device	Type
Cape Breton	57C-R456-130	WVE
Cape Breton	29C-R472-213	WVE
Cape Breton	67C-R472-328	WVE
Northeast	62N-R451-018	WVE
Northeast	76H-R433-007	WVE

CI Number: 43292

Title: **120H-Brushy Hill BPS Upgrades 230KV**

Start Date: 2013/02
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $1,834,212.10

DESCRIPTION:

This project provides the costs to upgrade the protection system at 120H- Brushy Hill (230kV) to comply with Northeast Power Coordinating Council (NPCC) bulk power system protection risk reduction plan. The estimated useful life of protection systems is approximately 40 years.

Depreciation Class: Transmission Station Equipment

Summary of Related CIs +/- 2 years:
2013 43291 Protection Risk Reduction 67N-Onslow 230KV $2,416,341
2014 CI TBD 3C-Port Hastings Upgrades 230kV $TBD
2015 CI TBD 88S-Lingan Upgrades 230kV $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: System Protection (Regulatory Compliance)

Why do this project?

In August 30, 2010, NPCC requested a Mitigation Plan for bulk power system (BPS) facilities that lack a second set of protective relays on a BPS element and/or a second battery at a BPS substation. NS Power has determined that four 230kV substations fall under the Mitigation Plan for bulk power and they are 120H-Brushy Hill 230kV, 67N-Onslow 230kV, 3C-Port Hastings 230kV and 88S-Lingan 230kV substations.

Why do this project now?

Implementation of all redundant protection and a second battery is required to be completed by end of 2016. Because of the scope of work required, NS Power plans to complete the four stations requiring this upgrade over the next four year period. NS Power is planning to complete 120H-Brushy Hill 230kV by end of 2013, 67N-Onslow to be completed in the end of 2014, 3C-Port Hasting to be completed by end of 2015 and 88S-Lingan by the end of the 2016.

Why do this project this way?

There is no other technical solution to comply with the bulk power system protection risk reduction plan. This project is required to comply with the NPCC request dated August 30, 2010, to submit to NPCC a Mitigation Plan for bulk power system (BPS) facilities that lack a second set of protective relays on a BPS element and/or a second battery at a BPS substation.

CI Number : 43292 - Protection Risk Reduction 120H-Brushy Hill 230KV **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		100,147	0	100,147
094		094 - Interest Capitalized		52,867	0	52,867
095		095-COPS Contracts AO		63,146	0	63,146
095		095-COPS Regular Labour AO		177,437	0	177,437
095		095 - T&CS Regular Labour AO		47,548	0	47,548
012	003	012 - Materials	003 - TP - Bldg.,Struct.Grnd.	83,900	0	83,900
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	118,500	0	118,500
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	35,373	0	35,373
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	303,810	0	303,810
013	022	013 - COPS Contracts	022 - TP - Elec Contr.Equip.	18,240	0	18,240
066	022	066 - Other Goods & Services	022 - TP - Elec Contr.Equip.	161,799	0	161,799
001	023	001 - T&D Regular Labour	023 - TP - Power Equip.-Station S	25,815	0	25,815
012	023	012 - Materials	023 - TP - Power Equip.-Station S	21,000	0	21,000
013	023	013 - COPS Contracts	023 - TP - Power Equip.-Station S	0	0	0
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	45,480	0	45,480
012	043	012 - Materials	043 - TP - Substn Dev.	144,000	0	144,000
001	061	001 - T&D Regular Labour	061 - TP - Switched Telecomm. Sys	9,264	0	9,264
012	061	012 - Materials	061 - TP - Switched Telecomm. Sys	10,000	0	10,000
001	085	001 - Regular Labour (No AO)	085 Design	5,250	0	5,250
001	085	001 - T&CS Regular Labour	085 Design	152,201	0	152,201
012	085	012 - Materials	085 Design	0	0	0
028	085	028 - Consulting	085 Design	76,800	0	76,800
001	086	001 - T&D Regular Labour	086 Commissioning	126,965	0	126,965
013	087	013 - COPS Contracts	087 Field Super.& Ops.	54,670	0	54,670
			Total Cost:	1,834,212	0	1,834,212
			Original Cost:			

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 43292
Title: 120H-Brushy Hill BPS Upgrades 230KV
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician/ Technician	Person Day	[redacted]		$ 242,897.69		
1.2	Engineering (P.Eng)	Hour			$ 101,220.00		
1.3	Project Support Labour (No AO)	Hour			$ 5,250.00		
1.4	Technologist	Hour			$ 20,720.00		
1.5	CADD	Hour			$ 30,261.00		
1.6					$ -		
				Sub-Total	$ 400,348.69		
2	**012 Materials**						
2.1	Protection Panel	Item	2	40,000.00	$ 80,000.00		41348
2.2	Primary Equipment Modifications	Lot	1	286,500.00	$ 286,500.00		41348
2.3	Communication Panel & Materials	Lot	1	14,900.00	$ 14,900.00		41348
2.4	Station Service	Lot	1	21,000.00	$ 21,000.00		
2.5	Telecom equipment	Lot	1	10,000.00	$ 10,000.00		
2.6	Miscellaneous Substation Equip & Mat	Lot	1	59,100.00	$ 59,100.00		
2.7	Civil Works Materials	Lot	1	79,000.00	$ 79,000.00		
2.8	Electrical Control Equip	Lot	1	12,210.00	$ 12,210.00		
				Sub-Total	$ 562,710.00		
3	**013 T&D Contracts**						
3.1	Control Building & Trench	Contract	[redacted]		$ 118,500.00		41348
3.2	Site Supervisor	Hour			$ 54,670.00		
3.3	Lift Equipment/ Metal Fabrication	Contract			$ 18,240.00		
				Sub-Total	$ 191,410.00		
4	**028 Consulting**						
4.1	Design Consultants	Hours	[redacted]		$ 76,800.00	[redacted]	
4.2							
4.3							
				Sub-Total	$ 76,800.00		
5	**066 Other Goods and Services**						
5.1	Project Contingency		1	161,799.00	$ 161,799.00		
5.2					$ -		
5.3					$ -		
5.4					$ -		
				Sub-Total	$ 161,799.00		
6	**094 Interest Capitalized**						
8.1	Interest		1	52,867.13	$ 52,867.13		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 52,867.13		
7	**095 Administrative Overhead**						
7.1	Contracts AO		1	63,146.17	$ 63,146.17		
7.2	Labour AO		1	224,984.41	$ 224,984.41		
7.3	Vehicle AO		1	100,146.70	$ 100,146.70		
				Sub-Total	$ 388,277.28		
Cost Estimate				**Total**	$ 1,834,212.10		
8	**Original Cost**						
8.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

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Mitigation Plan for NPCC Bulk Power System Protection Risk Reduction

This Plan is being submitted in accordance with the NPCC Request dated August 30, 2010 (reference Attachment) to submit to NPCC a Mitigation Plan for bulk power system (BPS) facilities that lack either or both of the following two attributes:

1. lack of a second set of protective relays on a BPS element,
2. the lack of a second battery at a BPS substation.

Mitigation Plan Scope of Work

After reviewing the Task Force on System Protection (TFSP) survey completed in 2007-2008, Nova Scotia Power has determined that the following 230 kV substations have BPS facilities that lack a second battery or a second set of protective relays on a BPS element.

At 120H Brushy Hill a second set of bus protection relays will be installed on bus 120H-B71 and bus 120H-B72 and transformer protections will be added to 120H-T71 and 120H-T72. A second DC supply will also be added to this substation which will include a 125 V battery, a charger and a DC distribution panel with transfer capability.

At 67N Onslow a second set of bus protection relays will be installed on bus 67N-B5, 67N-B7 and 67N-B9 and transformer protection will be added to 67N-T71. The DC supply for the B protection schemes will be modified to ensure compliance with NPCC Directory #4 Section 5.8.

At 3C Port Hastings a second set of bus protection relays will be installed on bus 3C-B71 and bus 3C-B72 and transformer protections will be added to 3C-T71 and 3C-T72. The DC supply for the B protection schemes will be modified to ensure compliance with NPCC Directory #4 Section 5.8.

At 88S Lingan a second set of bus protection relays will be installed on bus 88S-B71 and bus 88S-B72 and transformer protections will be added to 88S-T71, 88S-T72, 88S-GT1, 88S-GT2, 88S-GT3 and 88S-GT4. A second DC supply will also be added to this substation which will include a 125 V battery, a charger and a DC distribution panel with transfer capability.

The estimated completion dates for these projects are as follows:
120H Brushy Hill – Q4 2013
67N Onslow – Q4 2014
3C Port Hastings – Q4 2015
88S Lingan – Q4 2016

NPCC, Inc.
NORTHEAST POWER COORDINATING COUNCIL, INC.
1040 AVE OF THE AMERICAS, NEW YORK, NY 10018 TELEPHONE (212) 840-1070 FAX (212) 302-2782

August 30, 2010

Members, Northeast Power Coordinating Council, Inc.

Re: Approved Implementation Plan for Bulk Power System Protection Risk Reduction

Ladies and Gentlemen:

This is to inform you that the Reliability Coordinating Committee (RCC) at the June 9, 2010 meeting approved the attached Implementation Plan for the Bulk Power System Protection Risk Reduction. As required in the Implementation Plan, affected Facility Owner that has identified bulk power system (bps) facility(ies) lacking either or both of the following two attributes:

1. lack of a second set of protective relays on a bps element,
2. the lack of a second battery at a bps substation.

must establish a mitigation plan and submit that plan to the NPCC Task Force on System Protection (TFSP) within 18 months of the approval of the Implementation Plan or by December 9, 2011; the mitigation plan must identify the time-period needed to acquire and install equipment to bring those existing facility(ies) in conformance with the following, with explanations of any delays beyond five years. Delays beyond five years must be approved by the RCC.

- For those stations which have only a single battery bank, add a second battery bank in accordance with the requirements of Section 5.8 of Directory #4, and
- For those **elements** whose **protection** does not include two independent sets of **protective relays**, add a second set of **protective relays**, and associated auxiliary relays (if used), that meet the required operating time consistent with Section 5.5 of Directory #4. The second set of **protective relays** and associated auxiliary relays shall be physically separated from the existing **protective relays**.

If you have BPS facilities lacking one or both of two attributes identified above, please submit a mitigation plan by December 9, 2011. TFSP maintains a record of the survey completed in 2007-2008 of facilities which were identified to be lacking one or both of these attributes and would be glad to review your facilities on the list. Your prompt attention and response to this request will be appreciated. Mitigation plan should be submitted to NPCC to the attention of Mr. Quoc Le at quoc@npcc.org.

Please do not hesitate to contact Quoc at 212-840-1070, Extension 4908 with any questions regarding this. Thank you for your assistance in this matter.

Yours very truly,

Bryan

Bryan Gwyn, Chairman
Task Force on System Protection

Attachment (1):

- Approved Implementation Plan for Bulk Power System Risk Reduction

CC: Members, Task Force on System Protection
Members, Reliability Coordinating Committee

Implementation Plan for Bulk Power System Protection Risk Reduction

RCC Approved - June 9, 2010

I. Introduction

At the request of the RCC, an assessment of all NPCC BPS facilities was conducted in 2007-2008. The result of this assessment was presented to the RCC at the March 4, 2009 and September 10, 2009 meetings. The predominant risk presented was judged to be due to the lack of two attributes: specifically, lack of a second set of protection relays, and the lack of a second battery. This implementation plan is intended to mitigate the identified higher risk protection attributes at these facilities but does not necessary imply conformance with all provisions of Directory 4.

II. Facility Owner Mitigation Plan

An affected Facility Owner that has identified BPS facility(ies) lacking either of the two attributes above, must establish a mitigation plan and submit that plan to the TFSP within 18 months of the approval of this Implementation Plan by the RCC; the mitigation plan must identify the time-period needed to acquire and install equipment to bring those existing facility(ies) in conformance with the following, with explanations of any delays beyond five years. Delays beyond five years must be approved by the RCC.

– For those stations which have only a single battery bank, add a second battery bank in accordance with the requirements of Section 5.8 of Directory #4, and
– For those **elements** whose **protection** does not include two independent sets of **protective relays**, add a second set of **protective relays**, and associated auxiliary relays (if used), that meet the required operating time consistent with Section 5.5 of Directory #4. The second set of **protective relays** and associated auxiliary relays shall be physically separated from the existing **protective relays**.

The affected Facility Owner must submit a Periodic Progress Report (see III Below) to the TFSP to demonstrate efforts and schedules to attain conformance with respect to the above attributes. Deviations from previously submitted schedules resulting in extension of the mitigation dates will be reported to the TFSP, who will submit the information to the RCC along with the Facility Owner’s explanations for the delays. Any previously approved plans with delays beyond five years must be re-approved by the RCC.

III. Periodic Progress Report

TFSP will report to the RCC regarding receipt of all necessary mitigation plans.

The Facility Owner must provide annual progress reports to the TFSP for monitoring of project schedules.

TFSP will forward a summary report to the RCC annually on the progress of the implementation plans, until those plans are complete.

Developed by Task Force on System Protection

CI Number: 43369

Title: **New Mobile Transformer 15 MVA**

Start Date: 2013/01
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $1,719,218

DESCRIPTION:

The scope of this project is to procure a new 15 MVA mobile transformer to replace the existing 4P-MS unit in NS Power's fleet. A new mobile transformer has an expected useful life of 40 years.

Depreciation Class: Transmission Station Equipment

Summary of Related CIs +/- 2 years:
No projects in 2011, 2012, 2013, 2014 and 2015.

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

The current 4P-MS unit creates combustible gas from the insulating oil inside its tank when energized. These combustible gases represent an explosion hazard if they reach or exceed critical levels within the oil and therefore it must be replaced with a new 15 MVA (138-69kV -26,4-13_2kV) mobile transformer.

Attachment 1 provides the testing results for this transformer. The gasses present in this transformer represent a thermal fault inside the transformer that is in excess of 700 degC. The gasses that indicate this problem are ethylene, methane and ethane. There is also acetylene present which indicates a high energy discharge and possible arcing under oil. Carbon monoxide levels are also increasing which is an indication of cellulose paper degradation. The gasses continually increase when this transformer is energized, which indicate active fault conditions in the transformer. These are all "combustible" gasses, which when they reach elevated levels can create an explosive environment. The transformer has to be de-gassed when total combustible gas levels reach 2500 ppm as per IEEE C57.

Why do this project now?

The rate at which combustible gas was being generated in the current 4P-MS unit has been fairly steady, rising very slowly over time. Recently however, the gassing rate has risen to the point of requiring the 4P-MS unit to be de-gassed after about four weeks of continuous service, as opposed to approximately every six or more months. The increased rate of gassing implies a slow progression to an eventual internal failure. As time progresses, the risk of a sudden and unexpected increase in the rate of gassing, followed by an internal failure, also increases.

Why do this project this way?

The gassing problem with the 4P-MS unit could not be solved by a complete rewind and other internal changes and therefore the only other alternative is replacement with a new mobile transformer.

CI Number : 43369 - New Mobile Transformer 15MVA (138-69kV -26,4-13_2kV) **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		8,880	0	8,880
094		094 - Interest Capitalized		59,650	0	59,650
095		095-COPS Regular Labour AO		15,733	0	15,733
012	044	012 - Materials	044 - TP - Substn.Transf.	[redacted]	0	[redacted]
066	044	066 - Other Goods & Services	044 - TP - Substn.Transf.	[redacted]	0	[redacted]
001	085	001 - T&D Regular Labour	085 Design	8,062	0	8,062
001	085	001 - Regular Labour (No AO)	085 Design	5,417	0	5,417
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	086	001 - T&D Regular Labour	086 Commissioning	13,476	0	13,476
002	086	002 - T&D Overtime Labour	086 Commissioning	0	0	0
			Total Cost:	1,719,218	0	1,719,218
			Original Cost:	407,328		

Location: Transmission
CI# / FP#: 43369
Title: New Mobile Transformer 15 MVA
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Design Labour	Lot	1	$ 8,062.00	$ 8,062.00		
1.2	Commissioning Labour	Person Day	[redacted]		$ 13,475.60		
1.3	Project Support Labour (No AO)	Lot	1	$ 5,417.00	$ 5,417.00		
1.4					$ -		
1.5					$ -		
				Sub-Total	$ 26,954.60		
2	**012 Materials**						
2.1	New Mobile Transformer 15MVA	Lot	[redacted]			Cost Support #1- Quote for a 30MVA Tx adjusted for 15MVA Configuration	43233
2.2					$ -		
2.3					$ -		
2.4					$ -		
2.5					$ -		
				Sub-Total	[redacted]		
3	**066 - Other Goods and Services**						
3.1	Contingency	Lot	[redacted]				
3.2					$ -		
3.3					$ -		
				Sub-Total	[redacted]		
4	**094 Interest Capitalized**						
4.1	Interest	lot	1	59649.9	$ 59,649.90		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 59,649.90		
5	**095 Administrative Overhead**						
5.1	Labour AO		1	15733.2	$ 15,733.20		
5.2	Vehicle AO		1	8879.96	$ 8,879.96		
				Sub-Total	$ 24,613.16		
Cost Estimate				**Total**	$ 1,719,217.66		
6	**Original Cost**				$ 407,328.00		
6.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

GE Energy

Kelman Transport X

DGA Results

Type:
Transformer
Equipment ID:
4P MT-1
Location:
59C
Manufacturer:
vt ca
Sampling Pt:
radiator bottom valve
Sample Source:
Oil Sample
Date:
23 Feb 12 20:00 PM

Hydrogen	H2:	474
Water	H2O:	3
CarbonDioxide	CO2:	1309
CarbonMonoxide	CO:	1150
Ethylene	C2H4:	307
Ethane	C2H6:	40
Methane	CH4:	148
Acetylene	C2H2:	137.3
TDCG	:	2256
RS of Oil	:	15.2%

Diagnosis Tools:
(See TRANSPORT X for more information)

Key Gas:
(Selected by user)
None Selected

Rogers 3:
High energy arcing

Duval's Triangle:
Electrical and thermal fault

Japan ETRA Pattern:
(Selected by user)
None Selected

Japan ETRA Diagram:
Diagram A:
Discharges
Diagram B:
Discharges (Middle Energy)

Transformer Condition:
Warning
Caution Gases:

Hydrogen	>100
Methane	>120

Warning Gases:

CarbonMonoxide	>570
Ethylene	>100
Acetylene	>5
TDCG	>1900

GE Energy

Kelman Transport X

DGA Results

Type:
Transformer
Equipment ID:
mobile
Location:
4p
Manufacturer:
vt ca
Sampling Pt:
radiator bottom valve
Sample Source:
Oil Sample
Date:
19 Jan 12 15:37 PM

Hydrogen	H2:	151
Water	H2O:	1
CarbonDioxide	CO2:	834
CarbonMonoxide	CO:	400
Ethylene	C2H4:	191
Ethane	C2H6:	32
Methane	CH4:	75
Acetylene	C2H2:	52.4
TDCG	:	901
RS of Oil	:	100.0%

Diagnosis Tools:
(See TRANSPORT X for more information)

Key Gas:
(Selected by user)
None Selected

Rogers 3:
High energy arcing

Duval's Triangle:
Electrical and thermal fault

Japan ETRA Pattern:
(Selected by user)
None Selected

Japan ETRA Diagram:
Diagram A:
Discharges
Diagram B:
Discharges (Middle Energy)

Transformer Condition:
Warning
Caution Gases:

Hydrogen	>100
CarbonMonoxide	>350
TDCG	>700

Warning Gases:

Ethylene	>100
Acetylene	>5

CI Number: 43283

Title: **4C Lochaber Road Additional Transformer**

Start Date: 2012/10
Final Cost Date: 2013/11
Function: Transmission
Forecast Amount: $1,625,274

DESCRIPTION:

This item provides for the cost associated with the acquisition of an additional 25 MVA 138Kv/25Kv Transformer at 4C Lochaber Road Substation to comply with NS Power's substation transformer redundancy policy. The expected useful life of a transformer is approximately 40 years.

Depreciation Classes:
Transmission Plant Station Equipment
Transmission Plant Poles and Fixtures

Summary of Related CIs +/- 2 years:

No projects for 2011,2012, 2013, 2014 & 2015

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Capacity

Why do this project?

This project is being completed to mitigate the risk of prolonged loss of load due to transformer failure. Following the transformer failures experienced in 2010 and 2011, NS Power completed a review of its substation redundancy design and determined the appropriate response rather than relying on mobile substations was to modify substations serving approximately 40MW or greater of peak Customer load by installing redundant transformers. The peak load at 4C Lochaber Road exceeds 40MW.

Why do this project now?

Recent transformer failures and corresponding review of failures has led to a determination that additional redundancy is required on the system. This project is being advanced at this time to reduce the probability of loss of load due to a transformer failure.

Why do this project this way?

Purchasing an additional transformer will increase the capacity of the Lochaber Road Substation and provide a spare in the event of a transformer failure. There is room in this existing substation layout to accommodate this transformer without performing a major reconfiguration.

CI Number : 43283 - Additional Transformer 4C Lochaber Road **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		1,736	0	1,736
092		092-Vehicle T&D Reg. Labour AO		65,765	0	65,765
094		094 - Interest Capitalized		585	0	585
095		095-COPS Overtime Labour AO		3,076	0	3,076
095		095-COPS Contracts AO		18,969	0	18,969
095		095-COPS Regular Labour AO		114,655	0	114,655
001	003	001 - T&D Regular Labour	003 - TP - Bldg.,Struct.Grnd.	4,211	0	4,211
012	003	012 - Materials	003 - TP - Bldg.,Struct.Grnd.	9,070	0	9,070
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	6,000	0	6,000
012	007	012 - Materials	007 - TP - Environmental	11,700	0	11,700
013	007	013 - COPS Contracts	007 - TP - Environmental	10,000	0	10,000
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	21,055	0	21,055
011	022	011 - Travel Expense	022 - GTG - Elec Contr.Equip.	1,000	0	1,000
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	45,700	0	45,700
066	022	066 - Other Goods & Services	022 - TP - Elec Contr.Equip.	139,135	0	139,135
001	035	001 - T&D Regular Labour	035 - TP - Wood Poles	21,436	0	21,436
011	035	011 - Travel Expense	035 - TP - Wood Poles	4,500	0	4,500
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	8,001	0	8,001
012	043	012 - Materials	043 - TP - Substn Dev.	[redacted]	0	[redacted]
066	043	066 - Other Goods & Services	043 - TP - Substn Dev.	6,200	0	6,200
001	044	001 - T&D Regular Labour	044 - TP - Substn.Transf.	16,844	0	16,844
002	044	002 - T&D Overtime Labour	044 - TP - Substn.Transf.	8,422	0	8,422
011	044	011 - Travel Expense	044 - TP - Substn.Transf.	1,200	0	1,200
012	044	012 - Materials	044 - TP - Substn.Transf.	[redacted]	0	[redacted]
013	044	013 - COPS Contracts	044 - TP - Substn.Transf.	25,000	0	25,000
001	085	001 - Regular Labour (No AO)	085 Design	2,500	0	2,500
001	085	001 - T&D Regular Labour	085 Design	59,300	0	59,300
011	085	011 - Travel Expense	085 Design	1,260	0	1,260
028	085	028 - Consulting	085 Design	40,000	0	40,000
041	085	041 - Meals & Entertainment	085 Design	500	0	500
001	086	001 - T&D Regular Labour	086 Commissioning	25,267	0	25,267
013	087	013 - COPS Contracts	087 Field Super.& Ops.	16,500	0	16,500
			Total Cost:	1,625,274	0	1,625,274
			Original Cost:			

Location: Distribution
CI# / FP#: 43283
Title: Lochaber Road: Additional Transformer
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician/ Technician	Person Day	[redacted]	[redacted]	$ 74,957.58		
1.2	PowerLine Technician	Person Day	[redacted]	[redacted]	$ 21,435.50		
1.3	Engineering (P.Eng)	Hour	[redacted]	[redacted]	$ 35,000.00		
1.4	Project Support Labour (No AO)	Hour	[redacted]	[redacted]	$ 2,500.00		
1.5	Technologist	Hour	[redacted]	[redacted]	$ 11,521.06		
1.6	CADD	Hour	[redacted]	[redacted]	$ 13,200.00		
1.7					$ -		
				Sub-Total	$ 158,614.14		
2	**002 Overtime Labour**						
2.1	Oil Filtering	Person Day	[redacted]	[redacted]	$ 8,422.20		
2.2							
2.3							
2.4					$ -		
				Sub-Total	$ 8,422.20		
3	**012 Materials**						
3.1	25kV Recloser with Control	Each	1	[redacted]	[redacted]		
3.2	135-25kV Distribution Transformer (25/33/42 MVA)	Each	1	[redacted]	[redacted]	Cost Support Attachment 1: Previous Procurement Recommendation for a job at Dartmouth East (Which was later cancelled). This quote was lower than competition as the proponent advised NSPI that they are just entering the North American Market and prices are expected to increase.	
3.3	Oil Containment Equipment	Lot	1	11,770.00	$ 11,770.00		
3.4	Electrical Control Equipment	Lot	1	45,700.00	$ 45,700.00		
3.5	3 x 138 kV Surge Arrestors	Each	3	[redacted]	[redacted]	Cost Support Attachment 2	
3.6	Other Substation Devices & Equipment	Lot	1	[redacted]	[redacted]		
3.7	Civil Work Materials	Lot	1	9,000.00	$ 9,000.00		
3.8							
3.9							
				Sub-Total	$ 1,002,155.00		
4	**013 T&D Contracts**						
4.1	Civil Work	Contract	[redacted]	[redacted]	$ 6,000.00		
4.2	Field Supervision	Hour	[redacted]	[redacted]	$ 16,500.00		
4.3	Transformer Testing and Offloading	Contract	[redacted]	[redacted]	$ 35,000.00	Assumes Manufacturer Testing	
				Sub-Total	$ 57,500.00		
5	**028 Consulting**						
5.1	Transformer Inspection	Hour	[redacted]	[redacted]	$ 40,000.00		
5.2							
5.3							
				Sub-Total	$ 40,000.00		
6	**011 & 041 Travel and Meals**						
6.1	Accomodation/ Travel Expenses	Each	64	125	$ 7,960.00		
6.2	Meals		25	20	$ 500.00		
6.3					$ -		
				Sub-Total	$ 8,460.00		
7	**066 Other Goods and Services**						
7.1	Protection Panels	Lot	1	10,000.00	$ 10,000.00		
7.2	Boom/ Backhoe Truck Rental	Hour	[redacted]	[redacted]	$ 3,200.00		
7.3	Platform Lift Vehicle Rental	Month	[redacted]	[redacted]	$ 3,000.00		
7.4	Project Contingency	Lot		129,135.15	$ 129,135.15		
				Sub-Total	$ 145,335.15		
8	**094 Interest Capitalized**						
8.1	Interest		1	585.22	$ 585.22		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 585.22		
9	**095 Administrative Overhead**						
9.1	Contracts AO		1	18,969.26	$ 18,969.26		
9.2	Labour AO		1	117,731.31	$ 117,731.31		
9.3	Vehicle AO		1	67,501.55	$ 67,501.55		
				Sub-Total	$ 204,202.12		
Cost Estimate				**Total**	$ 1,625,273.83		
10	**Original Cost**						
10.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 & 2

Removed due to confidentiality

Nova Scotia Power Inc. Radial Transmission/Redundant Transformer Policy

A radial load is a load center, such as a substation, that provides power to a large population, connected to the power grid via a single transmission line. Loss of a radial transmission line results in loss of supply with no other way to connect the radial load to the grid. A single transmission line may have more than one radial load connected to it.

A lone substation, which is dedicated to a single customer, is not considered a radial load in this context. Any load, which is tapped from a transmission line connected between two supply points, is not considered a radial load since this load can be fed from either supply location.

Where a radial load exceeds 40MW, a planning study will be undertaken. The planning study will examine options of reducing the size of the load by load transfer to other substations, by considering local generation in the vicinity, and by other practical load reduction methods.

The planning study will also examine options to improve the line performance such as: vegetation control, lightning mitigation, line upgrade, and other practical technological methods.

In the case of multiple radial loads, which are connected to one radial transmission line, the planning study will examine the option of installing remote switching at the upstream substations to provide fast restoration to the radial loads upstream from the faulted line section.

Implementation of the above "stepped" approach will be the first mitigation measure for any radial load above 40MW. After implementation of these measures, should the radial load remain above 40MW and should the existing transmission supply exhibit deterioration in reliability, then a second transmission line will be evaluated to provide loop feed to improve the reliability.

When radial load grows past 60MW, a second transmission line will be evaluated regardless of performance.

Irrespective of the level of redundancy in transmission supply, when a substation directly supplies a total peak customer load exceeding 40 MW, a planning study will be undertaken. The study will review offloading the station to other sources in the event of a transformer failure. If there are not options to offloading the station then additional transformer capacity will be installed such that the total peak load can be supplied for loss of any of the installed transformers.

CI Number: 43231

Title: **2013 Substation Poly Chlorinated Bi-Phenol (PCB) Equipment Removal**

Start Date: 2013/01
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $1,496,626

DESCRIPTION:

This project provides for the costs associated with the PCB sampling of all substation oil-filled equipment (948 in 2013) and the removal of substation devices with 500 mg/kg or more of PCBs, to be in compliance with 2008 Federal Environmental PCB Regulations (P.C. 2008-1659 September 5, 2008).[1]

Depreciation Class: Transmission Station Equipment

Summary of Related CIs +/- 2 years:
2011 CI 40288 2011 Substation PCB Equipment Removal $2,510,193
2012 Substation PCB Equipment Removal $1,854,665
2014 CI TBD PCB Equipment Removal $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Requirement to Serve

Why do this project?

This is year four of an agreed upon five year program with Environment Canada to remove PCB containing transmission equipment as per the federal regulatory requirement and associated timelines.

Why do this project now?

Regulation P.C. 2008-1659 (September 5, 2008) requires that transmission substation equipment that does not meet federal PCB concentration limits must be removed from service prior to 2015.

Why do this project this way?

The sampling and possible replacement of equipment containing greater than 500 mg/kg concentration of PCBs must be planned over a period of several years to ensure outages are scheduled in a timely manner. Environment Canada regulations require completion by 2015.

[1] http://canadagazette.gc.ca/rp-pr/p2/2008/2008-09-17/html/sor-dors273-eng.html

CI Number : 43231 - 2013 Substation PCB Equipment Removal

Project Number

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin.

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		114,973	0	114,973
092		092-Vehicle T&D OT Labour AO		3,056	0	3,056
094		094 - Interest Capitalized		51,892	0	51,892
095		095-COPS Regular Labour AO		203,706	0	203,706
095		095 - T&CS Regular Labour AO		663	0	663
095		095-COPS Contracts AO		[redacted]	0	[redacted]
095		095-COPS Overtime Labour AO		5,414	0	5,414
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	264,459	0	264,459
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	14,823	0	14,823
012	043	012 - Materials	043 - TP - Substn Dev.	417,814	0	417,814
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	[redacted]	0	[redacted]
001	085	001 - Regular Labour (No AO)	085 Design	8,356	0	8,356
001	085	001 - T&CS Regular Labour	085 Design	2,122	0	2,122
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	14,400	0	14,400
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	1,496,626	0	1,496,626
			Original Cost:	372,294		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 43231
Title: 2013 Substation PCB Equipment Removal
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1					$ -		
1.2	Project Support Labour (No AO)	Lot	1	$ 8,356.28	$ 8,356.28		
1.3	T&D Regular Labour	Person Days	[redacted]		$ 264,458.65		
1.4	Supervision	Lot	1	$ 14,400.00	$ 14,400.00		
1.1	Engineering (P.Eng) Design	Lot	1	$ 2,122.00	$ 2,122.00		
				Sub-Total	$ 289,336.93		
2	**002 Overtime Labour**						
2.1	T&D Overtime Labour	Person Days	[redacted]		$ 14,823.16		
				Sub-Total	$ 14,823.16		
3	**012 Materials**						
3.1	Bushings, Instrument transformers, circuit breakers & insulating oil	Person Days	1	$ 417,814.19	$ 417,814.19		41429
2.3					$ -		
				Sub-Total	$ 417,814.19		
3	**013 COPS Contracts**						
3.1	Disposal of PCB Contaminated Insulating Oils	Lot	1	[redacted]			
3.2							
3.3					$ -		
				Sub-Total	[redacted]		
4	**094 Interest Capitalized**						
4.1	Interest		1	51891.78	$ 51,891.78		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 51,891.78		
5	**095 Administrative Overhead**						
5.1	Contract AO		1	[redacted]			
5.2	Admin AO		1	$ 209,783.30	$ 209,783.30		
5.3	Veh AO		1	$ 118,029.14	$ 118,029.14		
				Sub-Total	[redacted]		
Cost Estimate				**Total**	$ 1,496,625.54		
10	**Original Cost**						
10.1					$ 372,293.89		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: **43490**

Title: **2013 Steel Tower Painting**

Start Date: 2013/05
Final Cost Date: 2013/11
Function: Transmission
Forecast Amount: $1,375,442

DESCRIPTION:

This item is part of a program to apply anti-corrosive paint to lattice steel towers in order to extend the life of the structures. The towers to be painted have been prioritized based on the latest inspection data and will be:

L6033/L6035 Structures 1- 7 from Water St.
L5049 Structures 2 and 3
L5042 Structures 1 and 2 L5003 Structures 1 and 2

The cost includes the removal and collection of the existing loose lead paint, the proper disposal of this lead paint, working at heights of up to 300 feet and working in proximity to energized lines as well as material costs. From experience, the average expected useful life of standard painting products in deterring corrosion on transmission towers is 10 to 15 years.

Depreciation Class: Transmission Towers & Fixtures

Summary of Related CIs +/- 2 years:
2012 CI 41535 2012 Steel Tower Painting $1,270,605
This is a multi-year program that will continue beyond 2013. Future CIs TBD.

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Maintenance

Why do this project?

The environmental conditions that these towers are exposed to have deteriorated the protective coating on the structures and they are beginning to show signs of corrosion.

Why do this project now?

These towers require recoating to be completed in order to reduce the loss of metal, which will extend the life of the towers. The towers will be prioritized based on the age of the structures and the latest inspection data.

Why do this project this way?

The most cost effective approach is to recoat the steel towers prior to the corrosion penetrating the existing paint and contacting the metal after which painting is no longer an effective mitigation solution.

CI Number : 43490 -

Project Number

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin.

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		6,762	0	6,762
094		094 - Interest Capitalized		1,453	0	1,453
095		095-COPS Regular Labour AO		11,980	0	11,980
095		095 - T&CS Regular Labour AO		2,379	0	2,379
095		095-COPS Contracts AO		[redacted]	0	[redacted]
012	037	012 - Materials	037 - TP - Steel Towers	30,000	0	30,000
013	037	013 - COPS Contracts	037 - TP - Steel Towers	[redacted]	0	[redacted]
001	085	001 - Regular Labour (No AO)	085 Design	1,000	0	1,000
001	085	001 - T&CS Regular Labour	085 Design	7,616	0	7,616
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
011	085	011 - Travel Expense	085 Design	1,200	0	1,200
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	16,400	0	16,400
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	1,375,442	0	1,375,442
			Original Cost:	79,082		

Location: **Transmission**
CI# / FP#: 43490
Title: 2013 Steel Tower Life Extension
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Design Labour	Lot	1	$7,616.00	$ 7,616.00		
1.2	Field Supervison Labour	Lot	1	$16,400.00	$ 16,400.00		
1.3	Project Support Labour (No AO)	Lot	1	$1,000.00	$ 1,000.00		
1.4					$ -		
1.5							
1.6							
				Sub-Total	$ 25,016.00		
2	**012 Materials**						
2.1					$ -		
2.2	Miscellaneous Materials	Lot	1	30000	$ 30,000.00		
2.3							
2.4					$ -		
2.5					$ -		
2.6					$ -		
				Sub-Total	$ 30,000.00		
3	**013 T&D Contracts**						
3.1	Work on towers to Extend Life	Lot	13	[redacted]		Cost Support #1	41535
3.2							
3.3							
3.4							
				Sub-Total	[redacted]		
4	**011 Travel**						
4.1	Travel Expenses	Lot	1	1200	$ 1,200.00		
4.2							
4.3							
				Sub-Total	$ 1,200.00		
5							
5.1					$ -		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ -		
6	**094 Interest Capitalized**						
6.1	Interest		1	1452.79	$ 1,452.79		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 1,452.79		
7	**095 Administrative Overhead**						
7.1	Labour AO		1	14,359.45	$ 14,359.45		
7.2	Vehicle AO		1	6,761.72	$ 6,761.72		
7.3	Contract AO		1	[redacted]			
				Sub-Total			
Cost Estimate				**Total**	$ 1,375,442.46		
8	**Original Cost**				$ 79,082.00		
8.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

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REF

Corrosion Ratios of Steel to Zinc in Natural Corrosion Environments

X.G. Zhang*

ABSTRACT

Ratios of corrosion rates of steel and zinc in various natural environments were analyzed using data collected from published documents. Distinctive patterns were found for corrosion ratios in atmospheres, soils, and seawaters. These patterns provided new information on the characterization of corrosion environments and can be used to evaluate the relevance of laboratory corrosion testing to field corrosion performance. They are also useful as a guide for more effective application of zinc coatings to protect steel from corrosion in various environments.

KEY WORDS: atmosphere, coatings, field corrosion, seawater, soil, steel, zinc

INTRODUCTION

Zinc coatings are used widely for corrosion protection of steel because of their high corrosion resistance. However, this high corrosion resistance, relative to other materials such as steel, is not observed in many common laboratory corrosion tests.[1-2] Corrosion tests that produce realistic results have been developed for specific applications using specific correlation procedures, as in the paint and automotive industries.[1,3] However, there is not a general and practical method to evaluate the relevance of a corrosion test. Furthermore, there is still a lack of understanding of the specific effects of various test conditions on the corrosion behavior of zinc and steel.[4-6]

In the present study, ratios of corrosion rates of steel and zinc were examined in various corrosion environments. Corrosion of steel and zinc, two important metals, have been investigated extensively, very often together, in various corrosion environments, especially atmospheres, soils, and waters.[7-12] It is thought that a systematic examination of the corrosion ratios of steel to zinc, using corrosion rate data published in the literature, may offer new information on characteristics of various corrosion environments and provide a basis for evaluation of the relevance of corrosion testing.

A necessary condition for a relevant laboratory-accelerated corrosion test is that the laboratory exposure should generate a corrosion ratio for two different metal alloys similar to that experienced in the field exposure of interest, although the corrosion rates in the two exposures may not be similar. The test accelerates corrosion processes similarly for the two metals, and thus, generates similar acceleration factors. Corrosion ratio can be used to evaluate this similarity, and thus, the relevance of corrosion testing to field performance. Using corrosion ratio requires that the two materials tested have the same corrosion form so that the corrosion loss of these two materials can be compared meaningfully. This is the case for steel and zinc, which, in most natural corrosion environments, corrode in the form of general corrosion (i.e., corrosion proceeds uniformly across the metal surface).[4] Similar to the ratio of corrosion rates, the ratio of under-paint creep lengths of

Submitted for publication May 1998; in revised form, February 1999.
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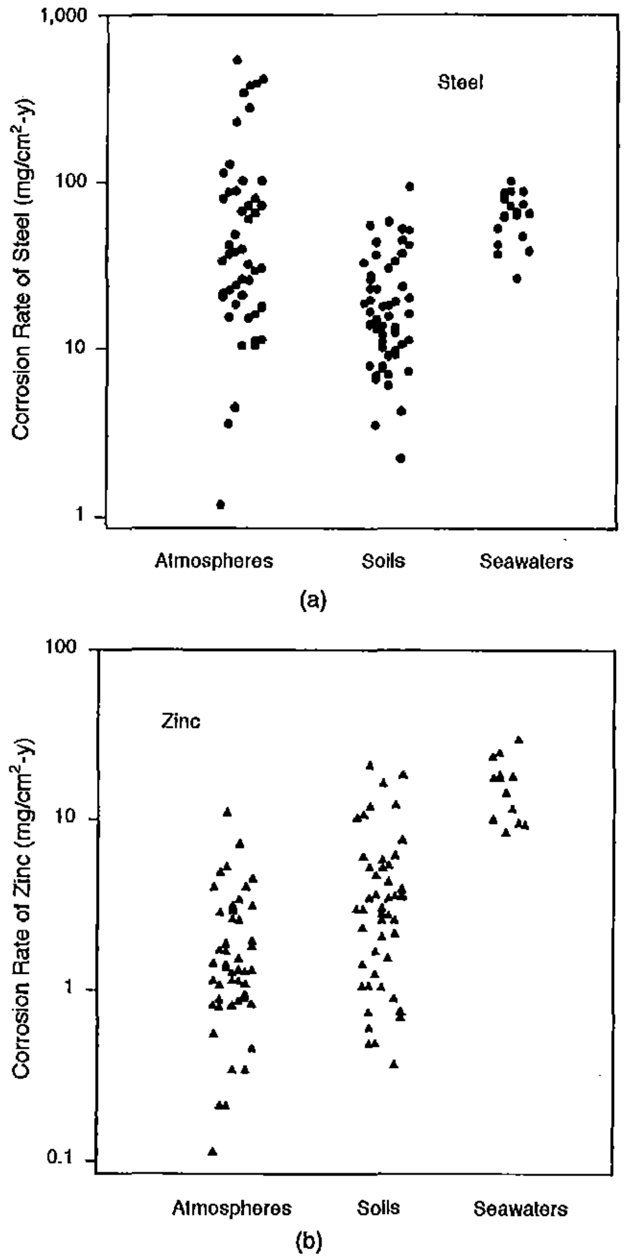

FIGURE 1. *Corrosion rates of steel and zinc in atmospheric,[7] soil,[11] and seawater[15-21] environments.*

painted, zinc-coated steels and painted, cold-rolled steel has been used to evaluate the appropriateness of accelerated tests for cosmetic corrosion.[13]

Corrosion rates of steel and zinc reported in the literature for different natural environments, such as atmospheres, soils, and seawaters, were collected, and the corrosion ratios were analyzed. Corrosion ratios generated under various laboratory test conditions are reported elsewhere.[14] Corrosion rate data for steel and zinc in natural environments are found in a large number of reports from investigations carried out over more than half a century and in many nations. Since very different corrosion rates can be found in different testing programs for the same testing site (a specific environment), to ensure data consistency, corrosion ratios were calculated only for the corrosion rates that were generated in the same testing program, so that the testing conditions (e.g., sample preparation, exposure condition, and length of exposure) were the same for steel and zinc.

RESULTS AND DISCUSSION

Corrosion Rates

Figure 1 shows corrosion rates of steel and zinc in three major natural environments (atmosphere, soil, and seawater). Steel and zinc corroded over a wide range of rates in each environment, and the ranges of corrosion rates greatly overlapped among the different environments. This was particularly true in atmospheric environments in which the range of corrosion rates was 2 orders of magnitude for zinc and 3 orders for steel. In the case of steel, the higher end of the corrosion rate range in atmospheric environments was much higher than those of soils or seawaters, indicating the most corrosive natural environments to steel were found in the atmosphere. However, the lowest corrosion rates for zinc were observed in atmospheric environments, while the highest ones were found in seawaters. A wide spread of corrosion rates also was found in different types of atmospheric environments (Figure 2).

Compared to atmospheres and soils, much less data are available for seawaters. This is largely because of the fact that the collection of long-term data for natural seawaters is much more difficult than for atmospheres and soils.[12] The range of corrosion rates in seawaters is much smaller than those in atmospheres and soils. This can be understood from the more homogenous nature of seawater environments (i.e., the similar physical and chemical make-up of different seawaters around the world).[4]

Corrosion Ratios and Distributions

Figure 3 shows corrosion ratios of steel and zinc in soils, seawaters, and four different types of atmospheric environments. It shows a clear distinction between the atmospheric and the other two environments. Among the atmospheric environments, the marine type appeared to have distinctively higher values than the other three types among which the values mostly overlapped. In all atmospheres, steel corroded ten to several hundred times faster than zinc. In contrast, corrosion ratio values in soils and seawaters were mostly below ten. The data in Figure 3 confirmed the fact that it is most beneficial to use zinc coatings for corrosion protection of steel in atmospheric environments.

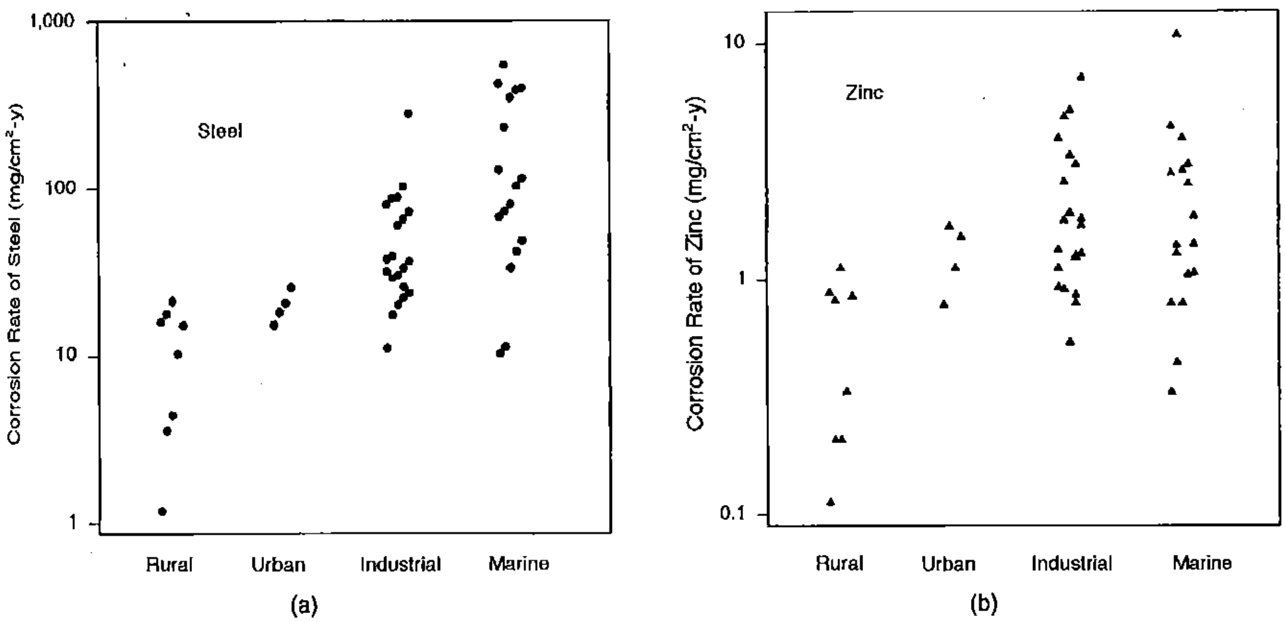

FIGURE 2. *Corrosion rates of steel and zinc in different types of atmospheric environments using the same data as in Figure 1.*

The difference between the corrosion ratios in atmosphere and soil can be seen clearly in Figure 4, which shows distributions of the corrosion ratios in these two corrosion environments. Analysis of the data indicated that the corrosion ratios in these two environments could be described by a lognormal distribution, which is defined by the following function:[23]

$$f(x) = \frac{1}{bx\sqrt{2\pi}} \exp\left[-\frac{\left(\ln(x) - a\right)^2}{2b^2}\right] \quad (1)$$

where f(x) is lognormal probability, x is the corrosion ratio, a is the mean of the log of the ratio, and b is the standard deviation of the log of the ratio. The relationships between a and b and the mean (μ) and standard deviation (σ) of the corrosion ratios are:

$$\mu = \exp\left(a + b^2/2\right) \quad (2)$$

and:

$$\sigma^2 = \left[\exp\left(b^2\right) - 1\right]\exp\left(2a + b^2\right) \quad (3)$$

The lognormal distribution is used widely to describe life data from accelerated testing for fatigue, electrical insulation, and corrosion.[23,24] Curve-fitting of the data in Figure 4 based on nonlinear regression of the data gives a = 3.18 and b = 0.38 for atmospheric environments and a = 1.95 and b = 0.52 for soils.[25] Peak values and means calculated according to Equations (2) and (3) are 20.7 and 25.6 for atmospheric environments and 5.3 and 8.06 for soils, respectively, indicating a distinct difference between the two corrosion environments. There were not enough data for a distribution analysis of the corrosion ratios in seawaters.

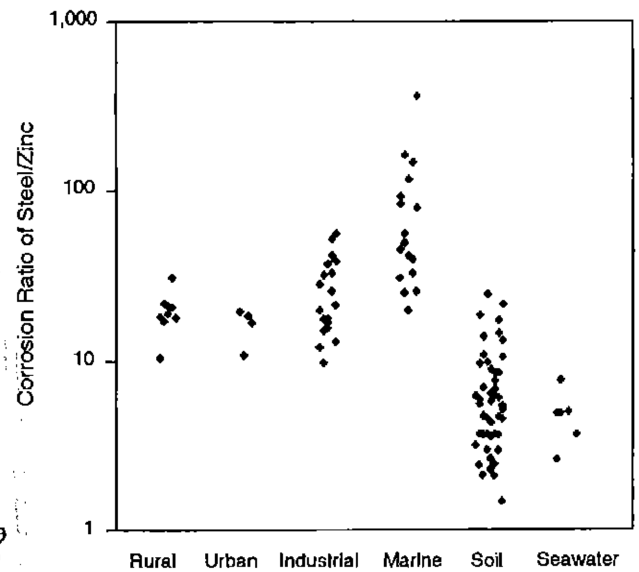

FIGURE 3. *Corrosion ratio of steel/zinc in soils, seawater, and various types of atmospheric environments (data from the same sources as in Figure 1).*

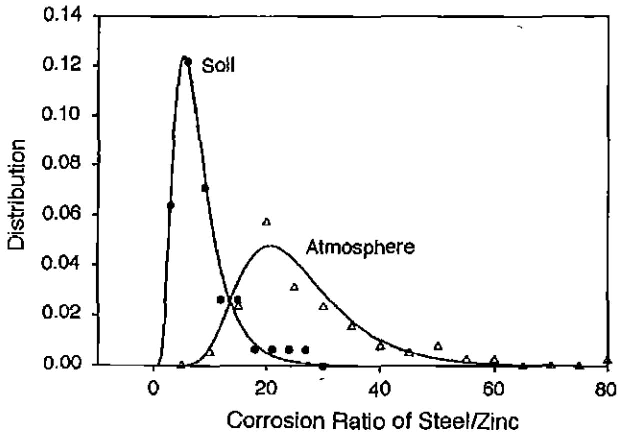

FIGURE 4. *Distribution of corrosion ratios of steel/zinc for 87 different atmospheric environments (2 years data)[7,10,22] and 52 different soils (10 years data).[11] Solid lines represent results from curve fitting of the data to Equation (1).*

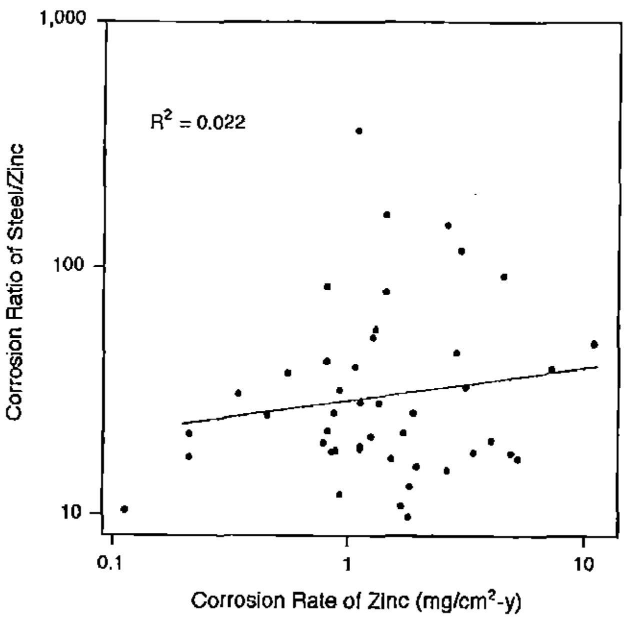

FIGURE 5. *Corrosion ratio of steel/zinc as a function of the corrosion rate of zinc in atmospheric environments (data from the same sources as in Figure 1). R^2 is the correlation coefficient between the corrosion ratio and the corrosion rate of zinc.*

Corrosion Ratios vs Corrosion Rates

Figure 5 is a plot of the ratio of the corrosion rate of steel to that of zinc as a function of the corrosion rate of zinc in atmospheric environments. Data showed no correlation between the corrosion ratio and the corrosion rate of zinc. However, if the same ratios were plotted as a function of the corrosion rate of steel (Figure 6), it was found that the corrosion ratio of steel/zinc increased with the corrosion rate of steel.

In soils, the relationship between corrosion ratio and corrosion rates of steel and zinc appeared to be different from that in atmospheres (Figures 7 and 8). Data showed no correlation between the corrosion ratio and corrosion rate of steel, but a correlation with the corrosion rate of zinc (i.e., corrosion ratio tended to decrease with the increasing corrosion rate of zinc). The fact that corrosion ratios have a strong correlation with the corrosion rates of steel, but not with those of zinc in atmospheric environments, while the opposite is true in soils, reflects the complex but specific effect of each type of corrosion environment on different materials.

Results in Figures 6 and 8 were meaningful to the effective use of zinc coatings for corrosion protection of steel. Data in Figure 6 suggested that the more corrosive an atmospheric environment is to steel, the higher the corrosion ratio of steel/zinc, hence, the more beneficial is the use of a zinc coating for protecting the steel in that environment. Similarly, the data in Figure 8 indicated that the use of a zinc coating on steel is more beneficial in soils in which the corrosion rates of zinc are relatively low.

Effect of Time

Figure 9 shows corrosion ratios as a function of time in open, atmospheric environments. Corrosion ratios in different types of atmospheres generally decreased with time. In contrast, under sheltered conditions, corrosion ratios appeared to increase with exposure time by a factor of as much as three for the test periods of 6 years to 10 years (Figure 10).

In soils, corrosion ratios exhibited a tendency to decrease with time (Figure 11, ratio values in soils were low compared to the average for the 52 soils shown in Figure 4). In contrast, in seawater, corrosion ratios appeared to increase with immersion time (Figure 12).

The opposite tendencies of corrosion ratios, with respect to time for open vs sheltered atmospheric exposure, clearly showed the strong dependence of the corrosion behavior of these two metals on specific environmental conditions. These opposite tendencies can be attributed to the fact that corrosion rates of steel are lower under a sheltered condition than in an openly exposed condition over a short term (e.g., 3 months), while the opposite is true for longer terms (e.g., 5 years).[28] For zinc, corrosion rates are generally much lower under a sheltered condition than in an openly exposed condition.[4] The major difference between an open and a sheltered condition is the lack of rain with a sheltered condition. Rain not only wets the metal surface and provides the electrolyte for the corrosion process, but also, in contrast to condensed surface water, has an effect of constantly renewing the electrolyte and washing away the dissolution products. Rain, therefore, has a significant effect on the formation and retention of solid corro-

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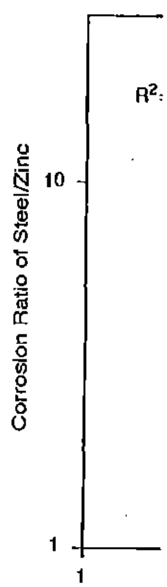

FIGURE 7. *Corro*
rate of steel in so

sion products, which strongly affects the subsequent corrosion behavior of metal.

Ratio Patterns

The difference in corrosion ratios and their dependence on exposure time can be used to characterize corrosion environments. Figure 3 indicates that atmospheric environments could be differentiated clearly from soils and seawaters since the corrosion ratios in atmospheric environments were much higher than those in soils and seawaters. Corrosion environments could be distinguished further according to the dependence of corrosion ratio on exposure time. In open atmospheres and soils, the ratio tended to decrease with time, while in seawaters, it tended to increase with time.

Table 1 is a summary of corrosion ratios of steel/zinc in various corrosion environments and their correlations with corrosion rates, as well as with testing time. Distinct patterns existed in the relationships between corrosion of the two metals and the corrosion environments. This implied that corrosion ratios of the two metals contained inherent information about the corrosion environments and can be used to characterize different corrosion environments.

Specifically, ratio patterns can be used to compare corrosion environments under laboratory conditions, and in the field to assess the relevance of corrosion testing. As shown in Table 1, the corrosion ratio of steel/zinc obtained from the ASTM salt spray test (SST) for 96 h was < 2,[14] which is much smaller than the corrosion ratios in natural environments.

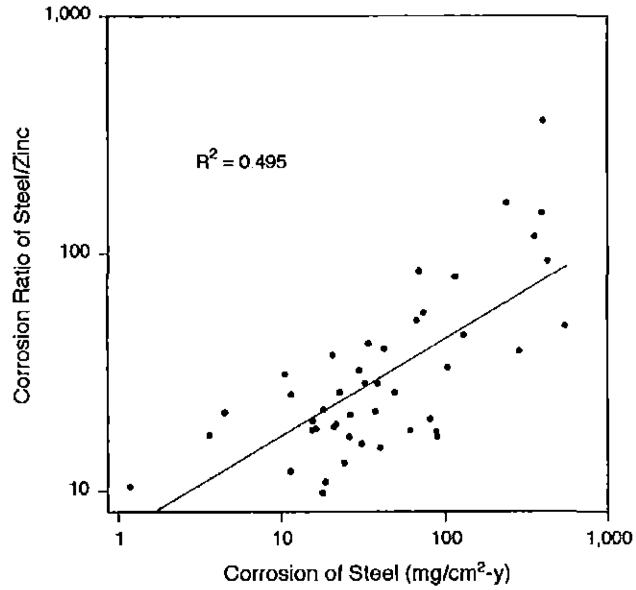

FIGURE 6. *Corrosion ratio of steel/zinc as a function of the corrosion rate of steel in atmospheric environments (data from the same sources as in Figure 1). The correlation is significant at 99.9% confidence level.*

This was a quantitative confirmation of the observation that SST generally does not correlate with real-world performance for steel and zinc products.[1,3-4] For zinc and its alloys, SST represents a particularly severe environment in which zinc corrodes in a different mechanism from that in natural environments.[4,6,13]

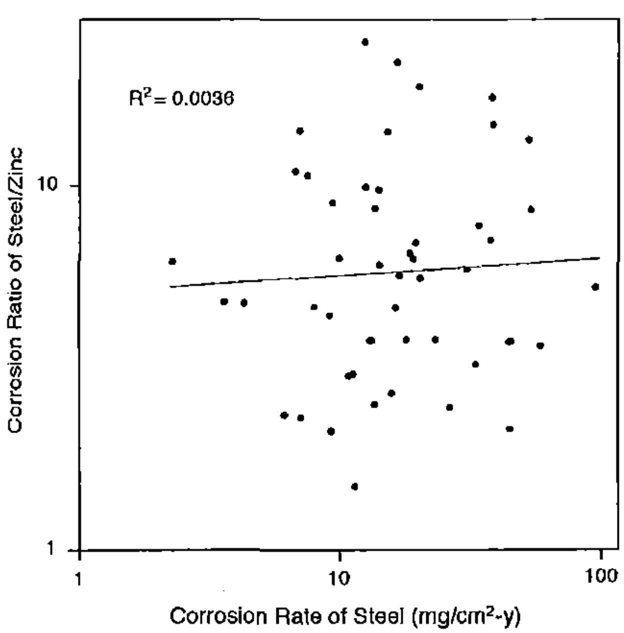

FIGURE 7. *Corrosion ratio of steel/zinc as a function of the corrosion rate of steel in soils (data from the same sources as in Figure 1).*

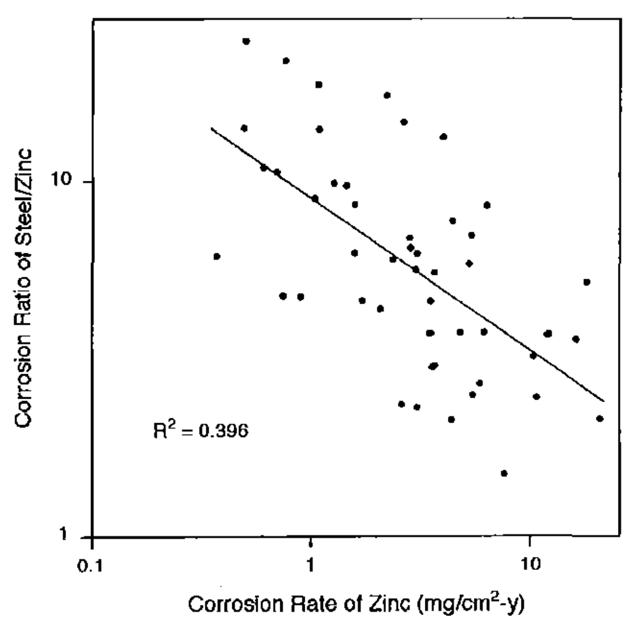

FIGURE 8. *Corrosion ratio of steel/zinc as a function of the corrosion rate of zinc in soils (data from the same sources as in Figure 1). The correlation is significant at 99.9% confidence level.*

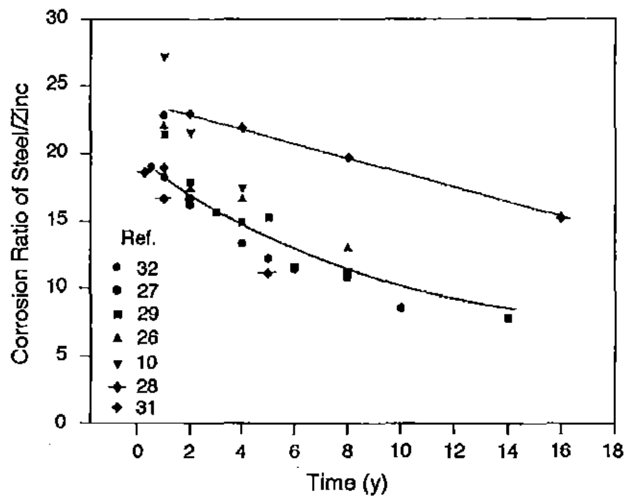

FIGURE 9 *Corrosion ratio of steel/zinc as a function of time in atmospheric environments, openly exposed samples. Values were averages taken from seven studies: four marine locations on the west coast of Sweden;[26] one urban and two rural locations in Norway;[27] a rural, an urban, an industrial, and a marine location in Sweden;[28] four different locations in Spain;[29-30] an inland site and a sea coast site in Panama;[31] a rural, an industrial, and a marine location in the former Soviet Union;[32] and 32 different locations in Scandinavia.[10]*

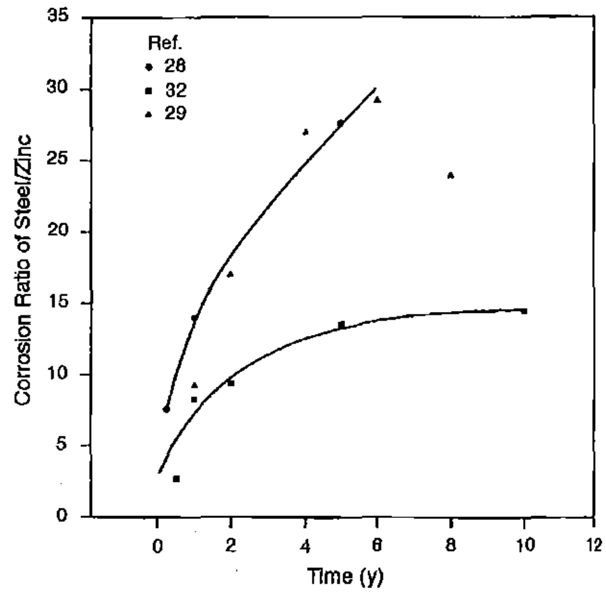

FIGURE 10. *Corrosion ratio of steel/zinc as a function of time in atmospheric environments, rain-shelter protected samples. Data was extracted from an average of values at a rural, an urban, an industrial, and a marine location in Sweden;[28] an average of a rural, an industrial, and a marine location in the former Soviet Union;[32] and one location in Spain.[29]*

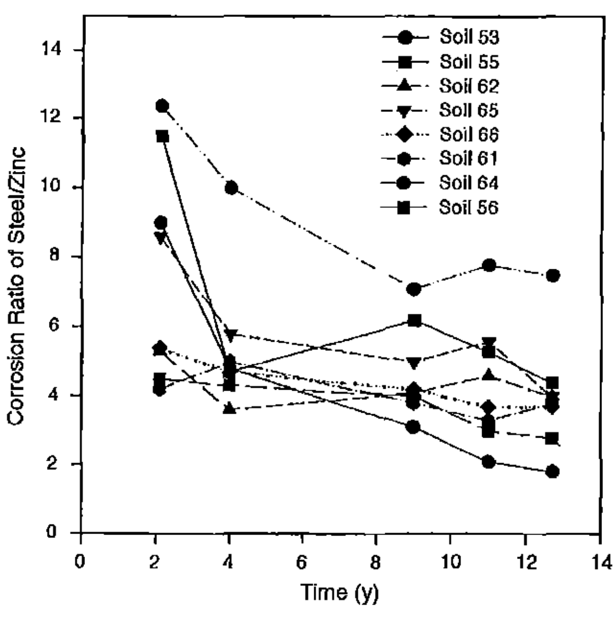

FIGURE 11. *Corrosion ratio of steel/zinc as a function of time in 8 different inorganic soils.[11] (Legends of the curves refer to identification of the soils in the original study.)*

The use of a corrosion ratio for evaluation of the relevance of corrosion testing has some clear advantages. It is a simple method that quantifies certain inherent qualities of a corrosion environment (i.e., its relative corrosiveness toward the two different materials). For a relevant laboratory corrosion test, relative corrosiveness must be similar to that of the field environment in question. Also, the corrosion ratio is a dimensionless parameter and the values experienced in real environments can be generated in accelerated tests. This is not the case for corrosion rates. Obtaining similar corrosion rates as in the field is generally not the objective of laboratory corrosion tests. Laboratory tests are mainly of accelerated nature and corrosion rates generated are usually much higher than those experienced in real environments.

Experimental results indicated that corrosion ratios of steel and zinc with values and variations close to those in natural environments can be produced in laboratory corrosion tests (Table 1).[14] For example, by changing the spray solution from 5% sodium chloride ([NaCl] solution for ASTM SST) to 0.01 M NaCl, the corrosion ratio of steel/zinc after 96 h of test changed from 1.8 to 7.5. Tests that reveal more realistically the corrosion performance of steel and zinc can be realized by introducing cyclic wetting and drying. It is known, particularly in the automotive and steel industries, that properly designed cyclic tests can generate very realistic results for the corrosion performance of painted steels and zinc-coated steels.[1,33] A systematic evaluation of the specific effect of laboratory test conditions on the corrosion behavior of steel and zinc is presented in a separate paper.[14]

CONCLUSIONS

✧ Corrosion ratio of steel/zinc was used to characterize various natural corrosion environments. Analyses of data from published literature revealed distinct characteristics of corrosion ratios in atmospheres, soils, and seawaters.
✧ Statistical analysis of data indicated that corrosion ratios in soils and atmospheres belonged to two different populations, which were found to follow lognormal distributions. Curve-fitting of the data to the lognormal distribution function gave the means of corrosion ratios, 25.6 and 8.07 for atmospheres and soils, respectively.
✧ Corrosion ratios in different environments not only varied characteristically in value but also in their dependence on the length of testing time and on the corrosion rates of steel and zinc. It was found that while the ratio decreased with time in open atmospheric exposure, it increased with time under a sheltered condition. It also was found that the corrosion ratio decreased with time in soils but increased with time in seawaters.
✧ These patterns provided new information on the characteristics of corrosion environments and can be used for evaluation of the relevance of laboratory corrosion tests to field conditions. Also, they are useful as a guide to the effective application of zinc coatings to protect steel from corrosion in various environments.

ACKNOWLEDGMENTS

The author acknowledges E.M. Valeriote, K. Tomantschger, and J. Hwang for their help in preparing this article and A.Q. Xing for the statistical data analysis.

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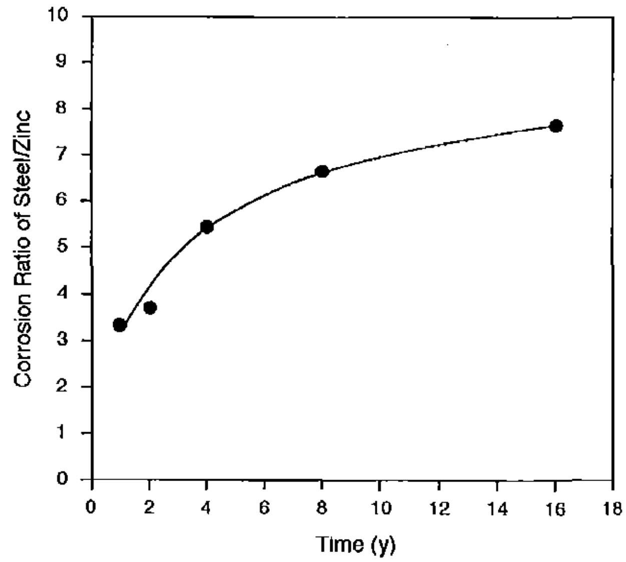

FIGURE 12. *Corrosion ratio of steel/zinc as a function of time in seawater.*[16]

TABLE 1
Corrosion Ratio of Steel/Zinc in Various Corrosion Environments

Environments	R_S/R_Z[(A)]	vs R_S	vs R_Z	vs Time
Atmospheres				
Open exposure	25	Strongly increased	None	Stongly decreased
Sheltered	15	–	–	Strongly increased
Soils	10	None	Stongly decreased	Stongly decreased
Seawater	4	–	–	Strongly increased
Salt spray test	< 2[(B)]	–	–	Slightly increased

(A) Values were taken from Figures 4 and 10 through 12 as the averages after 2 years.
(B) 96 hours.

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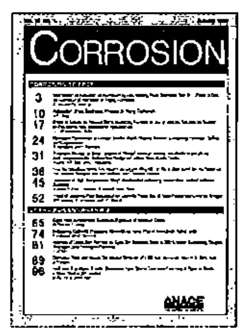

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ABSTRACT

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Zinc Galvanizing Deterioration Diagnosis of Steel Towers Using VTR Image Analysis Technology

by

A.KAWAHARA* K.OOURA
Tokyo Electric Power Co., Inc.

N.MASAOKA
Tomoe Corporation

(Japan)

1. Summary

To protect the steel material of power transmission towers from rusting, the steel is treated by hot dip galvanization (below, called "galvanization"). The color of galvanization changes as it deteriorates. We have established an objective and quantitative method to access the state of deterioration of galvanization by performing color image analysis of the discoloration caused by the deterioration.

We compared the degree of deterioration of their galvanization based on a visual inspection (conventional method) with that based on the image analysis method. As a result, the number of towers requiring repair according to the image analysis method is 7% less than that requiring repair according to the conventional method (visual inspection).

image analysis

7% less than general visual inspection

Key Words: power transmission towers, galvanization, image analysis, deterioration

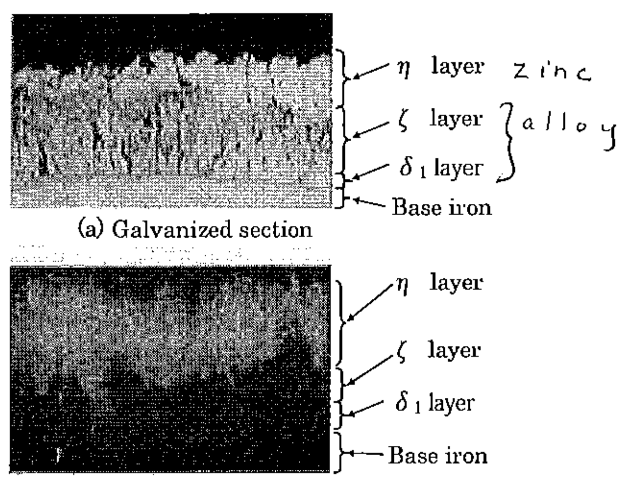
2. Outline of galvanization deterioration diagnosis method

2.1 Degree of deterioration of galvanization

Fig. 1 shows a microphotograph of the section of the galvanization and the typical external appearance of the galvanization.

The section of the galvanization consists of the pure zinc layer (η layer),the alloy layer, and the base iron layer. The alloy layer is divided into two kinds of alloy layers (ζ layer and δ_1 layer).

As the pure zinc on the surface of galvanization is destroyed by its long-term outdoor exposure, the layers of alloy and base iron below it are gradually exposed. The exposure of the iron in the alloy layers and the base iron causes corrosion producing iron oxides and iron hydroxides etc.



(a) Galvanized section

(b) External discoloration caused by deterioration

FIGUER 1.
Galvanizing Section and Discoloration Occurring Over Time

*Tokyo Electric Power Co.,Inc., 1-3 Uchisaiwai-cho 1-Chome Chiyoda-ku Tokyo100-0011 Japan

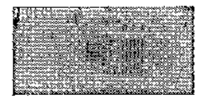
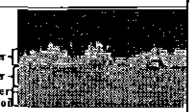
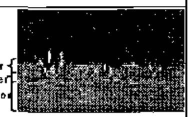
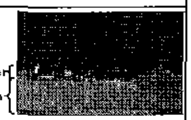
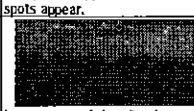
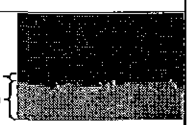
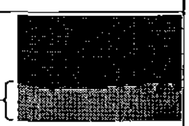
Discoloration characteristic of rusting appears on the surface of the steel according to the quantity of iron in the alloy layer and base iron layer and according to the products of corrosion that are formed. The content of the iron that causes this discoloration is about 6% of the ζ layer and between 7% and 11% of the δ_1 layer.
Therefore, if the pure zinc layer is worn off, exposing the alloy layer or the base iron, fine discoloration that is governed by the quantity of iron is observed.

Therefore, assuming that it is suitable to set the criteria for judging the degree of deterioration of galvanizing according to the degree of discoloration of the steel surface, these criteria are shown in Table 1.

2.2 Image diagnosis method

Fig. 2 shows an outline of the image diagnosis method. The image diagnosis is done by photographing members of the steel tower to be diagnosed with a 3CCD digital video camera and transmitting the photographed image data to a personal computer that analyzes the image data to assess the deterioration. The visual diagnosis system assesses the deterioration based on the discoloration of the steel. The discoloration was examined using the L*a*b color specification system (CIE (International Commission on Illumination) standard) appropriate for the digitization of color. Fig. 3 shows an outline of the L*a*b color specification system.

TABLE 1.
Degree of Deterioration Judgment Criteria

Degree of Deterioration	External Appearance	Section Conditions
I	 It appears to be bright gray.	η layer, ζ layer, δ_1 layer, Base iron 
II	 As the alloy is exposed,thin rusting appears and overall it appears yellow	ζ layer, δ_1 layer, Base iron 
III	 The alloy is fully exposed. It begins to appear red,and rust spots appear.	δ_1 layer, Base iron 
IV	 Large areas of the alloy layer and base metal are exposed,and the color is change to red and black over wide areas.	δ_1 layer, Base iron 
V	 The deterioration is more wide-spread than at deterioration stage IV,and black is visible over wide areas.	Base iron 

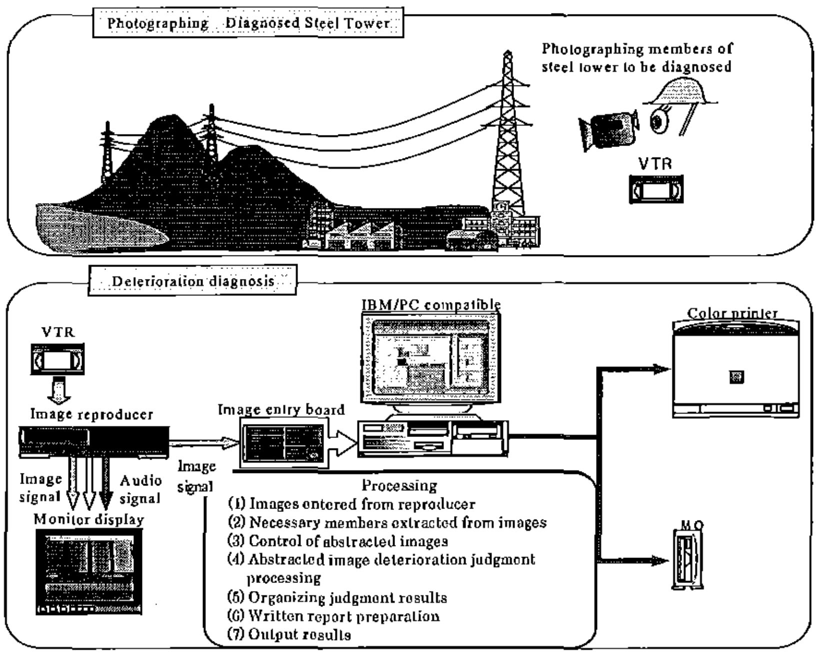


FIGURE 2
Outline of Image Diagnosis

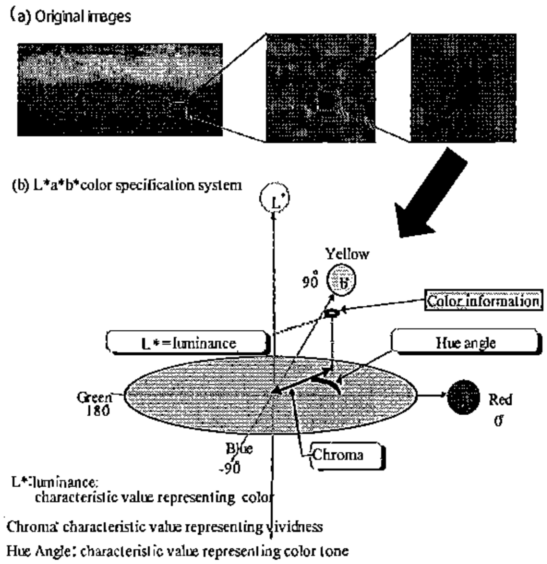


FIGURE 3.
Schematic Explanation of L*a*b Color Specification System

As Fig. 3 shows, an image is composed of an aggregate of points (picture elements) with differing color information. The image diagnosis is performed by digitizing the color information (luminance: L*, chroma, and hue angle) of all the picture elements in the image.

Along with the digitization of each picture element, the surface coverage by category of rusting that has occurred on the steel is analyzed.

The final judgment of the degree of deterioration is made comprehensively based on the digitized degree of discoloration and the surface coverage by category of rusting.

We were used to minimize the error of judgment by visual inspection (conventional method) using color sample. But, using image analysis, we are able to evaluate the deterioration of galvanization more objectively and quantitatively.

2.3 Photography method

Before the field photography, the inspectors prepare 1) a 3CCD digital video camera, 2) white sample used for white balance adjustment, and 3) color sample used for color correction.

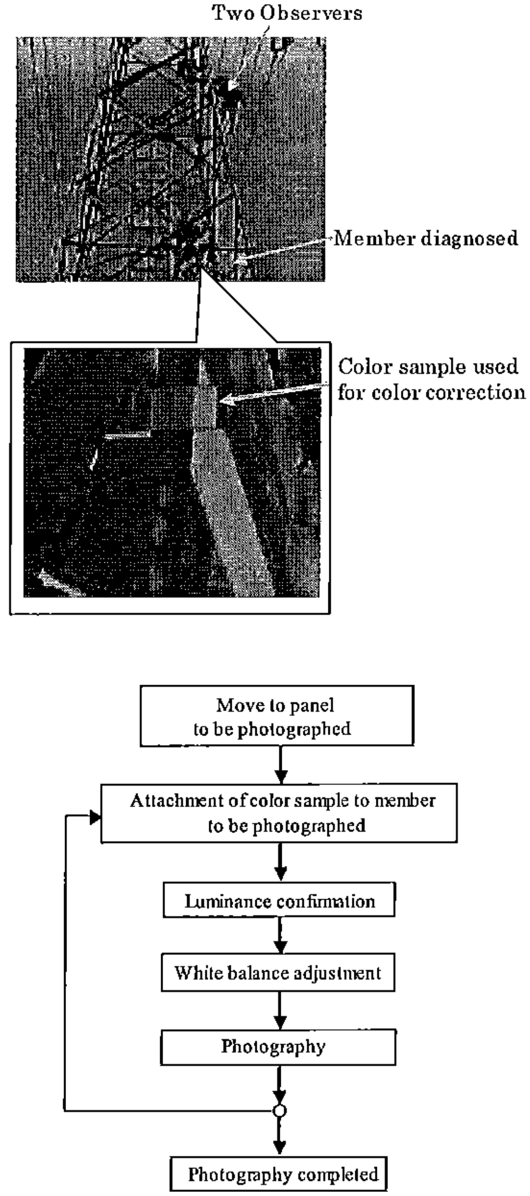


FIGURE 4
Field Photography Procedure and State of Photography

The photography is done by the following procedure. Fig. 4 shows the field photography method and the photography flow chart.

1) Initialization of the sensitivity of the digital camera by photographing a white board.
2) Vocal recording of the details of the location photographed.
3) Simultaneous photography of the steel and the color correction sample.

2.4 Image diagnosis

The images obtained for the diagnosis are stored in the personal computer as still images. The image diagnosis is done by processing the still images with a specialized program. As the still images are stored in the personal computer, their locations are confirmed by spoken record.

The results of the image diagnosis of each member are output as its degree of deterioration, surface coverage by category of rusting, converted membrane thickness, mean degree of deterioration by part, mean converted membrane thickness by part, and mean degree of deterioration of the tower. The above data can be tabulated by the personal computer's spreadsheet software and data base. Also, as shown in Fig. 5, the system can also analyze the state of rusting of the members and represent it as a computer graphic display.

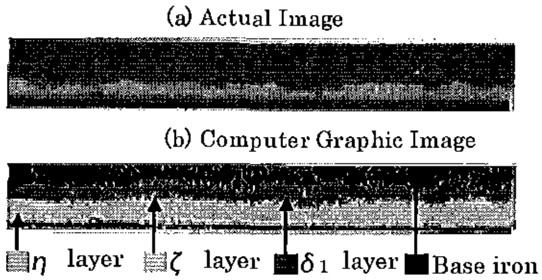


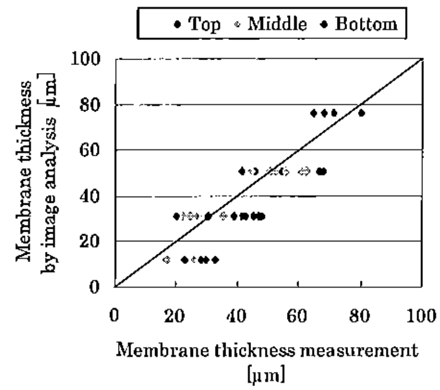
FIGURE 5
Rusting of Member

2.5 Confirmation of its practicality in field test

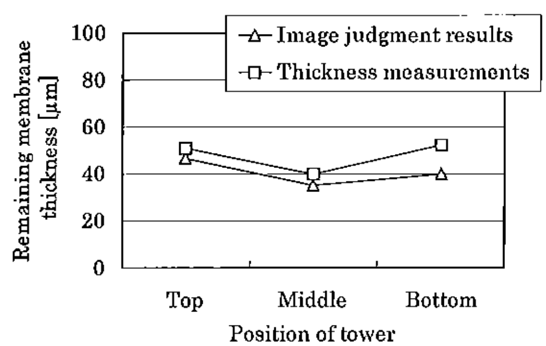
A field test of the image diagnosis system was performed using an actual steel tower. This trial was accompanied by visual inspection and measurement of the membrane thickness.

Fig. 6 compares the results of image diagnosis with the results of membrane thickness measurement for each member. And Fig 7. compares the averages of the membrane thickness.

For each member, the results of the membrane thickness measurement are a little different from those of image diagnosis. But Fig. 7 shows that the membrane thickness the image diagnosis results and the membrane thickness results provide the same deterioration judgment in each average value.



FIGRE 6
Practicality Confirmation for Each Member



FIGRE 7
Practicality Confirmation

3. Cost-effectiveness of the image diagnosis system

3.1 Steel tower repair timing and repair method

Deteriorated steel tower members are repaired by combining repainting and member replacement. The repair method selected is that most suited to the degree of deterioration in each case.

Surface preparation is an important step in repainting work. Adequate surface preparation of steel tower members is difficult because the work is done high above the ground. If adequate surface preparation is not done, the lifetime of the painted membrane may be shortened.

Steel towers should be repainted when 1) the iron base is not widely exposed, 2) galvanization remains, and 3) the state of deterioration permits surface preparation to be done relatively easily. Therefore, repainting is basically done at deterioration stage III. It is concluded that towers at deterioration stages I and II do not have to be repaired until the next inspection.

Table 2.
Results of Deterioration Diagnosis by Color Image Analysis

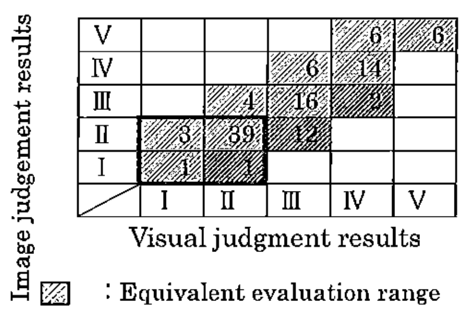
Member Number	Galvanization Coverage(%)	Thin Rusting Coverage(%)	Red Rusting Coverage(%)	Iron Rusting Coverage(%)	Image Diagnosis Result	Converted Membrane Thickness	Mean Degree of Deterioration by Member	Mean Converted Membrane Thickness by Member	Visual Assess-ment
Mean Membrane Thickness	64 μm	51 μm	31 μm	12 μm					
5ab1	59.3	9.4	0.0	0.3	2	51.0	2.4	43.0	3
5ab3	1.8	12.3	19.4	0.6	3	31.0			3
5ab4	2.2	34.5	54.3	8.5	3	31.0			3
5bc1	75.9	6.2	0.4	0.1	2	51.0			3
5bc2	38.9	3.3	13.5	2.5	3	31.0			3
5bc3	15.4	43.9	37.7	2.6	3	31.0			2
5bc4	90.4	0.6	0.0	0.0	1	76.4			1
5cd1	70.8	23.2	0.5	0.0	2	51.0			3
5cd2	6.5	8.9	17.3	3.3	3	31.0			3
5cd3	76.1	4.6	1.8	0.2	2	51.0			2
5da1	49.8	6.3	6.6	2.3	3	31.0			3
5da2	14.0	39.3	37.8	1.4	3	31.0			3
5da3	11.1	9.7	16.3	1.7	2	51.0			2
5da4	92.4	1.0	0.0	0.0	1	76.4			1
8ab1	18.2	39.2	18.9	22.6	4	12.0	2.8	35.0	4
8ab2	25.5	46.5	20.2	6.8	3	12.0			4
10da4	45.9	11.9	3.1	1.3	3	51.0			2
Total Number of Members Photographed	49%	20%	9%	3%	Mean Degree of Deterioration of Tower		2.6	Degree of Conformity With Visual Assessment	90%
Iron Rusting Coverage(%) of Members Photographed			12%		Mean Converted Membrane Thickness of Tower		39		

3.2 Comparison of image diagnosis with visual judgments

Fig. 8 shows a comparison of the results of deterioration diagnosis by image analysis with the results of the conventional visual inspection diagnosis method of 110 angle steel towers. Fig. 8 shows that the visual inspection results identified 15 of the 110 towers as being worse condition than actual condition (the actual condition is the result of image analysis).The actual degree of deterioration of 19 towers was more advanced than it was according to the condition than actual condition (the actual condition is the result of image analysis). visual examination. Therefore, the application of image diagnosis to steel towers can improve the timing of repair work.

Fig. 9, that was prepared based on Fig. 8, compares the number of steel towers requiring repair work. Fig. 9 shows that the image analysis diagnosis system reduced the number of towers requiring repair work by 8 (approx. 7%) from the number found by the conventional method (visual examination).

Although, the cost of image analysis is twice as much as that of visual inspection, the reduction of repair work by 7% leads to lower cost regardless of the higher cost of image analysis.



: Equivalent evaluation range (image diagnosis and visual examination results consist)

: Case where deterioration is more advanced than in visual examination results

: Case where the visual examination judged deterioration worse than actual state of deterioration

: Case where repair is unnecessary

FIGURE 8
Comparison of Results of Deterioration Diagnosis of Steel Tower Members(Angle Steel Towers)

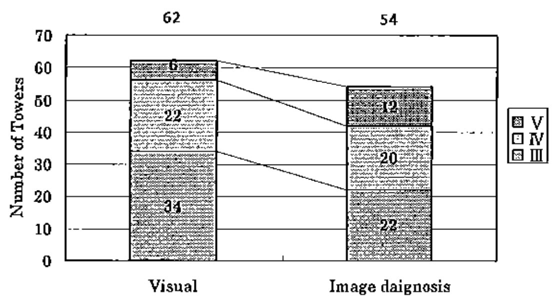


FIGURE 9
Number of Towers Requiring Repair
(Comparison of Examination Methods)

4. Conclusion

A method of using the discoloration of steel that occurs as its galvanization deteriorates to diagnose the degree of deterioration of the galvanizing was developed.

This method is more quantitative, objective, and precise than the conventional visual examination method. The application of this method to actual steel towers has eliminated scattering of the degree of deterioration evaluations. It permits the quantitative diagnosis of deterioration of galvanization.

Steel towers diagnosed using this diagnosis technology can be repaired at the most appropriate time. This new method reduced the number of towers that were judged to need repair work by 8 (7%) towers.

Acknowledgement

The authors wish to express their deep gratitude to Professor Ishii Akisuke of the Faculty of Engineering at Kagawa University for his guidance and advice that he provided throughout the development of this system.

DAMAGE DETECTION AND REPAIR MEASURES REGARDING MEDIUM-VOLTAGE LATTICED TOWERS

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INTRODUCTION

When medium-voltage overhead power lines have been in service for many years, the network operators usually find themselves confronted with the question of how to maintain their system on a methodical, efficient and cost-effective basis. This requires a systematic analysis of the actual condition of the system, which implies assessing the quality of a rather extensive network of lines that has been expanded in the course of time but has not always been sufficiently documented. If we take a look at the history of the medium-voltage overhead line network as it presents itself in Germany, it is obvious that the network operators will be faced with the fact that maintenance and reconstruction measures of a fundamental kind will become necessary in the future, since the majority of lines will reach an age of between 40-60 years within the next decade. This is particularly true for latticed steel towers because this type of masts have now been in service for a very long time. In this paper, the authors will try to show how network operators might proceed in order to assess the current quality and condition of such steel towers and to develop adequate and efficient reconstruction concepts.

HISTORY OF THE MEDIUM-VOLTAGE OVERHEAD LINE NETWORK

In Germany, the first three-phase alternating-current overhead line was built from Lauffen to Frankfurt/Main at the end of the 19th century. By the middle of the twenties, the major industrial areas all had been electrified on a large scale [1]. After 1958, the medium-voltage overhead line network was further expanded in the manner shown in the diagram below (Figure 1). The diagram provides an overview of the various types of overhead line systems related to different voltage levels.

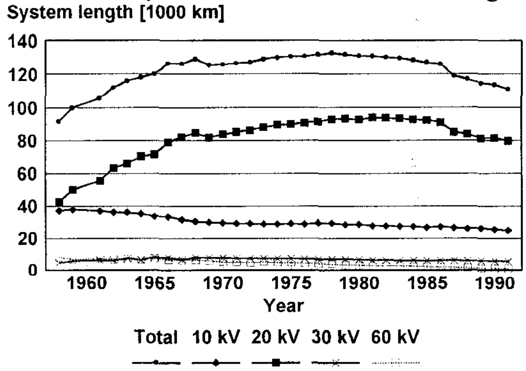


Figure 1: Historical development of the medium-voltage overhead line network [2]

The length of the system (in kilometres) is also indicated in each case. For the period prior to 1958 the data available were insufficient despite the fact that two thirds of the network had already been established at that time. As can be seen, the network was expanded mainly in the 20-kV range in the years up to 1970. After 1986 line length declines. This is attributable to the fact that cable networks were beginning to replace overhead lines at that time.

Frequency of damage

The "Vereinigung Deutscher Elektrizitätswerke" [Association of German Power Stations] (VDEW) [2] maintains a database (Fault and Damage Statistics) in which all tower breakdown incidents relating to the medium-voltage overhead line network, as well as all damages occurring on tower components, have been recorded since 1958. As regards tower damage - as shown in Figure 2, broken down by voltage level - the database unfortunately allows no classification of damage incidents by tower type.

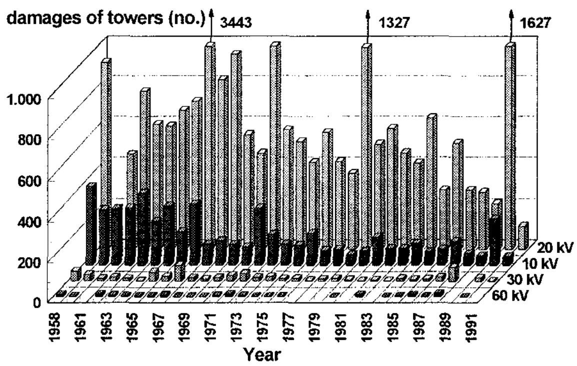


Figure 2: Tower breakdown and damage

In all, 15700 cases of damage could be found. On average, this means 477 cases of damage per year. In terms of average system length, this means 0.415 cases of damage per 100 km / per year. As the diagram highlights, there are great variations, caused mainly by extreme weather conditions in large-areas. As regards the specific causes of damage, atmospheric influences - such as storms, or thunderstorms - played a main role, together with conductor overloads caused by snow. white frost or conductor dancing. However, external influences - such as overthrown trees, forest or moor fires - might also have caused such damages in consequence of high tensile stresses leading to conductor failure. No particular mention has been made of cases where ageing was the main reason for the trouble.

IMPACT OF AGEING PROCESSES OCCURRING IN THE OVERHEAD LINE NETWORK

Due to the great number of components which they incorporate, and also due to the long service life of these components, overhead line networks must be investigated on a probability basis. Thus, the intensity and frequency of potential stresses occurring in components may be described by using a statistical distribution function - e.g., a normal function (see Figure 3). What is to be expected actually is a great number of medium stresses and a small number of very large stresses. The load carrying capacity of new components is also characterised by a certain variation, which may be described by using a mean value in combination with the five-percent fractile.

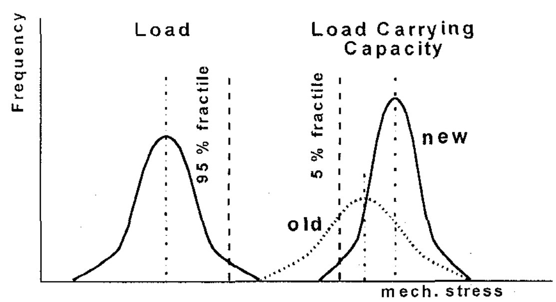


Figure 3: Stresses generated in components vs. load carrying capacity of components

The components must be dimensioned and manufactured in such a way that a sufficiently great distance will be maintained between the peak-load area and the lower area of distribution of the load carrying capacitiy. This distance is defined by means of adequate safety factors (in Germany, a factor of 1.5 is used for normal stresses and a factor of 1.1 for exceptional loads, compared to the yield point). Caused by ageing processes, however, the load carrying capacity of a component changes in the course of its service life, with the mean value decreasing and, above all, the range of variation increasing. As a result, the load carrying capacity of the components is exceeded more frequently at high loads, with failure being caused in the components more often. As ageing continues, cases of damage occur more and more frequently.

DAMAGE MECHANISMS AND RECONSTRUCTION CONCEPTS RELATING TO LATTICED STEEL TOWERS

The mechanisms causing damage in latticed steel towers and their foundations are quite different, depending on the design of the tower. With a view to the technical development and construction of latticed steel towers in the medium-voltage range, the following three stages may be differentiated:

Around 1920: Latticed steel towers having riveted angle sections came into use. Which means that only the vertical sections and cross arms of the tower were equipped with screwed connections. Further features included grillage foundation, red-lead and bituminous coating of underground parts, and red-lead and thick-film coating of the above-ground parts of the tower.

Around 1950: Connection of diagonal members by screwed or welded connections.

Around 1955: Concrete foundations generally came into use.

Around 1960: Hot-galvanisation of the steel construction with subsequent coating (duplex method).

In the following, the long-term operating and reconstruction experience gained with respect to the various components and assemblies will be discussed.

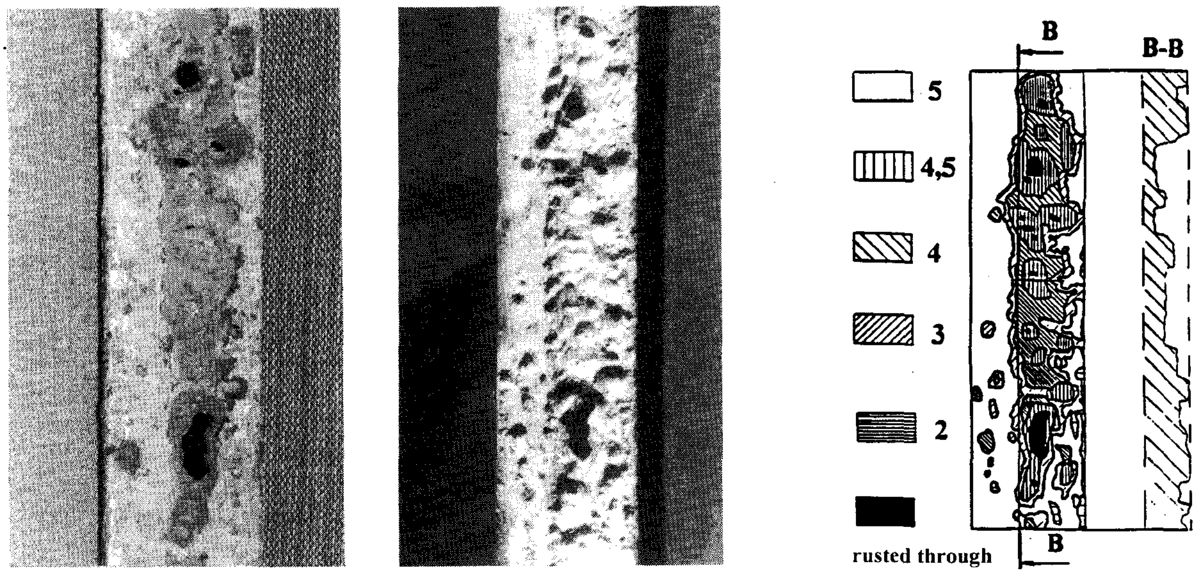
Foundation

Grillage foundations. The towers were erected on grillages placed in excavations. Stability was achieved by filling the pitch with earth. Despite the fact that the underground steel sections had been coated with bituminous materials to protect them against corrosion, considerable corrosive effects were nonetheless found after a service life of 40-60 years. Figure 4 shows corrosion pits found on a main leg near the grillage. After cleaning the angle sections thoroughly by sandblasting, measurements showed that the cross sections had been reduced by up to 60 per cent.

Where the ground was sandy, corrosion effects tended to be greatest in the range of the first metre below ground. Where the ground contained loess and clay, corrosion effects could be found also in deeper areas. Impregnated wooden grillages that were arranged below ground water level showed no signs of damage whatsoever even after 60 years of service. The damage just described can of course be detected only by excavation and by cleaning the steel surfaces thoroughly. Reconstruction is possible by applying new steel sections by lap or butt welding. This requires, however, that the steel used in the existing construction is weldable.

Concrete foundations. The concrete foundations have been designed either as single footings or as block foundations, depending on the height and location of the tower. In both cases, cracks extending radially from the main legs - and, in the case of single footings, running out in the shape of a secant - represent a very common damage pattern. Causes may include internal tensions due to poor heat distribution and moisture control in the course of the manufacturing process. This effect is particularly frequent in larger-size block foundations. In consequence of such cracks, the main legs are no longer protected against corrosion. By and by the cracks widen due to frost impact; in extreme cases, this leads to a complete splitting-up of the foundation

Where foundations have been made of reinforced concrete, the steel is corrosion-protected by the alkalinity of the concrete (pH value of 10-12). In the course of time, however, a chemical reaction (carbonisation) takes place on the surface of above-ground concrete parts, caused by a diffusion of CO_2 from the ambient air into



Surface cleaned Surface sandblasted Diagram showing residual wall thickness

Figure 4: Corrosion pits found on a main leg

the concrete - a process that leads to a reduction of the pH value. If this value falls below the level of 9, the reinforcing steel gets more and more attacked by corrosion inside the concrete. This goes along with an expansion of the corrosion products, which in turn leads to cracking and, eventually, crack-off of the concrete covering those parts. As Figure 5 shows, the speed with which such carbonisation develops is a function of both concrete quality and time. Which means that high-quality concrete is less subject to carbonisation than low-quality concrete. Moreover, a sufficiently thick concrete cover is also an important factor influencing the life of the foundation. Repair may be possible by closing existing cracks by using suitable multicomponent resins (PUR or epoxy), and by providing the foundation with a coating that is water vapour permeable but retains CO_2.

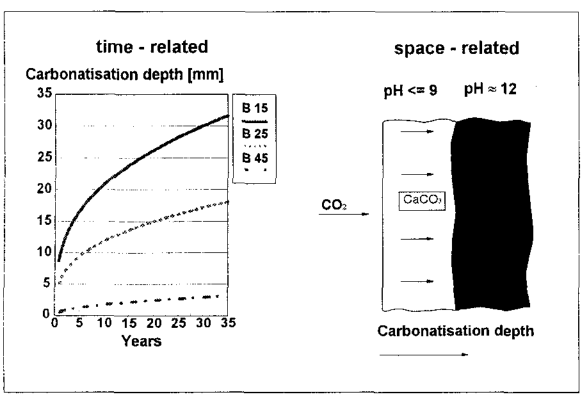


Figure 5: Development of carbonatisation in different grades of concrete

To achieve this, several steps including hardening and drying periods are required. In addition, temperature- and moisture-related requirements must be observed. Prior to reconstruction, however, concrete quality as well as the position of the reinforcing steel and the surface's adhesive strength under tension need to be checked.

From an economic point of view it is usually advisable to remove the defective foundation caps, provide them with adequate crack armouring and concrete them in place again.

Tower Construction

Coating / Corrosion Protection. The coatings are subject to ageing due to atmospheric influences that lead to a reduction in coating thickness. Moreover, the coating loses its elasticity due to the impact of UV radiation. As a result, cracking occurs in the coating due to the stresses caused by temperature changes, and the coating peels off.

Non-galvanised towers are provided with a multi-layer coating that is renewed after a period of 10-15 years. Before applying a new paint, it is important to give the surface a thorough cleaning. Any corrosion areas detected must then be treated. In the case of galvanised towers the duplex method has proved to be useful, with the coating to be applied immediately after erecting the tower.

Crevice Corrosion. Corrosion effects tend to be most frequent in the upper tower members, particularly so in the area of riveted or screwed connections if the construction has not been galvanised. The reason is that moisture accumulates by capillary action, which by and by leads to corrosion. Since it is difficult to reach these areas when carrying out corrosion protection measures, it is hardly possible to provide long-term protection by simply painting over a corroded crevice. However, the corroded parts exercise tensile stresses on the connecting elements so that rivets or screws eventually even get torn off in extreme cases. From the cross section shown in Figure 6 we can see how crevice corrosion tends to progress in a wedge-like manner, penetrating into the area between two sections. As a consequence, the screwed connection gets also subjected to an axial load.

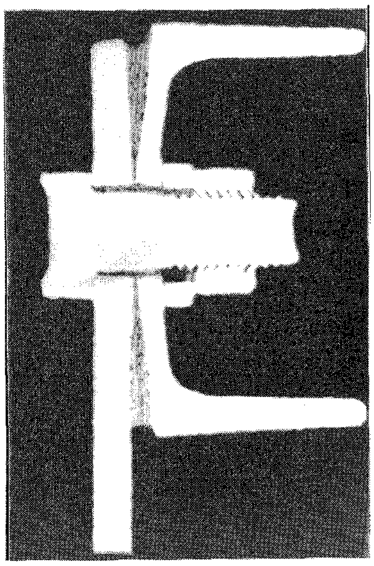


Figure 6: Cross section of a screwed connection, showing wedge-type corrosion effects

Figure 7 shows the ductile behaviour of a screw whose material has distinct flow characteristics (upper picture) in contrast to a screw showing a brittle fracture (lower picture). The respective stress-strain diagrams make it plain that the ductile material has sufficient strain potential after the elastic range has been exceeded (and before fracture occurs). The brittle material, in contrast, reaches its fracture limit rather soon when the stress increases (caused, for example, by crevice corrosion).

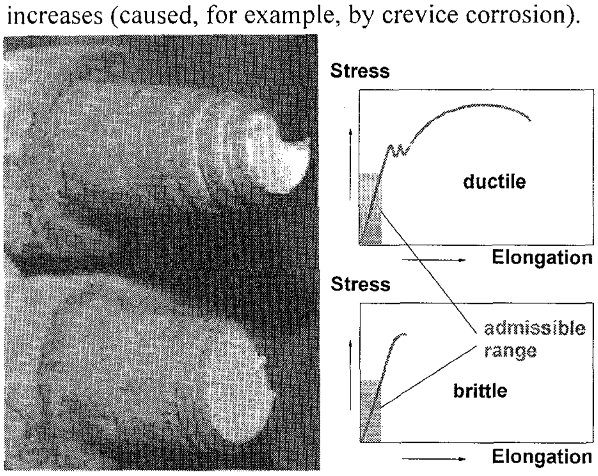


Figure 7: Ductile and brittle fracture behaviour of screws

Ultrasonic screw stress measuring devices may be used to measure the mechanical stress occurring in the screws and to determine what reconstruction measures are appropriate in the specific case. Such a measurement can be carried out on an exemplary basis in order to determine critical crevice widths, taking into account the geometry of the tower.

Reconstruction by opening and cleaning the screwed or riveted connections probably makes sense only when the tower has been little affected by corrosion and therefore exhibits only a small number of damage areas. One reconstruction solution used in practice consists in welding the connecting seams at the butt joints. In doing so, however, the requirements contained in the pertinent technical codes of practice must be observed. As experience has shown, repair/reconstruction measures are no longer advisable if corrosion exceeds a certain limit in the connection area, since it is not possible to achieve long-term success in such cases.

Internal Corrosion in Latticed Towers Consisting of Tubular Sections. In the forties and fifties some utility companies made use of tubular sections in order to optimise latticed steel tower constructions. The advantage of such sections lies in the fact that they provide more buckling strength. Since, however, condensation water can accumulate inside the tubes, this may lead to increased corrosion. To check residual wall thickness, ultrasonic measuring devices may be used. In the case of main legs consisting of tubular sections projecting into the concrete foundation, an endoscopic examination has proved to be useful. In the case of one overhead line, for example, condensation water was found in 52% of the tubular-section main legs checked. Among these main legs, 28% were found to be affected by medium-size corrosion marks; in 14% of the cases corrosion was severe. By welding on cover plates and filling up existing cavities, lasting rehabilitation success can be achieved.

Ageing of the Material. Apart from corrosion, which undermines the stability of the towers, another factor causing damage has been found in recent years: the ageing processes occurring in steel. Analyses of broken towers showed that brittle fractures had occurred in the sections. As can be seen from the fracture surfaces shown in Figure 9, the material had not been ductile enough. This deficiency in the material may be due to certain alloying constituents contained in the steel at percentages that would no longer be acceptable today. The ductility of the steel may be adversely affected, for example, by carbon, sulphur, phosphorus or nitrogen.

If steels have a relatively high nitrogen content, this will - by and by - adversely affect the toughness of the material in areas where the steel was subjected to plastic deformation. Such deformation may have been caused in the manufacturing process (e.g., by punching holes), during assembly (e.g., by widening) or by high loads (e.g., by storms). The damage analyses carried out on SAG-VTZ's premises showed that - in extreme cases - such deformation led to a load-at-break reduction of 60 per cent. Damage caused by deficiencies in the material may be detected by means of metallography, chemical analyses or by using a scanning electron microscope (SEM). The situation of embrittled hole areas can be remedied by improving load transmission. This method presupposes, however, that the causes of embrittlement as well as the load carried by the respective section are known. In the case of small latticed steel tower constructions, however, these reconstruction methods are not economical.

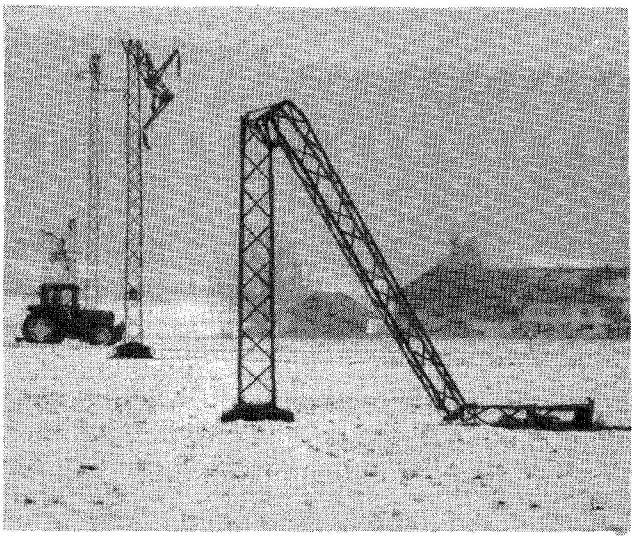


Figure 8: Cascade fracture of a medium-voltage overhead power line

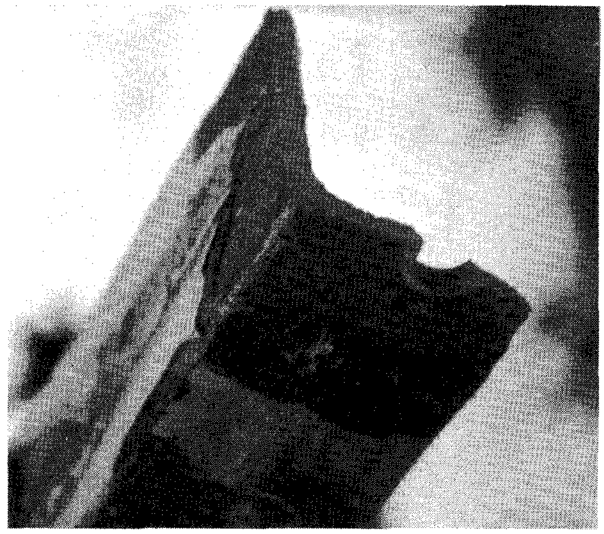


Figure 9: Fractured main leg showing no ductile deformation

PLANNING AND IMPLEMENTATION OF RECONSTRUCTION MEASURES

To assure the future reliability of an overhead power line, it is essential to eliminate weak points in due time. This presupposes that the actual condition concerning the load carrying capacity of the line is known. For this, regular checks of a general kind must be performed on the lines. In addition, targeted checks are required. In the following, it will be described in some detail how requisite repair and reconstruction measures may be organised. Our example is based on a regional utility company operating a medium-voltage overhead line network having a length of approximately 3,500 km.

During the regular annual checks the lines are inspected visually, whereby particular attention is given to the condition of the towers and their coatings. The results obtained constitute a rough basis of evaluation allowing a decision as to whether or not further measures are required. Minor cases of damage are then remedied directly by the local department in charge of the respective line section. If the measures required are more extensive, reconstruction is carried out by the central functional department.

For checking the condition of an overhead line in more detail, it is useful - as experience has shown - to collect, in a first step, as much information as possible, using a variety of sources. Such sources may include:

- site and section plans; tower list
- age of the towers
- type and number of conductors; tensile stress
- previous reconstruction, if any
- tower design, type of construction and static loading capacity

Based on these data, it should be possible to minimize the costs of the examination by comparing the results with those obtained from lines that have previously been checked. In a next step, a visual inspection of the line is required in order to determine its actual condition and record the findings in a condition check sheet. From this information, damage patterns may be derived. If required, further checks and examinations - regarding the steel, for example - may be planned and carried out. In addition, any missing data that are needed for planning purposes are also recorded. These data include:

- year of construction
- type of construction of the tower (riveted or welded)
- tower top pattern/design
- type and condition of foundation
- condition of coating
- location; crossing situation

If these checks are carried out by trained personnel, it should be possible to make a rough evaluation of the results right on the spot, i. e., to determine whether short-, medium- or long-term reconstruction measures are required.

To assess the condition of the tower, the following calculations are performed:

- Determination of the load carrying capacity of the tower in light of the condition found. What is particularly important in this connection are such factors as ageing or reduced cross sections found in angle sections.
- Calculation of the loads, including both normal and exceptional loads, in accordance with pertinent standard specifications applicable at the time of construction or at the time of subsequent modification (conductor upgrading), taking into account also the current situation (such as a road junction that may have been built in later years).
- Calculation of the loads required by the rules currently in force regarding normal and exceptional loads.

It is desirable that the actual load carrying capacity of the tower - including the safety factors - should exceed the load values required by the technical rules applicable at the time. Towers that only meet the requirements set by the technical rules applicable at the time of construction or at the time of subsequent modification need not be replaced or reinforced if they are not located at

an intersection and provided also that no repair or reconstruction measures are required.
Depending on the scope of damage found, reconstruction measures are carried out as provided for in Table 1. Apart from reconstruction requirements, there are further factors that need to be taken into account in selecting an adequate reconstruction concept:

Technical situation relating to the line	- Overhead line running over building site or open country - Number of towers needing repair
Network situation	- Relative importance of the line - Modification planned for other reasons - Network requirement planning - Cable system installation (replacing overhead line)
Economic situation	- Funds available

ECONOMIC ASPECTS CONCERNING THE IMPLEMENTATION OF RECONSTRUCTION CONCEPTS

Since the costs of reconstruction are highly dependent on given price levels, costs will of course vary between countries. We therefore refer to percentages only, based on - and compared with - the costs of a complete rebuild or replacement (see Table 2). The costs for installing a tension tower depend, primarily, on the line-related technical situation and tend to be twice or three times as high as those for a suspension tower. Since absolute reconstruction costs are approximately the same for both types of tower, relative reconstruction costs are therefore higher in the case of suspension towers. The values indicated in Table 2 are just a rough cost estimate based on the experience gained from reconstruction measures carried out in the past. So deviations are of course possible, depending on the type and scope of the damage to be remedied. Seen from an economic point of view, it is always advisable to determine the nature and scope of the damage as accurately as possible in order to obtain a reliable basis for tower assessment.
The total reconstruction costs relating to a complete overhead line section will roughly be those indicated in Table 3.

TABLE 2: Costs of reconstruction measures (measured against complete replacement)

Type of Measure	Suspension Tower	Tension Tower
Complete replacement	100%	100%
Replacement but using existing foundation	70%	70%
Complete reconstruction	25%	10%
Reconstruction in ground entry area	15%	7%
Tower reinforcement	15%	7%
Corrosion protection	10%	5%

TABLE 3: Cost percentages (related to complete reconstruction)

Type of Work	percentage
Planning	14%
Line routing	8%
Dismanteling	8%
Installation	43%
Material	27%

SUMMARY

The above explanations make it clear that it is essential for an overhead power line operator to start collecting reliable data on the condition of the network at an early stage in order to be able to choose the right time, economically, for tower reconstruction and line renewal. This requires, however, development and implementation of an adequate organisational concept. In particular, the staff needed for the work involved must be properly trained in order to ensure complete data collection as well as uniform and consistent data evaluation. In the future, such issues will surely gain in importance, particularly so if one considers also the need for preserving the substance and value of existing overhead power lines.

BIBLIOGRAPHY

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2. Vereinigung deutscher Elektrizitätswerke, 1961 - 1992, "VDEW Statistics of faults and damages ", VDEW Frankfurt/Main, Deutschland

TABLE 1: Types of Damage and Corresponding Reconstruction Measures:

Scope of Damage	Reconstruction Measure
Tower and foundation severely impaired	Replacement of tower and foundation
Tower severely impaired; foundation unimpaired and sufficiently dimensioned	Replacement of tower, using existing foundation
Tower severely impaired in some places	Reconstruction of the entire latticed steel tower
Tower severely impaired in ground entry area	Reconstruction of the tower in ground entry area
Load carrying capacity insufficient; tower only with minor damage	Tower reinforcement
Some corrosion, but strength and stability of the tower unimpaired	Corrosion protection (removal of rust; coating)

CI Number: 43285

Title: **99W Bridgewater- Add Capacity Bank**

Start Date: 2012/10
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $1,097,853

DESCRIPTION:

This project is to install a second 138 kV 36MVAR Capacitor Bank including a 138kV breaker at the 99W Bridgewater Substation. The expected useful life of a capacitor bank is approximately 30 years.

Depreciation Class:
Transmission Plant Station Equipment

Summary of Related CIs +/- 2 years:
No projects for 2011, 2012, 2013, 2014 & 2015

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Capacity

Why do this project?

Most of the generation in Nova Scotia flows from Cape Breton and is transported to the load centre in Halifax and to the Western parts of Nova Scotia via the transmission corridor from Lingan/Woodbine to Port Hastings, Onslow, Brushy Hill, and Bridgewater. In order to transport real power (MW) over long distances and minimize losses, voltage support is needed at the receiving end in the form of reactive power (MVAR).

Why do this project now?

This capacitor bank would further reduce system losses annually by an average of 1 MW, resulting in approximately $137,700/year reduction in energy costs. It is also estimated that 1% of the time that Halifax generation can be replaced by less expensive generation, resulting in additional savings of approximately $130,000/year. Therefore it is estimated, based on current load projections that this project can result in an annual saving of $267,700/year.

With the closure of the Bowater Mersey Mill, the overall system losses with the 2nd capacitor bank reduces to 0.4 MW since the power import to Bridgewater area decreases with this large industrial load off-line. Without the Bowater Mersey load, the cost reduction on system losses reduces to approximately $55,100/year plus approximately $130,000/year by displacing Halifax generation. It is estimated that this project can still result in an annual saving of $185,100/year with the Bowater Mersey Mill closed.

Why do this project this way?

NS Power examined the need for reactive power in the system. It was determined, through system load flow and dynamic analysis that the most effective and economic solution is to install an additional 36MVAR capacitor bank at Bridgewater Substation.

CI Number : 43285 - 99W Bridgewater Add Capacitor Bank **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		52,422	0	52,422
094		094 - Interest Capitalized		18,470	0	18,470
095		095-COPS Regular Labour AO		91,290	0	91,290
095		095-COPS Contracts AO		22,988	0	22,988
001	003	001 - T&D Regular Labour	003 - TP - Bldg.,Struct.Grnd.	4,211	0	4,211
012	003	012 - Materials	003 - TP - Bldg.,Struct.Grnd.	92,288	0	92,288
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	47,682	0	47,682
066	003	066 - Other Goods & Services	003 - TP - Bldg.,Struct.Grnd.	83,150	0	83,150
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	18,950	0	18,950
011	022	011 - Travel Expense	022 - TP - Elec Contr.Equip.	1,000	0	1,000
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	115,800	0	115,800
014	022	014 - Overtime Meals	022 - TP - Elec Contr.Equip.	750	0	750
066	022	066 - Other Goods & Services	022 - TP - Elec Contr.Equip.	0	0	0
012	023	012 - Materials	023 - TP - Power Equip.-Station S	13,000	0	13,000
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	26,108	0	26,108
012	043	012 - Materials	043 - TP - Substn Dev.	373,400	0	373,400
014	043	014 - Overtime Meals	043 - TP - Substn Dev.	750	0	750
066	043	066 - Other Goods & Services	043 - TP - Substn Dev.	6,200	0	6,200
001	085	001 - T&D Regular Labour	085 Design	50,560	0	50,560
001	085	001 - Regular Labour (No AO)	085 Design	6,500	0	6,500
011	085	011 - Travel Expense	085 Design	1,410	0	1,410
028	085	028 - Consulting	085 Design	24,000	0	24,000
041	085	041 - Meals & Entertainment	085 Design	500	0	500
001	086	001 - T&D Regular Labour	086 Commissioning	24,424	0	24,424
013	087	013 - COPS Contracts	087 Field Super.& Ops.	22,000	0	22,000
			Total Cost:	1,097,853	0	1,097,853
			Original Cost:			

Location: **Distribution**
CI# / FP#: 43285
Title: 99W Bridgewater- Add Capacity Bank
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician/ Technician	Person Day	[redacted]		$ 73,693.00		
1.2							
1.3	Engineering (P.Eng)	Hour			$ 29,960.00		
1.4	Project Support Labour (No AO)	Hour			$ 6,500.00		
1.5	Technologist	Hour			$ 7,400.00		
1.6	CADD	Hour			$ 13,200.00		
1.7					$ -		
				Sub-Total	$ 130,753.00		
2	**012 Materials**						
2.1	138 Kv 36MVAr Capacitor Bank	Each	1	[redacted]		Cost Support Attachment 1	27768
2.2	138 Kv Reactor	Each	3	4,200.00	$ 12,600.00		27768
2.3	138 Kv Lightening Arresters	Each	3	2,200.00	$ 6,600.00		27768
2.4	138 Kv Switches	Each	2	15,000.00	$ 30,000.00		27768
2.5	138 Kv IPO Circuit Breaker	Each	1	[redacted]		Cost Support Attachment 2; Grossed to 2012 Dollars	27768
2.6	Other Substation Devices	Lot	1	29,200.00	$ 29,200.00		
2.7	Structural Steel	All Devices	1	60,499.98	$ 60,499.98		27768
2.8	Protection Panels	Each	2	40,000.00	$ 80,000.00		27768
2.9	Other Electical Control Equipment	Lot	1	30,800.00	$ 30,800.00		
2.1	Station Service	Each	1	13,000.00	$ 13,000.00		
2.11	Foundation Materials	Lot	1	31,788.00	$ 31,788.00		
				Sub-Total	$ 594,487.98		
3	**013 T&D Contracts**						
3.1	Field Supervision (Civil)	Hour	[redacted]		$ 8,250.00		
3.2	Field Supervision (Electrical)	Hour			$ 13,750.00		
3.3	Concrete Foundations	Lot	1	47,682.00	$ 47,682.00		
				Sub-Total	$ 69,682.00		
5	**028 Consulting**						
5.1	P&C Engineering Consultant	Hour	[redacted]		$ 24,000.00		
5.2							
5.3							
				Sub-Total	$ 24,000.00		
6	**011, 014 & 041 Travel and Meals**						
6.1	Mileage	Km	3000	0.37	$ 1,110.00		
6.2	Accomodation/ Travel Expenses	Days	10	130	$ 1,300.00		
6.3	Meals	Each	100	20	$ 2,000.00		
				Sub-Total	$ 4,410.00		
7	**066 Other Goods and Services**						
7.1	Boom/ Backhoe Truck Rental	Hour	[redacted]		$ 3,200.00		
7.2	Platform Lift Vehicle Rental	Month			$ 3,000.00		
7.3	Project Contingency	Lot			$ 83,149.96		
7.4							
				Sub-Total	$ 89,349.96		
8	**094 Interest Capitalized**						
8.1	Interest		1	18,470.15	$ 18,470.15		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 18,470.15		
9	**095 Administrative Overhead**						
9.1	Contracts AO		1	22,988.07	$ 22,988.07		
9.2	Labour AO		1	91,289.69	$ 91,289.69		
9.3	Vehicle AO		1	52,422.44	$ 52,422.44		
				Sub-Total	$ 166,700.20		
Cost Estimate				**Total**	$ 1,097,853.29		
10	**Original Cost**						
10.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 - 3

Removed due to confidentiality

CI Number: 43672

Title: **82V-T1 Transformer Rewind**

Start Date: 2013/05
Final Cost Date: 2013/11
Function: Transmission
Forecast Amount: $960,432

DESCRIPTION:

This project is required to proactively rewind 82V-T1 to prevent a forced outage resulting from mechanical failure of internal coil blocking.

Related CIs +/- 2 years:
No Related projects 2011, 2012, 2013, 2014 & 2015.

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Maintenance

Why do this project?

82V-T1 is a Canadian General Electric transformer built in 1976. Three other identical transformers of the same design have recently experienced mechanical failures that resulted in failure of the windings. The failure mode is due to insufficient coil blocking. Due to the identical design of 82V-T1 to the failed units, there is a high probability that 82V-T1 will fail in a similar mode.

Why do this project now?

Due to the high number of high current through faults that 82V-T1 has seen over its service life, it is probable that this transformer will fail in service during through fault activity. If this unit were to fail during peak loading periods, there would not be transformation capacity at Elmsdale to carry the entire customer load, and either load would have to be shifted to other adjacent substations, or a mobile transformer would have to be installed for an extended period of time to carry the customer load.

Why do this project this way?

By proactively rewinding this transformer NS Power will avoid an extended customer outage that would result from the loss of this transformer supply.

CI Number : 43672 - 82V-T1 Transformer Rewind **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		16,971	0	16,971
094		094 - Interest Capitalized		7,747	0	7,747
095		095-COPS Regular Labour AO		30,068	0	30,068
095		095-COPS Contracts AO		169,899	0	169,899
095		095 - T&CS Regular Labour AO		4,286	0	4,286
001	044	001 - T&D Regular Labour	044 - TP - Substn.Transf.	33,689	0	33,689
002	044	002 - T&D Overtime Labour	044 - TP - Substn.Transf.	0	0	0
012	044	012 - Materials	044 - TP - Substn.Transf.	129,000	0	129,000
013	044	013 - COPS Contracts	044 - TP - Substn.Transf.	515,000	0	515,000
001	085	001 - Regular Labour (No AO)	085 Design	2,580	0	2,580
001	085	001 - T&CS Regular Labour	085 Design	13,720	0	13,720
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
011	085	011 - Travel Expense	085 Design	5,000	0	5,000
028	085	028 - Consulting	085 Design	25,000	0	25,000
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	7,472	0	7,472
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	960,432	0	960,432
			Original Cost:	218,775		

Location: Transmission
CI#: 43672
Title: 82V-T1 Transformer Rewind
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (CI#'s)
1	**001 Regular Labour**						
1.1	Electrician	Manday	[redacted]	[redacted]	$ 33,689.00		
1.3	Engineering	Manday	[redacted]	[redacted]	$ 13,720.00		
1.4	Project Support Labour	Lot	1	2,580.00	$ 2,580.00		
1.5	Site supervision	Lot	1.00		$ 7,472.00		
				Sub-Total	$ 57,461.00		
2	**012 Materials**						
2.1	New bushings	set	1	40000	$ 40,000.00		
2.2	Reactor	ea	1	15000	$ 15,000.00		
2.3	Lead arrangement	ea	1	18000	$ 18,000.00		
2.4	Gauges	set	1	6000	$ 6,000.00		
2.5	Oil	ea	1	50000	$ 50,000.00		
				Sub-Total	$ 129,000.00		
3	**013 COPS Contracts**						
3.1	Rewind	ea	1	[redacted]	[redacted]		
3.2	Rail shipment	ea	2	[redacted]	[redacted]		
3.3	Crane lifts	ea	2	[redacted]	[redacted]		
3.4	Sandblast & Paint	lot	1	[redacted]	[redacted]		
				Sub-Total	$ 515,000.00		
4	**028 Consulting**						
4.1	Design Consulting	Lot	1	25000	$ 25,000.00		
				Sub-Total	$ 25,000.00		
5	**011 Travel and Living**						
5.3	Travel	Lot	1	5000	$ 5,000.00		
				Sub-Total	$ 5,000.00		
6	**094 Interest Capitalized**						
6.1		Lot	1	7747.13	$ 7,747.13		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 7,747.13		
7	**095 Administrative Overhead**						
7.1	Labour AO				$ 34,354.21		
7.2	Vehicle AO				$ 16,970.67		
7.3	Contract AO				$ 169,898.51		
				Sub-Total	$ 221,223.39		
Project Cost Estimate				**Total**	$ 960,431.52		
8	**Original Cost**						
8.1					$ 218,775.11		

Note 1: Reference to "Completed similar projects (CI#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43267

Title: **13V Gulch Replace 13V-GT1 & 13V-VR1**

Start Date: 2013/03
Final Cost Date: 2014/06
Function: Transmission
Forecast Amount: $954,407

DESCRIPTION:

The scope of this project is to replace the existing 13V-GT1, generator, step-up transformer and the 13V-VR1 3 phase voltage regulator with functionally equivalent, new transformers.

The replacement generator, a step-up transformer will be placed in the same position as the old transformer and connected to the existing high voltage wiring. An interface box will be installed to allow extension and reconnection of the existing low voltage, secondary cables, which are used to provide protection and monitoring functions. The winding arrangement will be changed to wye/delta from the existing delta/wye, which is normal industry practice. The current unit was an available, existing spare unit that was used when the original, wye/delta, generator, step-up unit was replaced approximately 25 years ago.

The existing phase regulator will be replaced with 3 new, single phase units conforming with current distribution standards and a separate grounding transformer to compensate for the change to a delta LV winding in the new replacement, generator, step-up transformer. The current 3 phase regulator has the capabilities of a grounding transformer built, as per the original requirements. The replacement regulators and new grounding transformer will be located in the regulator yard, which will be expanded to accommodate the increase in equipment size.

Summary of Related CIs +/- 2 years:
No projects for 2011, 2012, 2013, 2014 & 2015

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

Results from electrical insulation testing have indicated that the existing 13V-GT1 transformer is at end of life. The 13V-VR1 regulator is 57 years old and overloaded. Spare parts are also no longer available for this unit.

Why do this project now?

Since recent electrical insulation test results indicate that the existing 13V-GT1 transformer is at the end of its useful life, it is no longer reasonable to expect reliable performance from this device. To avoid the need for a reactionary response to a sudden failure, it recommended that the 13V-GT1 transformer be proactively replaced with a functionally equivalent, new transformer.

The 13V-VR1 regulator is overloaded and must be replaced for reasons of capacity, as well as age.

Why do this project this way?

The 13V-GT1 generator transformer is the interface device between the 13V-G1 (Gulch Hydro) generator and the 69kV transmission line that delivers the output energy to the NS Power system. There is no other way to transfer the energy from the generator to the system except through an interfacing, generator step up transformer.

The 13V-VR1 is a three phase device, which is difficult to replace, if a failure occurs, hence the change to standard single phase units, of which NS Power has many, as well as an inventory of spare units.

CI Number : 43267 - 13V Gulch Hydro Replace 13V-GT1 and 13V-VR1 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		16,529	0	16,529
092		092-Vehicle T&D OT Labour AO		1,250	0	1,250
094		094 - Interest Capitalized		14,508	0	14,508
095		095-COPS Overtime Labour AO		2,215	0	2,215
095		095 - T&CS Regular Labour AO		7,715	0	7,715
095		095-COPS Contracts AO		28,905	0	28,905
095		095-COPS Regular Labour AO		29,286	0	29,286
001	003	001 - T&D Regular Labour	003 - TP - Bldg.,Struct.Grnd.	671	0	671
002	003	002 - T&D Overtime Labour	003 - TP - Bldg.,Struct.Grnd.	0	0	0
012	003	012 - Materials	003 - TP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	31,496	0	31,496
001	007	001 - T&D Regular Labour	007 - TP - Environmental	1,342	0	1,342
002	007	002 - T&D Overtime Labour	007 - TP - Environmental	0	0	0
012	007	012 - Materials	007 - TP - Environmental	[redacted]	0	[redacted]
013	007	013 - COPS Contracts	007 - TP - Environmental	16,100	0	16,100
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	3,691	0	3,691
002	022	002 - T&D Overtime Labour	022 - TP - Elec Contr.Equip.	0	0	0
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	6,728	0	6,728
013	022	013 - COPS Contracts	022 - TP - Elec Contr.Equip.	3,680	0	3,680
001	035	001 - T&D Regular Labour	035 - TP - Wood Poles	4,026	0	4,026
002	035	002 - T&D Overtime Labour	035 - TP - Wood Poles	0	0	0
012	035	012 - Materials	035 - TP - Wood Poles	[redacted]	0	[redacted]
066	035	066 - Other Goods & Services	035 - TP - Wood Poles	1,196	0	1,196
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	1,342	0	1,342
002	039	002 - T&D Overtime Labour	039 - TP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - TP - O/H Cond.	690	0	690
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	9,726	0	9,726
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	0	0	0
012	043	012 - Materials	043 - TP - Substn Dev.	[redacted]	0	[redacted]
066	043	066 - Other Goods & Services	043 - TP - Substn Dev.	2,116	0	2,116
001	044	001 - T&D Regular Labour	044 - TP - Substn.Transf.	9,730	0	9,730
002	044	002 - T&D Overtime Labour	044 - TP - Substn.Transf.	6,064	0	6,064
011	044	011 - Travel Expense	044 - TP - Substn.Transf.	1,610	0	1,610
012	044	012 - Materials	044 - TP - Substn.Transf.	[redacted]	0	[redacted]

CI Number : 43267 - 13V Gulch Hydro Replace 13V-GT1 and 13V-VR1 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
013	044	013 - COPS Contracts	044 - TP - Substn.Transf.	28,750	0	28,750
041	044	041 - Meals & Entertainment	044 - TP - Substn.Transf.	805	0	805
066	044	066 - Other Goods & Services	044 - TP - Substn.Transf.	94,070	0	94,070
001	085	001 - T&CS Regular Labour	085 Design	24,696	0	24,696
001	085	001 - Regular Labour (No AO)	085 Design	6,593	0	6,593
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
028	085	028 - Consulting	085 Design	92,000	0	92,000
001	086	001 - T&D Regular Labour	086 Commissioning	9,562	0	9,562
002	086	002 - T&D Overtime Labour	086 Commissioning	0	0	0
013	087	013 - COPS Contracts	087 Field Super.& Ops.	7,590	0	7,590
			Total Cost:	954,407	0	954,407
			Original Cost:	72,919		

Location: Transmission
CI# / FP#: 43267
Title: 13V Gulch Hydro Replace 13V-GT1 and 13V-VR1
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (no AO)	Lot	1	$ 6,593.00	$ 6,593.00		
1.2	Electrician Labour	Person Day	[redacted]		$ 40,089.91		
	Design Labour	Hour	[redacted]		$ 24,696.00		
1.3					$ -		
1.4							
				Sub-Total	$ 71,378.91		
2	**012 Materials**						
2.1	Step up Transformer for Generator, 3 phase voltage regulator and Ground transformer	Lot	1	[redacted]		Please refer to Cost Support #1 for the bids received for a similar transformer purchase	
2.2	Foundations	Lot	1	[redacted]			
2.3	Oil/Water Separator Tank	ea	1	[redacted]			
2.4	New Protection Relay	ea	1	6728	$ 6,728.00		
2.5	Poles, Anchors & Framing	Lot	1	[redacted]			
2.6	Overhead Conductor	Lot	1	690	$ 690.00		
2.7	Surge Arrestors, Switches and Insulators	Lot	1	[redacted]			
				Sub-Total	$ 497,144.00		
3	**013 T&D Contracts**						
3.1	Civil	Lot	1	31496	$ 31,496.00		
3.2	Oil Containment	Lot	1	16100	$ 16,100.00		
3.3	Placement of New Tranformers	Lot	1	28750	$ 28,750.00		
3.4	Field Supervision	Lot	1	7590	$ 7,590.00		
3.5	Misc Contracts	Lot	1	3680	$ 3,680.00		
				Sub-Total	$ 87,616.00		
4	**011 Travel Expenses**						
4.1		Lot	1	1610	$ 1,610.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 1,610.00		
5	**041 Meals and Entertainment**						
5.1		Lot	1	805	$ 805.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 805.00		
6	**002 Overtime Labour**						
6.1	Electrician OT Labour	Person Day	[redacted]		$ 6,064.02		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 6,064.02		
7	**028 Consulting**						
7.1	Transformer Testing & Offloading	Lot	1	92000	$ 92,000.00		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 92,000.00		
8	**Other Goods & Services**						
8.1	Transformer Inspection	Lot	1	97382	$ 97,382.00		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 97,382.00		
9	**094 Interest Capitalized**						
9.1	Interest	lot	1	14507.87	$ 14,507.87		
9.2					$ -		
9.3					$ -		
				Sub-Total	$ 14,507.87		
10	**095 Administrative Overhead**						
10.1	Labour AO				$ 39,215.60		
10.2	Vechicle AO				$ 17,779.18		
10.3	Contract AO				$ 28,904.52		
				Sub-Total	$ 85,899.30		
Cost Estimate				**Total**	$ 954,407.10		
11	**Original Cost**						
11.1					$ 72,919.46		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

Fluid Analysis Report

Serial No.	155496	*Supplementary ID*	33
Apparatus type	TRN	*Tank*	MAIN
Owner	CNS06	*New samples*	2
Substation	Gulch Hydro	*DGA result*	1/0
Designation	13V-T51	*Fluid condition*	0/0
Norms	TRN_IEEE_69_288KV	*Moisture code*	1/0
Fluid type	Mineral Oil	*PCB result code*	0/0
Manufacturer	FPC	*Oil test status*	UNREVIEWED

Gas Analysis

Sample date	*2011-10-27 11:34:00*	*2011-06-08 14:10:00*	*2010-01-27 15:37:00*	*2007-02-27*	*2004-02-17*
Fluid temp	7	50	30	35	30
Hydrogen (H2)	0	20	20	25	25
Methane (CH4)	0	12	17	20	15
Ethane (C2H6)	0.0	16.0	15.0	17.0	19.0
Ethylene (C2H4)	0.0	4.0	11.0	13.0	12.0
Acetylene (C2H2)	0.0	0.0	0.0	2.0	2.0
Carbon Monoxide (CO)	0	1400	1280	1320	1240
Propylene (C3H6)	0	73	97		
Carbon Dioxide (CO2)	0	13500	13600	13100	13500
Oxygen (O2)	0	13000	15400	7730	13800
Nitrogen (N2)	0	82000	65400	67100	66700
Total heat gas				50	46
TDCG				1397	1313
Equivalent TCG				1.386	1.247
Total partial press				79.3	84.1
Est. safe handling limit				11.4	11.3
Calculated monitor ppm				263	249
CO2/CO				9.924	10.887
Oxygen/Nitrogen (O2/N2)				0.115	0.207
DGA retest days				365	365
DGA retest date				2008-02-27	2005-02-16
Baseline					
DGA reference days				1106.0	796.0
DGA result				1	1
DGA diagnosis					

Fluid Quality

Sample date	*2011-10-27 11:34:00*
Fluid temp	7
Dielectric breakdown D1816 (2 mm)	60.0
Acid number	0.230
Interfacial tension	19.3
Specific Gravity	0.867
Color	3.0
Visual	CLEAR
Fluid quality retest days	
Fluid quality retest date	
Fluid condition	
Fluid diagnosis	
Inhibitor code	

Moisture Analysis

Sample date	*2011-06-08 14:10:00*	*2010-01-27 15:37:00*	*2007-02-27*	*2004-02-17*	*2001-12-13*
Fluid temp	50	30	35	30	20
Moisture	13	23	14	12	23
Relative saturation			14	14	42
Dew point			-8	-11	1
Moisture code			1	1	2
Moisture diagnosis					HUMID-OIL

Furans

Sample date	*2011-10-27 11:34:00*
Fluid temp	7
2-furfural (2FAL)	778
5-methyl-2-furfural (5M2F)	83
5-hydroxymethyl-2-furfural (5H2F)	0
Furfuryl alcohol (2FOL)	0

From:	MACARTHUR, SCOTT
To:	PENNY, BRIAN
Cc:	STILES, ANDREW; DROVER, MATTHEW; BARNHILL, KYLE
Subject:	RE: 13V-T51
Date:	Friday, February 03, 2012 2:32:11 PM
Attachments:	Untitled.msg 13V-T51 Load.msg

Brian,

June 8/11 main tank pf = 0.08%. The history back to 1996 indicates that the pf really hasn't changed. We just did the out-of-service maintenance on this transformer back in Oct./11 and I have attached the pf results. There doesn't seem to have been any appreciable change from the previous out-of-service testing. There is no transformer metering on 13V-T51 but attached is the loading history for the past 28 days from SCADA. The 13V-T51 transformer is rated at 7.5/10 MVA and it looks like the actual loading tops out at about 5.5 MVA so we shouldn't be cooking it. Also, there is no winding temperature gage but the oil temperature history for 2011 shows that it tops out at 50 degrees C. Keep in mind that although there is distribution load on this transformer it is also the generator transformer for the Gulch Hydro generator, so it is subject to some fairly high fluctuations in loading depending on the generation schedule.

I will arrange for the additional oil sampling you have requested as soon as I have someone going in that direction.

Regards,
Scott

From: PENNY, BRIAN
Sent: Thursday, February 02, 2012 5:10 PM
To: MACARTHUR, SCOTT
Cc: STILES, ANDREW; DROVER, MATTHEW; BARNHILL, KYLE
Subject: 13V-T51

Hi Scott,

Attached is a fluid sample report for 13V-T51. DGA and everything looks ok but the fluid quality is becoming poor. Dielectric breakdown looks good, but IFT and acid number are not good. Also, the Furan analysis has 778 parts of 2-furfural (try and say that term with a couple of drinks in you). A furfural number of over 500 (this is measured in parts per billion not ppm) is thought to be cause for concern. It is an indication of cellulose degradation.

Do you have a recent power factor test of the oil? We should also have a jar sample taken and sent to the lab for the 100 degC power factor test. A 100degC power factor over 5 is cause for concern and if it is over 7.5% it is bad. Another check on this is if the 100deg test is greater than 10 times the 20 degree test, it indicates the presence of polar compounds in the oil and the oil is probably shot.

Any idea on what the loading is down there? Just wondering if we are cooking it, or maybe it is just showing it's age (built in 1952).

Thanks,

Brian Penny, P.Eng.
Senior Apparatus Engineer
Transmission Maintenance and Operations
Nova Scotia Power Inc.
902-428-3000 ext 5241 Ph
902-497-1121 cell
902-428-7550 fax
brian.penny@nspower.ca

Nameplate - Two-winding Transformer

Company	Nova Scotia Power Inc.	**Serial Number**	155496
Location	Gulch	**Special ID**	13V-T51
Division	VSM	**Circuit Designation**	
Manufacturer	Pack	**Configuration**	D-Y
Year Manufactured	1952	**Tank Type**	FREE-BREATH
Mfr Location	Ontario	**Coolant**	OIL
Phases	3	**Class**	ONAN/ONAF
Oil Volume	2725 IG	**BIL**	kV
Weight	77860 LB	**Winding Config.**	Delta-Wye
kV	72.45, 13.8	**VA Rating**	7.5, 10, , MVA
Note			

Test Date	10/18/2011	**Test Time**	1:52:37 PM	**Weather**	PTCLDY
Air Temperature	14 °C	**Tank Temperature**	20 °C	**Rel. Humidity**	44 %
Tested by		**Work Order #**		**Last Test Date**	
Checked by		**Test Set Type**	M4K	**Retest Date**	
Checked Date		**Set Top S/N**		**Reason**	ROUTINE
Last Sheet #		**Set Bottom S/N**		**Travel Time**	
P.O. #		**Ins. Book #**		**Duration**	
Copies		**Sheet #**		**Crew Size**	

Arrester Nameplate

Location	Serial #	Mfr	Overall Catalog	Unit Catalog	Type	Rated kV	Order
LOW SIDE X1	X1						
LOW SIDE X2	X2						
LOW SIDE X3	X3						

Overall Tests

Meas.	Test kV	mA	Watts	%PF corr	Corr Fctr	Cap(pF)	IR_{auto}	IR_{man}
CH + CHL	10.000	23.981	5.303		0.99	6359.9		
CH	10.000	7.914	1.659	2.08	0.99	2098.9	I	
CHL(UST)	10.000	16.052	3.642	2.25	0.99	4256.9	I	
CHL		16.067	3.644	2.25	0.99	4261.000		
CL + CHL	4.999	34.361	6.971		0.99	9112.6		
CL	5.000	18.300	3.319	1.79	0.99	4853.4	I	
CHL(UST)	4.999	16.061	3.655	2.26	0.99	4259.0	I	
CHL		16.061	3.652	2.25	0.99	4259.200		

Hot Collar Tests

Serial #	ID	Test Mode	Skirt #	Test kV	mA	Watts	IR_{auto}	IR_{man}
	H1	UST		10.000	0.1070	0.0170	G	
	H2	UST		10.001	0.1140	0.0140	G	
	H3	UST		10.000	0.1070	0.0170	R	
	X1	UST		4.999	0.0730	0.0050	G	
	X2	UST		5.000	0.0790	0.0100	G	
	X3	UST		4.999	0.0800	0.0060	R	
	X0	UST		5.000	0.0680	0.0050	G	

Insulating Fluid Tests

Sample Location	Deg C	Test kV	mA	Watts	%PF corr	Corr Fctr	IR_{auto}	IR_{man}
mT VOID	16	10	0.4700	-000.18	-4.40	1.15	I	
mt	16	10	0.8890	0.0030	0.03	1.15	G	

Surge Arrester Tests

Location	Test Mode	Test kV	mA	Watts	IR_{auto}	IR_{man}
LOW SIDE X1	GND RB	5.000	0.7860	0.1640	Q	
LOW SIDE X2	GND RB	5.000	0.7490	0.2160	Q	
LOW SIDE X3	GND RB	5.000	0.7720	0.1600	Q	

Exciting Current Tests

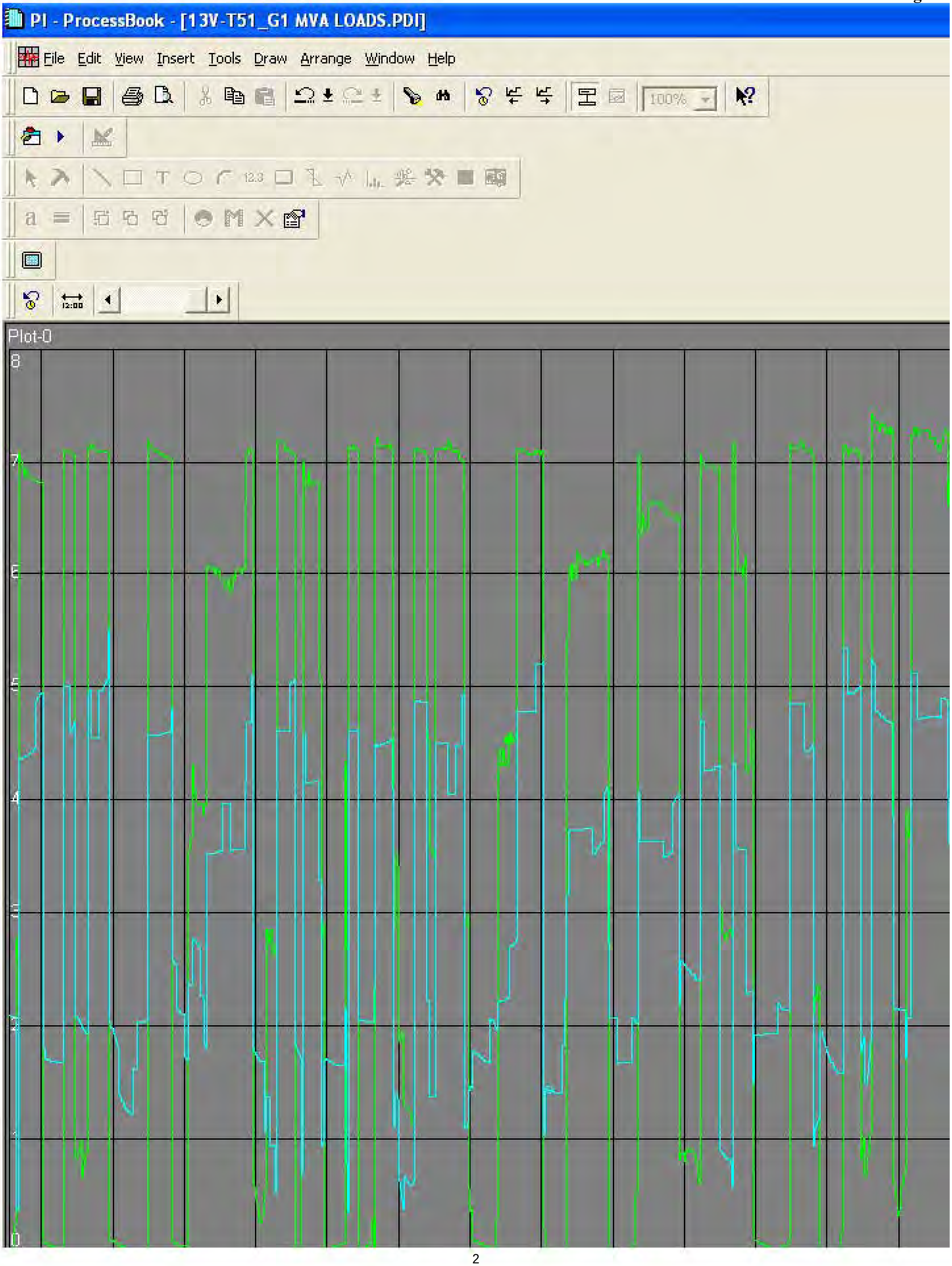
	Mfr	Type	Steps	Boost %	Buck %	Position Found	Position Left	Oil Volume
De-Energized Tap Changer								
On-Load Tap Changer	Pack		5					

			H1 - H2			H2 - H3			H3 - H1				
DETC	LTC	Test kV	mA	Watts	X	mA	Watts	X	mA	Watts	X	IR_{auto}	IR_{man}
D		10.003	24.009	125.69	L	55.851	294.33	L	54.509	290.39	L	G	

From: GODFREY, BOB
Sent: Friday, February 03, 2012 2:09 PM
To: MACARTHUR, SCOTT
Subject: 13V-T51 Load

Hi Scott,

For the last 28 days………….


PI - ProcessBook - [13V-T51_G1 MVA LOADS.PDI]
File Edit View Insert Tools Draw Arrange Window Help
100%
12:00
Plot-0
8
7
6
5
4
3
2
1
0

CI Number: 43606

Title: **L5549 Upgrade**

Start Date: 2013/03
Final Cost Date: 2013/07
Function: Transmission
Forecast Amount: $706,359

DESCRIPTION:

This project is required to replace deteriorated cross arms and insulators on line 5549 that have reached the end of the service life. This work has been identified and prioritized as part of our inspection program. There are 433 insulators to be changed and 78 cross arms.

Related CIs +/- 2 years:
No Related projects 2011, 2012, 2013, 2014 & 2015.

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

The cross arms and insulators scheduled for replacement have reached the end of their service lives. This work will enhance the overall reliability performance of L5549.

Why do this project now?

This work has been prioritized based on provincial inspection results.

Why do this project this way?

This work has been scoped in such a way to minimize costs associated with working in environmentally sensitive areas.

A portion of the labour associated with this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements

CI Number : 43606 - L5549 Upgrade **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		1,830	0	1,830
094		094 - Interest Capitalized		8,565	0	8,565
095		095-COPS Regular Labour AO		3,243	0	3,243
095		095-COPS Contracts AO		155,683	0	155,683
013	007	013 - COPS Contracts	007 - TP - Environmental	[redacted]	0	[redacted]
012	035	012 - Materials	035 - TP - Wood Poles	17,112	0	17,112
013	035	013 - COPS Contracts	035 - TP - Wood Poles	[redacted]	0	[redacted]
012	038	012 - Materials	038 - TP - Insulators	40,879	0	40,879
013	038	013 - COPS Contracts	038 - TP - Insulators	[redacted]	0	[redacted]
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	2,527	0	2,527
002	039	002 - T&D Overtime Labour	039 - TP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - TP - O/H Cond.	1,509	0	1,509
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	[redacted]	0	[redacted]
001	085	001 - Regular Labour (No AO)	085 Design	1,190	0	1,190
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	1,913	0	1,913
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	706,359	0	706,359
			Original Cost:	38,883		

Location: Transmission
CI# / FP#: 43606
Title: L5549 Upgrade
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (no AO)	Lot	1	$ 1,190.00	$ 1,190.00		
1.2	Electrician Labour	Person Day	[redacted]		$ 2,526.68		
1.3	Site Supervision	Lot	1	$ 1,912.60	$ 1,912.60		
				Sub-Total	$ 5,629.28		
2	**012 Materials**						
2.1	Overhead Conductor, Insulators, Poles,etc.	Lot	1	59,499.87	$ 59,499.87		
2.2					$ -		
				Sub-Total	$ 59,499.87		
3	**013 T&D Contracts**						
3.1	EUS Labour	Hours	[redacted]		$ 458,132.87		
3.2	Environment Bog Mats	Lot	[redacted]				
3.3	Pole Haulage	Lot					
				Sub-Total	$ 471,908.92		
4	**094 Interest Capitalized**						
4.1	Interest	lot	1	8564.88	$ 8,564.88		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 8,564.88		
5	**095 Administrative Overhead**						
5.1	Labour AO				$ 3,242.88		
5.2	Vehicle AO				$ 1,830.30		
5.3	Contract AO				$ 155,682.73		
				Sub-Total	$ 160,755.91		
Cost Estimate				**Total**	$ 706,358.85		
6	**Original Cost**						
6.1					$ 38,882.76		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43266

Title: **89S-ST2 Point Aconi Replace Station Service Transformer**
Start Date: 2013/05
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $681,377

DESCRIPTION:

The scope of this project is to replace the existing 89S-ST2 station service transformer with a functionally equivalent, new transformer. The replacement transformer will be placed in the same position as the old transformer and connected to the existing high voltage wiring. An interface box will be installed to allow extension and reconnection of the existing low voltage, secondary cables, which are used to provide protection and monitoring functions.

Related CIs +/- 2 years:
No Related projects 2011, 2012, 2013, 2014 & 2015.

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

The 89S-ST2 transformer was relocated to 89S from 4S in 1992. It was built in 1950, is at end of its useful life and will not take vacuum for dry out purposes.

Why do this project now?

Since the existing 89S-ST2 transformer is at the end of its useful life, it is no longer reasonable to expect reliable performance from this device. To avoid the need for a reactionary response to a sudden failure, it recommended that the 89S-ST2 transformer be proactively replaced with a functionally equivalent, new transformer.

Why do this project this way?

The 89S-ST2 station service transformer is the interface device providing station service power to the Pt. Aconi power plant, for when the generator is not running. There is no other way to deliver station service power this power plant.

CI Number : 43266 - 89S-ST2 Point Aconi Replace Station Service Transformer **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		6,528	0	6,528
092		092-Vehicle T&D OT Labour AO		1,186	0	1,186
094		094 - Interest Capitalized		10,129	0	10,129
095		095-COPS Contracts AO		8,157	0	8,157
095		095 - T&CS Regular Labour AO		2,708	0	2,708
095		095-COPS Overtime Labour AO		2,101	0	2,101
095		095-COPS Regular Labour AO		11,567	0	11,567
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	1,426	0	1,426
002	022	002 - T&D Overtime Labour	022 - TP - Elec Contr.Equip.	0	0	0
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	[redacted]	0	[redacted]
013	022	013 - COPS Contracts	022 - TP - Elec Contr.Equip.	1,840	0	1,840
012	043	012 - Materials	043 - TP - Substn Dev.	[redacted]	0	[redacted]
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	19,090	0	19,090
001	044	001 - T&D Regular Labour	044 - TP - Substn.Transf.	9,394	0	9,394
002	044	002 - T&D Overtime Labour	044 - TP - Substn.Transf.	5,752	0	5,752
011	044	011 - Travel Expense	044 - TP - Substn.Transf.	1,610	0	1,610
012	044	012 - Materials	044 - TP - Substn.Transf.	[redacted]	0	[redacted]
041	044	041 - Meals & Entertainment	044 - TP - Substn.Transf.	805	0	805
066	044	066 - Other Goods & Services	044 - TP - Substn.Transf.	53,820	0	53,820
001	085	001 - Regular Labour (No AO)	085 Design	6,593	0	6,593
001	085	001 - T&CS Regular Labour	085 Design	8,670	0	8,670
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	086	001 - T&D Regular Labour	086 Commissioning	5,014	0	5,014
002	086	002 - T&D Overtime Labour	086 Commissioning	0	0	0
013	086	013 - COPS Contracts	086 Commissioning	3,795	0	3,795
			Total Cost:	681,377	0	681,377
			Original Cost:	78,164		

Location: Transmission
CI# / FP#: 43266
Title: 89S-ST2 Point Aconi Replace Station Service Transformer
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (no AO)	Lot	1	$ 6,593.41	$ 6,593.41		
1.2	Electrician Labour		[redacted]		$ 15,833.83		
1.3	Design Labour	Lot	1.00	$ 8,670.00	$ 8,670.00		
1.4							
				Sub-Total	$ 31,097.24		
2	**002 Overtime Labour**						
2.1	Electrician OT Labour	Person Day	[redacted]		$ 5,752.00		
2.2							
2.3							
2.4							
				Sub-Total	$ 5,752.00		
3	**011 Travel Expenses**						
3.1		Lot	1	1610	$ 1,610.00		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 1,610.00		
4	**012 Materials**						
4.1	Transformer	Each	1	[redacted]			
4.2	Misc Substation Devices	Lot	1				
4.3	Misc Electrical Control equipment	Lot	1				
				Sub-Total	$ 521,192.00		
5	**013 T&D Contracts**						
5.1	Mobile Mobilization/ Demobilization	Lot	1	24725	$ 24,725.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 24,725.00		
6	**041 Meals and Entertainment**						
6.1		Lot	1	805	$ 805.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 805.00		
7	**066 Other Goods & Services**						
7.1	Transformer Testing	Lot	1	[redacted]			
7.2	Crane Rental	Hours	24				
7.3	Transformer Placement	Lot	1				
				Sub-Total	$ 53,820.00		
8	**094 Interest Capitalized**						
8.1	Interest	lot	1	10129.27	$ 10,129.27		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 10,129.27		
9	**095 Administrative Overhead**						
9.1	Labour AO				$ 16,376.01		
9.2	Vehicle AO				$ 7,714.04		
9.3	Contract AO				$ 8,156.79		
				Sub-Total	$ 32,246.84		
Cost Estimate				**Total**	$ 681,377.35		
10	**Original Cost**						
10.1					$ 78,164.10		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43200

Title: **Pole Retreatment 2013**

Start Date: 2013/06
Final Cost Date: 2013/09
Function: Transmission
Forecast Amount: $678,882

DESCRIPTION:

This project provides for the cost of re-treatment of approximately 5700 transmission poles. This is a multi-year program that will continue beyond 2013.

Summary of Related CIs +/2- years:
2011 CI 40279 2011 Pole Retreatment $516,341
2012 CI 41386 2012 Pole Retreatment $556,017
2014 CI TBD Pole Retreatment $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Maintenance

Why do this project?

Pole re-treatment is a proven and accepted cost effective approach to extend the life of the pole.

Why do this project now?

NS Power re-instated the pole retreatment program in 2006, a decision supported by the UARB following the November 2004 Storm.

Why do this project this way?

Cycle based pole retreatment is a cost effective way to extend the life of treated wood poles.

CI Number : 43200 - Pole Retreatment 2013 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2012 08/04 Forecast

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		1,649	0	1,649
094		094 - Interest Capitalized		6,553	0	6,553
095		095 - T&CS Regular Labour AO		625	0	625
095		095-COPS Regular Labour AO		2,922	0	2,922
095		095-COPS Contracts AO		[redacted]	0	[redacted]
011	035	011 - Travel Expense	035 - TP - Wood Poles	3,000	0	3,000
013	035	013 - COPS Contracts	035 - TP - Wood Poles	[redacted]	0	[redacted]
001	085	001 - T&CS Regular Labour	085 Design	2,000	0	2,000
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
011	085	011 - Travel Expense	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	4,000	0	4,000
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	678,882	0	678,882
			Original Cost:			

Location: Transmission
CI# / FP#: 43200
Title: 2013 Pole Retreatment Program
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1							
1.2	Field Supervison Labour	Lot	1	$ 4,000.00	$ 4,000.00		
1.3	Engineering Labour	Lot	1	$ 2,000.00	$ 2,000.00		
1.4					$ -		
1.5							
1.6				Sub-Total	$ 6,000.00		
2	**013 Contracts**						
2.1	Pole Retreatment Contract (third party)	Lot	1	[redacted]		Cost Support 2	41386
2.2							
2.3							
2.4							
				Sub-Total	[redacted]		
3	**011 Travel**						
3.1	Travel Expenses	Lot	1	$ 3,000.00	$ 3,000.00		
3.2							
3.3							
				Sub-Total	$ 3,000.00		
4	**094 Interest Capitalized**						
4.1	Interest	Lot	1	$ 6,552.70	$ 6,552.70		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 6,552.70		
5	**095 Administrative Overhead**						
5.1	Labour AO	Lot	1	$ 3,546.80	$ 3,546.80		
5.2	Vehicle AO	Lot	1	$ 1,649.20	$ 1,649.20		
5.3	Contracts AO	Lot	1	[redacted]			
				Sub-Total	[redacted]		
Cost Estimate				**Total**	$ 678,881.64		
6	**Original Cost**						
6.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

This work is expected to be completed by a third party contractor with NS Power supervision.
The estimate for contracts is based on actual costs incurred in this program in previous years.
The list of lines to be completed in 2013 is as follows:

Lines Scheduled	Operating Section Number and Name	Approximate Pole Quantity
5022	43V-Canaan Rd. - 92V-Michelin, Waterville	210
5030	10N-Aberdeen St. - 6N-Black River Rd.	435
5505	67C-Whycocomagh - 9C-Aberdeen	176
5549	30N-Maccan - 19N-Hickman St. Sw. Sta.	197
5559	67C-Whycocomagh - 58C-S.W. Margaree	384
5569	4S-Townsend St. - 6S-Terrace St.	40
6512	Tap L-6537 (Baddeck) - 104S-Baddeck 138/13.2 kV	36
6513	1N-Onslow - 74N-Springhill	543
6537	2C-Port Hastings - 5S-Glen Tosh	951
6540	2S-Victoria Junction - 8S-Sysco South	89
7004	91N-Dalhousie Mountain - 3C-Port Hastings	1290
7012	3C-Port Hastings - 88S-Lingan	1349
Totals		**5700**

Attachment 2

Removed due to confidentiality

CI Number: 43426

Title: **78W-Martins Brook – Relocate Substation to Opposite Side of Road**

Start Date: 2013/03
Final Cost Date: 2013/10
Function: Transmission
Forecast Amount: $455,700

DESCRIPTION:

The existing 78W-Martins Brook substation is located under line L-5547 on the north side of Schnares Crossing Road, a few kilometers west of Martins Brook, where this line crosses that road. The land under and around the transmission line on the south side of the road is available and undeveloped.

The scope of this project is to rebuild the substation on the south side property on the transmission line ROW, a prepared location for installing the mobile transformer. As distribution voltage regulators were installed on each of the two feeders in 2012, new vacuum recloser/feeder reclosers will be mounted on the feeder poles beside the road, adjacent to the old substation site. The new substation will consist of a new fenced yard, a line tap connection, HV switch and fuse, an LV switch, a span of 12kV line to connect to the feeders on the street and relocation of the existing transformer.

Summary of Related CIs +/- 2 years:
2012 Routine D051 29038 System Performance Improvements $ 458,585

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Maintenance

Why do this project?

The 78W substation is under the line conductors on the transmission line ROW and is surrounded by a business that utilizes heavy equipment. There is encroachment up to the substation fence and no designated location for the mobile transformers. Undeveloped land is available on the opposite side of the road. The congestion problems and mobile issue are solvable by relocating the substation to be under the line on the opposite side of the road.

Why do this project now?

The 3 MVA transformer in the substation has a non-functioning On-Load Tap Changer (OLTC) that cannot be repaired, and which was jumpered out internally inside the tank a few years ago, requiring the installation of distribution, voltage regulators on each feeder on the street. In addition, very low maintenance reclosers featuring modern vacuum (i.e. non-oil) interrupters, coupled with internal voltage and current sensors linked to a modern digital control make it practical to install substation feeder reclosers on poles on the street. This allows a reduction in the amount of substation infrastructure that needs to be relocated. Lastly, the HV switch and fuse are 51 years old and near the end of their life.

Why do this project this way?

The tap changer on the existing transformer is jumpered out due to a failure and because of the small size of this transformer it would be just as expensive to replace the whole transformer rather than just replacing the tap-changer. The reclosers are on deteriorating timbers (no concrete slabs) and would need to be by-passed with the installation of a mobile transformer in order to install proper concrete slabs. In order to install the mobile transformer at this site (which is also a system contingency) it has to be installed on the neighbour's land which requires permission from the landowner. Clearances are also an issue since the neighbour owns the land surrounding the station and his machinery has been in contact with the distribution and transmission circuits in the past. The substation is built in a low area and fills with water and ice on a regular basis – which has caused ground grid problems and recloser control damage in the past. The present ground grid also needs to be replaced.

The land across the road is available and vacant and the use of modern low maintenance reclosers reduces the amount of infra-structure that needs to be recreated. In addition, a location to install the mobile transformer can be prepared. The alternative is to retire this substation and to increase the capacity in another more distant substation, along with upgrades the distribution feeders to accommodate the increased distance to the source bus. These changes would be more costly.

NS Power will be completing this work.

CI Number : 43426 - 78W-Martins Brook – Relocate Substation to opposite Side of Road **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		1,186	0	1,186
092		092-Vehicle T&D Reg. Labour AO		11,672	0	11,672
094		094 - Interest Capitalized		4,186	0	4,186
095		095-COPS Overtime Labour AO		2,101	0	2,101
095		095-COPS Regular Labour AO		20,680	0	20,680
095		095 - T&CS Regular Labour AO		3,997	0	3,997
095		095-COPS Contracts AO		35,668	0	35,668
001	003	001 - T&D Regular Labour	003 - TP - Bldg.,Struct.Grnd.	839	0	839
002	003	002 - T&D Overtime Labour	003 - TP - Bldg.,Struct.Grnd.	0	0	0
012	003	012 - Materials	003 - TP - Bldg.,Struct.Grnd.	19,723	0	19,723
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
066	003	066 - Other Goods & Services	003 - TP - Bldg.,Struct.Grnd.	2,070	0	2,070
001	023	001 - T&D Regular Labour	023 - TP - Power Equip.-Station S	671	0	671
002	023	002 - T&D Overtime Labour	023 - TP - Power Equip.-Station S	0	0	0
012	023	012 - Materials	023 - TP - Power Equip.-Station S	1,668	0	1,668
001	035	001 - T&D Regular Labour	035 - TP - Wood Poles	2,684	0	2,684
002	035	002 - T&D Overtime Labour	035 - TP - Wood Poles	0	0	0
012	035	012 - Materials	035 - TP - Wood Poles	37,950	0	37,950
066	035	066 - Other Goods & Services	035 - TP - Wood Poles	598	0	598
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	4,026	0	4,026
002	039	002 - T&D Overtime Labour	039 - TP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - TP - O/H Cond.	1,150	0	1,150
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	12,917	0	12,917
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	0	0	0
012	043	012 - Materials	043 - TP - Substn Dev.	131,491	0	131,491
066	043	066 - Other Goods & Services	043 - TP - Substn Dev.	9,890	0	9,890
001	044	001 - T&D Regular Labour	044 - TP - Substn.Transf.	4,026	0	4,026
002	044	002 - T&D Overtime Labour	044 - TP - Substn.Transf.	5,752	0	5,752
011	044	011 - Travel Expense	044 - TP - Substn.Transf.	1,610	0	1,610
041	044	041 - Meals & Entertainment	044 - TP - Substn.Transf.	805	0	805
066	044	066 - Other Goods & Services	044 - TP - Substn.Transf.	2,783	0	2,783
001	085	001 - T&CS Regular Labour	085 Design	12,794	0	12,794
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
001	086	001 - T&D Regular Labour	086 Commissioning	1,678	0	1,678

CI Number : 43426 - 78W-Martins Brook – Relocate Substation to opposite Side of Road **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
002	086	002 - T&D Overtime Labour	086 Commissioning	0	0	0
013	087	013 - COPS Contracts	087 Field Super.& Ops.	[redacted]	0	[redacted]
001	088	001 - T&D Regular Labour	088 Survey/Mapping	1,468	0	1,468
002	088	002 - T&D Overtime Labour	088 Survey/Mapping	0	0	0
066	088	066 - Other Goods & Services	088 Survey/Mapping	11,500	0	11,500
			Total Cost:	455,700	0	455,700
			Original Cost:	22,921		

Location: Transmission
CI# / FP#: 43426
Title: 78W-Martins Brook Relocate Substation
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (no AO)				$ -		
1.2	Electrician Labour	Person Day	[redacted]		$ 28,309.00		
	Site Supervision				$ -		
1.6	Design Labour	Person Day	[redacted]		$ 12,794.00		
1.7							
1.8							
1.9							
1.1		hr			$ -		
				Sub-Total	$ 41,103.00		
2	**012 Materials**						
2.2	Wood Poles	Lot	1	33000	$ 33,000.00		
2.3	Substation Devices	Lot	1	114340	$ 114,340.00		
2.4	Grounding Material	Lot	1	17150	$ 17,150.00		
2.5	Misc Materials	Lot	1	27492	$ 27,492.00		
2.6					$ -		
2.7					$ -		
2.8					$ -		
2.9					$ -		
				Sub-Total	$ 191,982.00		
3	**002 Overtime Labour**						
3.1	Electrician Labour	Person Day	8.54	673.78	$ 5,752.00		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 5,752.00		
4	**013 T&D Contracts**						
4.1	Civil	Lot	1	[redacted]			
4.2	Field Supervsion	Lot	1				
4.3					$ -		
				Sub-Total	$ 108,118.00		
5	**011 Travel Expenses**						
5.1	Travel	Lot	1	1610	$ 1,610.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 1,610.00		
6	**041 Meals and Entertainment**						
6.1	Meals	Lot	1	805	$ 805.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 805.00		
7	**Other Goods & Services**						
7.1	Surveys & Easements	Lot	1	10000	$ 10,000.00		
7.2	Boom Truck Rental	Hour	40	80	$ 3,200.00		
7.3	Mobile Transport	Lot	2	1000	$ 2,000.00		
7.4	Crane	Hour	6	250	$ 1,500.00		
7.5	Low Bed Trailer	Hour	12	60	$ 720.00		
7.6	Other Goods & Services	Lot	1	9421	$ 9,421.00		
7.7					$ -		
7.8					$ -		
				Sub-Total	$ 26,841.00		
8	**094 Interest Capitalized**						
8.1	Interest	lot	1	4185.7	$ 4,185.70		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 4,185.70		
9	**095 Administrative Overhead**						
9.1	Labour AO				$ 26,777.49		
9.2	Vehicle AO				$ 12,857.58		
9.3	Contract AO				$ 35,668.14		
				Sub-Total	$ 75,303.21		
Cost Estimate				**Total**	$ 455,699.91		
10	**Original Cost**						
10.1					$ 22,921.45		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43261

Title: **6V-Hollow Bridge Hydro Replace 6V-GT1**

Start Date: 2013/04
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $435,537

DESCRIPTION:

The scope of this project is to replace the existing 6V-GT1 generator step-up transformer with a functionally equivalent, new transformer. The replacement transformer will be placed in the same position as the old transformer and connected to the existing high voltage wiring. An interface box will be installed to allow extension and reconnection of the existing low voltage, secondary cables, which are used to provide protection and monitoring functions.

Related CIs +/- 2 years:
No Related projects 2011, 2012, 2013, 2014 & 2015.

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

The existing 6V-GT1 transformer is at end of its useful life. Previous issues with this transformer include a winding failure in 1960 where coils were replaced (although the core had damage it was not replaced) and shifting of core and coil assembly in 1987. According to Hartford Steam Boiler "mean age" of transformer failure is 17.7 years, though transformers should have a life expectancy of up to 40 years (depending on loading) and excluding external factors such as lightning and down-stream "through faults" which stress transformer insulation.

Why do this project now?

Since the existing 6V-GT1 transformer is at the end of its useful life, it is no longer reasonable to expect reliable performance from this device. To avoid the need for a reactionary response to a sudden failure, it recommended that the 6V-GT1 transformer be proactively replaced with a functionally equivalent, new transformer.

Why do this project this way?

The 6V-GT1 generator transformer is the interface device between the 6V-G1 (Hollow Bridge) generator and the 69kV transmission line that delivers the output energy to the NS Power system. There is no other way to transfer the energy from the generator to the system except through an interfacing, generator step up transformer.

CI Number : 43261 - 6V-Hollow Bridge Hydro Replace 6V-GT1 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		9,445	0	9,445
092		092-Vehicle T&D OT Labour AO		1,250	0	1,250
094		094 - Interest Capitalized		7,303	0	7,303
095		095 - T&CS Regular Labour AO		2,694	0	2,694
095		095-COPS Contracts AO		1,252	0	1,252
095		095-COPS Regular Labour AO		16,735	0	16,735
095		095-COPS Overtime Labour AO		2,215	0	2,215
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	1,661	0	1,661
002	022	002 - T&D Overtime Labour	022 - TP - Elec Contr.Equip.	0	0	0
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	[redacted]	0	[redacted]
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	6,962	0	6,962
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	0	0	0
012	043	012 - Materials	043 - TP - Substn Dev.	[redacted]	0	[redacted]
001	044	001 - T&D Regular Labour	044 - TP - Substn.Transf.	9,421	0	9,421
002	044	002 - T&D Overtime Labour	044 - TP - Substn.Transf.	6,064	0	6,064
011	044	011 - Travel Expense	044 - TP - Substn.Transf.	1,610	0	1,610
012	044	012 - Materials	044 - TP - Substn.Transf.	[redacted]	0	[redacted]
041	044	041 - Meals & Entertainment	044 - TP - Substn.Transf.	805	0	805
066	044	066 - Other Goods & Services	044 - TP - Substn.Transf.	53,820	0	53,820
001	085	001 - T&CS Regular Labour	085 Design	8,624	0	8,624
001	085	001 - Regular Labour (No AO)	085 Design	5,824	0	5,824
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	086	001 - T&D Regular Labour	086 Commissioning	4,865	0	4,865
002	086	002 - T&D Overtime Labour	086 Commissioning	0	0	0
013	087	013 - COPS Contracts	087 Field Super.& Ops.	3,795	0	3,795
			Total Cost:	435,537	0	435,537
			Original Cost:	24,699		

Location: Transmission
CI# / FP#: 43261
Title: 6V-GT Hollow Bridge Hydro Replace
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (no AO)	Lot	1	$ 5,823.83	$ 5,823.83		
1.2	Electrician Labour	Person Day	[redacted]		$ 22,908.52		
1.6	Design Labour	Hour			$ 8,624.00		
1.7							
1.8							
1.9							
1.1							
				Sub-Total	$ 37,356.35		
2	**012 Materials**						
2.1	Transformer	ea	1	[redacted]			
2.2	Misc Substation Devices	Lot	1				
2.3	Misc Electrical Control Equipment	Lot	1				
2.4					$ -		
				Sub-Total	$ 291,192.00		
3	**013 T&D Contracts**						
3.1	Field Supervision	Lot	1	3795	$ 3,795.00		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 3,795.00		
4	**011 Travel Expenses**						
4.1		Lot	1	1610	$ 1,610.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 1,610.00		
5	**041 Meals and Entertainment**						
5.1		Lot	1	805	$ 805.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 805.00		
6	**002 Overtime Labour**						
6.1	Electrician OT Labour	Person Day	[redacted]		$ 6,064.02		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 6,064.02		
7	**066 Other Goods and Services**						
7.1	Inspection & Witnessing of Tests	Lot	1	46000	$ 46,000.00		
7.2	Transformer Placement	Lot	1	7820	$ 7,820.00		
7.3					$ -		
				Sub-Total	$ 53,820.00		
8	**094 Interest Capitalized**						
8.1	Interest	lot	1	7303.46	$ 7,303.46		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 7,303.46		
9	**095 Administrative Overhead**						
9.1	Labour AO				$ 21,643.68		
9.2	Vehicle AO				$ 10,695.29		
9.3	Contract AO				$ 1,251.98		
				Sub-Total	$ 33,590.95		
Cost Estimate				**Total**	$ 435,536.78		
10	**Original Cost**						
10.1					$ 24,699.02		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43486

Title: **89H-511 Add Battery, Battery Charging Set, Remote Terminal Unit (RTU) and Replace Breaker**

Start Date: 2013/04
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $421,477

DESCRIPTION:

This project will replace the 89H-511 circuit breaker, dating from 1966. This breaker currently protects a section of line L-5511 where it taps line L-5510, about 3/4 of the way from Trenton to Malay/Ruth Falls. In addition, a new battery, charger and SCADA RTU would also be installed.

A new breaker and associated switches in conjunction with the 520 switch towards Malay and Ruth Falls will be installed. The existing 520 switch will become 520A and a 520B will be installed. The bypass (520C) will be in-line switches.

Summary of Related CIs +/- 2 years:
No projects for 2011, 2012, 2013, 2014 & 2015

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

The 89H-511 circuit breaker is 48 years old and installed on a timber foundation that has experienced some structural failure to the point of requiring repairs to be undertaken. In addition, this circuit breaker has an AC powered tripping circuitry, featuring a short duration energy storage device. The original device failed and was replaced with another device of similar age taken from another breaker. If this tripping device should fail, then the breaker would become inoperable.

Why do this project now?

The 62N-510 breaker is reaching its end of its useful life and the lack of spare parts for a critical component along with a deteriorating timber foundation could soon affect reliable performance.

Why do this project this way?

The pole spacing of the line structure straddling the existing 89H-511 breaker is only 13’ - too small for the wide, modern SF6 gas circuit breakers. To re-use this location, the line L-5511 taps connection would need to be by-passed to allow this structure to be rebuilt.

In addition, when constructed, 48 years ago, the Sheet Harbour generating system was important to the New Glasgow area, so the Upper Musquodoboit tap featured a breaker. Today, the primary importance of the Sheet Harbour system is for kilowatt–hours, not capacity. Furthermore, the majority of the line faults, today, are on this portion of line L-5511 between Trafalgar and Sheet Harbour. By placing the breaker on that section of line, there should be an improvement in reliability for the large load at 88H-Upper Musquodoboit.

NS Power personnel will complete this work.

CI Number : 43486 - 89H-511 Add Battery, Battery Charging Set, RTU and Replace Breaker **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		7,084	0	7,084
094		094 - Interest Capitalized		7,067	0	7,067
095		095-COPS Regular Labour AO		12,551	0	12,551
095		095 - T&CS Regular Labour AO		7,375	0	7,375
095		095-COPS Contracts AO		32,876	0	32,876
001	003	001 - T&D Regular Labour	003 - TP - Bldg.,Struct.Grnd.	740	0	740
002	003	002 - T&D Overtime Labour	003 - TP - Bldg.,Struct.Grnd.	0	0	0
012	003	012 - Materials	003 - TP - Bldg.,Struct.Grnd.	22,385	0	22,385
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
066	003	066 - Other Goods & Services	003 - TP - Bldg.,Struct.Grnd.	2,864	0	2,864
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	3,020	0	3,020
002	022	002 - T&D Overtime Labour	022 - TP - Elec Contr.Equip.	0	0	0
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	20,269	0	20,269
013	022	013 - COPS Contracts	022 - TP - Elec Contr.Equip.	[redacted]	0	[redacted]
001	023	001 - T&D Regular Labour	023 - TP - Power Equip.-Station S	3,355	0	3,355
002	023	002 - T&D Overtime Labour	023 - TP - Power Equip.-Station S	0	0	0
012	023	012 - Materials	023 - TP - Power Equip.-Station S	22,310	0	22,310
012	035	012 - Materials	035 - TP - Wood Poles	3,450	0	3,450
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	2,349	0	2,349
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	0	0	0
012	043	012 - Materials	043 - TP - Substn Dev.	115,318	0	115,318
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	[redacted]	0	[redacted]
066	043	066 - Other Goods & Services	043 - TP - Substn Dev.	3,910	0	3,910
001	061	001 - T&D Regular Labour	061 - TP - Switched Telecomm. Sys	1,678	0	1,678
002	061	002 - T&D Overtime Labour	061 - TP - Switched Telecomm. Sys	0	0	0
012	061	012 - Materials	061 - TP - Switched Telecomm. Sys	23,000	0	23,000
001	085	001 - T&CS Regular Labour	085 Design	23,607	0	23,607
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
066	085	066 - Other Goods & Services	085 Design	575	0	575
001	086	001 - T&D Regular Labour	086 Commissioning	6,039	0	6,039
002	086	002 - T&D Overtime Labour	086 Commissioning	0	0	0
013	087	013 - COPS Contracts	087 Field Super.& Ops.	10,120	0	10,120
			Total Cost:	421,477	0	421,477
			Original Cost:	0		

Location: Distribution
CI# / FP#: 43486
Title: 89H-511 Add Battery, Battery Charging Set, Remote Terminal Unit (RTU) and Replace Breaker
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician/ Technician	Person Day	[redacted]		$ 17,181.39		
1.2	Engineering (P.Eng): Design	Lot	1	23607.00	$ 23,607.00		
1.3					$ -		
1.4					$ -		
				Sub-Total	$ 40,788.39		
2	**012 Materials**						
2.1	Wood Poles	[redacted]			$ 3,450.00		
2.2	Civil Materials	Lot	1	22,385.00	$ 22,385.00		
2.3	Substation Devices & Equipment	Lot	1	115,318.00	$ 115,318.00		
2.4	Electrical Control Equipment	Lot	1	20,269.00	$ 20,269.00		
2.5	Remote Terminal Unit	[redacted]			$ 10,000.00		
2.6	Radios				$ 13,000.00		
2.7	Batteries & Battery Charger				$ 22,310.00		
				Sub-Total	$ 206,732.00		
4	**013 T&D Contracts**						
4.1	Field Supervision	Hour	[redacted]		$ 10,120.00		
4.2	Civil Works	Lot					
4.3	Installation	Lot					
				Sub-Total	$ 99,655.00		
7	**066 Other Goods and Services**						
7.1	Project Contingency	Lot	1	7349	$ 7,349.00		
7.2							
7.3							
7.4							
				Sub-Total	$ 7,349.00		
8	**094 Interest Capitalized**						
8.1	Interest		1	7,066.91	$ 7,066.91		
8.2							
8.3							
				Sub-Total	$ 7,066.91		
9	**095 Administrative Overhead**						
9.1	Contracts AO		1	32,876.18	$ 32,876.18		
9.2	Labour AO		1	19,925.86	$ 19,925.86		
9.3	Vehicle AO		1	7,083.87	$ 7,083.87		
				Sub-Total	$ 59,885.91		
Cost Estimate				**Total**	$ 421,477.21		
10	**Original Cost**				$ 15,433.00		
10.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43204

Title: **L5503 Retirement**

Start Date: 2013/06
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $402,387

DESCRIPTION:

This project involves the removal of poles, conductor and anchors on L5503, a 69kV line from Port Hastings to Cleveland.

Summary of Related CIs +/- 2 years:
2013 CI 43287 2C-Port Hastings- Retire 2C-T1 & T2 and 69kV & 25kV Buses $266,691

JUSTIFICATION:

Justification Criteria: Transmission Plant

Why do this project?

The Cleveland substation, 22C has been upgraded from 69kV to 138kV with the installation of a 138kV-25kV transformer. Upon energizing the new transformer, L5503 which served 22C at 69kV will no longer be required and therefore must be removed.

Why do this project now?

This 69kV transmission line will no longer be required upon energizing the new transformer at the Cleveland substation. This asset must be removed and retired.

Why do this project this way?

De-energizing L5503 is part of a successive planning process. Removal of the line mitigates the liability associated with a de-energized and abandoned line.

Labour for this project will be sourced through NS Power’s existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power’s workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 43204 - L5503 Retirement

Project Number

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin.

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		3,035	0	3,035
094		094 - Interest Capitalized		306	0	306
095		095-COPS Regular Labour AO		5,377	0	5,377
095		095-COPS Contracts AO		95,829	0	95,829
012	004	012 - Materials	004 - TP - Misc.Equipment	0	0	0
013	007	013 - COPS Contracts	007 - TP - Environmental	[redacted]	0	[redacted]
013	035	013 - COPS Contracts	035 - TP - Wood Poles	[redacted]	0	[redacted]
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	193,143	0	193,143
001	085	001 - T&D Regular Labour	085 Design	1,239	0	1,239
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	6,122	0	6,122
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	402,387	0	402,387
			Original Cost:	77,812		

Location: Transmission
CI# / FP#: 43204
Title: L5503 Retirement
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	T&D Design Labour	Lot	1	$ 1,238.77	$ 1,238.77		
1.2	T&D Labour (Site Supervision)	Lot	1	$ 6,122.00	$ 6,122.00		
1.3					$ -		
1.4					$ -		
				Sub-Total	$ 7,360.77		
2	**013 T&D Contracts**						
2.1	Line Work	Hours	[redacted]		$ 193,143.00	Contract Rate 2013	
2.2	Bog Mats	Lot	[redacted]				
2.3	Pole Hauling	Lot					
				Sub-Total	$ 290,479.00		
3	**094 Interest Capitalized**						
3.1	Interest		1	306.47	$ 306.47		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 306.47		
4	**095 Administrative Overhead**						
4.1	Contracts AO		1	95829	$ 95,829.00		
4.2	Labour AO		1	5377.04	$ 5,377.04		
4.3	Vehicle AO		1	3034.85	$ 3,034.85		
				Sub-Total	$ 104,240.89		
Cost Estimate				**Total**	$ 402,387.13		
5	**Original Cost**				$ 77,812.32		
5.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

CI Number: 43268

Title: **9W-Tusket Replace 9W-B53 Structure**

Start Date: 2013/05
Final Cost Date: 2013/07
Function: Transmission
Forecast Amount: $309,026

DESCRIPTION:

This project will replace the 6 wood poles and associated wooden crossarms comprising the structure supporting the 69kV bus 9W-B53.

Summary of Related CIs +/- 2 years:
No projects for 2011, 2012, 2013, 2014 &2015

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

This project is necessary because the existing structural timber components are in a deteriorated state.

Why do this project now?

It is necessary to do this project now, because the poles have reached the end of life.

Why do this project this way?

The lowest cost alternative is to replace the poles, as it is not possible to replace the functionality of this bus structure in any other way.

NS Power personnel will be completing this work.

CI Number : 43268 - 9W-Tusket Replace 9W-B53 Structure **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		34,645	0	34,645
092		092-Vehicle T&D OT Labour AO		6,929	0	6,929
094		094 - Interest Capitalized		725	0	725
095		095 - T&CS Regular Labour AO		633	0	633
095		095-COPS Regular Labour AO		61,382	0	61,382
095		095-COPS Overtime Labour AO		12,276	0	12,276
001	035	001 - T&D Regular Labour	035 - TP - Wood Poles	83,692	0	83,692
002	035	002 - T&D Overtime Labour	035 - TP - Wood Poles	33,611	0	33,611
012	035	012 - Materials	035 - TP - Wood Poles	47,610	0	47,610
066	035	066 - Other Goods & Services	035 - TP - Wood Poles	7,176	0	7,176
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	0	0	0
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	0	0	0
012	043	012 - Materials	043 - TP - Substn Dev.	16,698	0	16,698
001	085	001 - T&CS Regular Labour	085 Design	2,027	0	2,027
001	085	001 - Regular Labour (No AO)	085 Design	1,286	0	1,286
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
001	086	001 - T&D Regular Labour	086 Commissioning	336	0	336
002	086	002 - T&D Overtime Labour	086 Commissioning	0	0	0
			Total Cost:	309,026	0	309,026
			Original Cost:	19,646		

Location:
CI# / FP#: 43268
Title: 9W Tusket Replace 9W-B53 Structure
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	PLT Labour to Install Poles	Person Day	[redacted]		$ 84,027.65		
1.2	Project Support Labour (No AO)	Lot	1	$ 1,286.16	$ 1,286.16		
1.3	Engineering (P.Eng)	Lot	1	$ 2,027.00	$ 2,027.00		
				Sub-Total	$ 87,340.81		
2	**002 Overtime Labour**						
2.1	PLT Labour to Install Poles	Person Day	[redacted]		$ 33,611.06		
2.2							
				Sub-Total	$ 33,611.06		
3	**012 Materials**						
3.1	Wood Poles & Framing Fixtures	Lot	1	47610	$ 47,610.00		
3.2	Substation Connectors & Conductor	Lot	1	16698	$ 16,698.00		
3.3							
				Sub-Total	$ 64,308.00		
4	**066 Other Goods and Services**						
4.1	Boom Truck Rental	Hour	[redacted]		$ 7,176.00		
4.2							
4.3					$ -		
				Sub-Total	$ 7,176.00		
5	**094 Interest Capitalized**						
5.1	Interest Capitalized	Lot	1	724.5	$ 724.50		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 724.50		
6	**095 Administrative Overhead**						
6.1	Contract AO		1	0	$ -		
6.2	Labour AO		1	74291.88	$ 74,291.88		
6.3	Vehicle AO		1	41573.53	$ 41,573.53		
				Sub-Total	$ 115,865.41		
Cost Estimate				**Total**	$ 309,025.78		
7	**Original Cost**				$ 19,645.93		
7.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43222

Title: **2013 Substation Insulator and Cut-Out Replacements**

Start Date: 2013/03
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $303,055

DESCRIPTION:

This project scope provides for the replacement of porcelain insulators and cutouts on select equipment in transmission substations.

Targeted substations include the following:

36W Green Harbour13V Gulch (Hydro)
37W Lockeport 70V Bridgetown
91W Middlefield 93V Saulnierville
84W Robinson Corner 36V Hillaton
57W Caledonia 83V Wolfville Ridge
17V St. Croix 3V Hells Gate
2V Avon 652V Stepdown of 50V-401 (Klondike)
2W Lr Lake Falls 14V Ridge Hydro 74V Cornwallis 6V Hollow Bridge

Summary of Related Projects +/- 2 Years:
2011 CI 40285 Substation Insulator and Cut-Out Replacement $1,056,414
2012 CI 41399 Substation Insulator and Cut-Out Replacement $800,013
2014 CI TBD Substation Insulator and Cut-Out Replacement $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

This work is being undertaken as part of the overall customer reliability improvement investment. This is year four of a five year (2010-2014) plan to improve reliability to NS Power's customers. Porcelain insulators and cutouts have been failing resulting in customer outages. These failures come as a result of moisture in hairline cracks which have developed in the porcelain insulator. Transmission outages generally affect a large number of customers as these failures typically interrupt supply to one or more substations. It is expected that replacing substation insulators and cut-out will result in 2,850 annual avoided customer hours of interruption.

Why do this project now?

Program insulator and cutout replacement on a prioritized substation basis is required to improve customer reliability. Substations have been identified based on their condition and size. Porcelain insulator and cutout failures contribute to customer outages.

Why do this project this way?

The best approach to reduce outages caused by insulator and cutout failures is to focus on specific substations and replace the cutouts in kind.

NS Power personnel will be completing this project.

CI Number : 43222 - 2013 Substation Insulator and Cut-Out Replacements

Project Number

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin.

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		30,357	0	30,357
094		094 - Interest Capitalized		7,530	0	7,530
095		095-COPS Regular Labour AO		53,785	0	53,785
001	038	001 - T&D Regular Labour	038 - TP - Insulators	36,047	0	36,047
011	038	011 - Travel Expense	038 - TP - Insulators	77,000	0	77,000
012	038	012 - Materials	038 - TP - Insulators	12,017	0	12,017
041	038	041 - Meals & Entertainment	038 - TP - Insulators	38,500	0	38,500
001	085	001 - T&D Regular Labour	085 Design	1,500	0	1,500
001	085	001 - Regular Labour (No AO)	085 Design	240	0	240
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	36,080	0	36,080
011	087	011 - Travel Expense	087 Field Super.& Ops.	10,000	0	10,000
			Total Cost:	303,055	0	303,055
			Original Cost:	48,086		

Location: **Transmission**
CI# / FP#: 43222
Title: 2013 Transmission Substation Insulator and Cutout Replacements
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (no AO)	Lot	1	$ 240.00	$ 240.00		
1.2	Electrician Labour	Person Day	[redacted]	[redacted]	$ 36,047.23		
1.3	Site Supervision	Lot	1	$ 36,080.00	$ 36,080.00		
1.4	Design Labour	Lot	1	$ 1,500.00	$ 1,500.00		
1.5							
				Sub-Total	$ 73,867.23		
2	**012 Materials**						
2.1	Insulators and Cutouts	Lot	1	12017	$ 12,017.00		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 12,017.00		
3	**011 Travel Expenses**						
3.1	Accomodations	day	616	125	$ 77,000.00		
3.2	Truck Rental	month	5	2000	$ 10,000.00		
3.3					$ -		
				Sub-Total	$ 87,000.00		
4	**041 Meals and Entertainment**						
4.1	Meals	lot	1	38500	$ 38,500.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 38,500.00		
5	**094 Interest Capitalized**						
5.1	Interest	lot	1	7529.67	$ 7,529.67		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 7,529.67		
6	**095 Administrative Overhead**						
6.1	Labour AO		1	53,784.63	$ 53,784.63		
6.2	Vehicle AO		1	30,356.51	$ 30,356.51		
6.3	Contract AO		1				
6.4							
				Sub-Total	$ 84,141.14		
Cost Estimate				**Total**	$ 303,055.04		
7	**Original Cost**				$ 48,086.00		
7.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43323

Title: **Tufts Cove Line Swap**

Start Date: 2013/01
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $266,923

DESCRIPTION:

This project is required to relieve generation constraints at Tufts Cove, allowing more economic gas fired generation to be dispatched for a wider range of load levels. Swapping line terminals of L-6003 and L-6040 will permit an increase in net output of 91H-Tufts Cove of 85 MW.

Summary of Related CIs +/- 2 years:
No projects for 2011, 2012, 2013, 2014 & 2015

JUSTIFICATION:

Justification Criteria: Transmission

Sub Criteria: Overloaded Equipment

Why do this project?

The loss of circuit breaker 91H-605 (breaker fault or breaker-backup scheme) results in the loss of L-6003 plus L-6007, overloads L-5003 plus L-6014 with high generation at 91H-Tufts Cove at system load levels less than 1600 MW (82% of the time). Swapping line terminals of L-6003 and L-6040 will eliminate this contingency and permit an increase in net output of 91H-Tufts Cove of 85 MW.

This project is required to relieve generation constraints at Tufts Cove, allowing more economic gas fired generation to be dispatched for a wider range of load levels.

Why do this project now?

Current forecasts provide that natural gas prices are expected to remain economic until at least 2015, resulting in continued out-of-merit generation costs. The load at 58H-Imperial Oil may decrease if the refinery is closed or converted to a storage facility, which increases the net export from Tufts Cove.

Why do this project this way?

Preliminary economic analysis has determined that this is the cheapest alternative. The proposed alternative will not eliminate all congestion, but will provide relief to approximately 85 MW of restricted Tufts Cove generation.

A portion of the labour associated with this project will be sourced through NS Power’s existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power’s workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 43323 - Tuft's Cove Line Swap

Project Number

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin.

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		4,372	0	4,372
092		092-Vehicle T&D Reg. Labour AO		16,190	0	16,190
094		094 - Interest Capitalized		9,377	0	9,377
095		095 - T&CS Regular Labour AO		7,581	0	7,581
095		095-COPS Regular Labour AO		28,685	0	28,685
095		095-COPS Overtime Labour AO		7,747	0	7,747
095		095-COPS Contracts AO		17,714	0	17,714
001	022	001 - T&CS Regular Labour	022 - GTG - Elec Contr.Equip.	24,267	0	24,267
001	022	001 - Regular Labour (No AO)	022 - GTG - Elec Contr.Equip.	1,000	0	1,000
002	022	002 - T&D Overtime Labour	022 - GTG - Elec Contr.Equip.	8,423	0	8,423
012	022	012 - Materials	022 - GTG - Elec Contr.Equip.	4,800	0	4,800
066	022	066 - Other Goods & Services	022 - GTG - Elec Contr.Equip.	20,514	0	20,514
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	4,287	0	4,287
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	8,575	0	8,575
012	039	012 - Materials	039 - DP - O/H Cond.	3,500	0	3,500
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	53,694	0	53,694
001	085	001 - T&D Regular Labour	085 Design	30,770	0	30,770
011	085	011 - Travel Expense	085 Design	555	0	555
028	085	028 - Consulting	085 Design	6,000	0	6,000
041	085	041 - Meals & Entertainment	085 Design	450	0	450
001	086	001 - T&D Regular Labour	086 Commissioning	4,211	0	4,211
002	086	002 - T&D Overtime Labour	086 Commissioning	4,211	0	4,211
			Total Cost:	266,923	0	266,923
			Original Cost:			

Location: Distribution
CI# / FP#: 43323
Title: Tuft's Cove Line Swap
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (No AO)	Hr	[redacted]		$ 1,000.00		
1.2	Electrician/Technician	Person Day	[redacted]		$ 29,498.09		
1.3	Power Line Technician	Person Day	[redacted]		$ 4,306.80		
1.4	T&D Engineering	Hr	[redacted]		$ 14,048.32		
1.5	CADD Operators	Hr	[redacted]		$ 8,265.15		
1.6	Technologists	Hr	[redacted]		$ 7,416.65		
1.7							
				Sub-Total	$ 64,535.00		
2	**002 Overtime Labour**						
2.1	Electrician/Technician (Switching)	Person Day	[redacted]		$ 12,633.38		
2.2	Power Line Technician (Switching)	Person Day	[redacted]		$ 8,575.62		
2.3					$ -		
				Sub-Total	$ 21,209.00		
3	**012 Materials**						
3.1	Control Cable	m	[redacted]		$ 4,800.00	Engineering Estimate	
3.2	Overhead Conductor	m	[redacted]		$ 3,500.00		
3.3							
				Sub-Total	$ 8,300.00		
4	**013 COPS Contracts**						
4.1	Line Work	Hr	[redacted]		$ 53,694.00	2013 Contract Rate	
4.2					$ -		
				Sub-Total	$ 53,694.00		
5	**028 Consulting**						
5.1	Engineering Consultant	Hr	[redacted]		$ 6,000.00		
5.2					$ -		
				Sub-Total	$ 6,000.00		
6	**011 & 041 Travel and Meal Expenses**						
6.1	Mileage	Km	1500	0.37	$ 555.00		
6.2	Meals	Each	15	30	$ 450.00		
6.3					$ -		
				Sub-Total	$ 1,005.00		
7	**066 Other**						
7.1	Project Contingency (i.e. Substation Materials)	Lot	1	20514	$ 20,514.00	~10% of Project Total	
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 20,514.00		
8	**094 Interest Capitalized**						
8.1	Interest	Lot	1	9377	$ 9,377.00		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 9,377.00		
9	**095 Administrative Overhead**						
9.1	Contract AO	Lot	1	$ 17,714.00	$ 17,714.00		
9.2	Labour AO	Lot	1	$ 44,013.00	$ 44,013.00		
9.3	Vehicle AO	Lot	1	$ 20,562.00	$ 20,562.00		
				Sub-Total	$ 82,289.00		
Cost Estimate				**Total**	$ 266,923.00		
10	**Original Cost**						
10.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

CI Number: 43287

Title: **2C-Port Hastings- Retire 2C-T1 & T2 and 69kV & 25kV Buses**

Start Date: 2013/01
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $266,691

DESCRIPTION:

The scope of this project is to retire and remove the 69-25kV supply transformer 2C-T2, along with the 69kV supply breaker 2C-513 and the two 25kV reclosers (2C-401 & 402). It also includes the retirement of the 139-69kV auto-transformer 2C-T1, along with the two other 69kV supply breakers 2C-511 & 512 which are the normal and backup supply breakers for the 69kV line L-5503 to 22C Cleveland. This 69kV line is also being retired, due to age related deterioration, in CI 43204.

The original (c. 1964) supply breaker to 2C-T1 (2C-651) was replaced in 1987 and will be left in place until it can be better determined whether a 138-25kV transformer and a 25kV distribution bus may need to be added to the 2C substation.

Summary of Related CIs +/- 2 years
2013 CI 43204 L5503 Retirement $402,387

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Maintenance

Why do this project?

This project is required to retire equipment that has reached the end of its service life and has been, or is being, functionally replaced in a different way. The existing 69kV and 25kV bus structure and two of the 69kV breakers are believed to have been constructed in 1961. The remaining equipment was installed in 1964, except for breaker 2C-513, which was installed in 1971, likely replacing pre-existing fuses.

In addition, the 2C-T1 auto-transformer is required to replace a similar sized unit in the 75W-Westhavers Elbow substation, which has a failed on-load tap changer (OLTC); and which cannot be repaired due to obsolescence of that model of OLTC.

The 2C-T2 transformer and the 25kV reclosers, which are still in serviceable condition, will become spares. All other equipment will be scraped.

Why do this project now?

Almost all of this equipment, including the wood pole structure, is deteriorated and is being retired as it is being functionally replaced in another way.

NS Power has experienced a failure of one of the 69kV PTs as well as a long duration, reliability incident caused by an electrical insulation failure on terminal blocks in a deteriorated outdoor CT junction box.

Why do this project this way?

This project is being carried out in this way because the 69kV source bus at the 2C-Port Hastings substation is an isolated remnant of the 69kV transmission that once existed on Cape Breton Island. As this older 69kV infra-structure has been gradually converted to 138kV when it reached the end of its serviceable life, it makes more technical and economic sense to retire this equipment rather than replace it at the 2C-Port Hastings substation.

This project will be completed by NS Power and third party contractors.

CI Number : 43287 - 2C-Port Hastings- Retire 2C-T1 & T2 and the 69kV & 25kV Buses **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		2,134	0	2,134
092		092-Vehicle T&D Reg. Labour AO		26,611	0	26,611
095		095-COPS Overtime Labour AO		3,782	0	3,782
095		095-COPS Regular Labour AO		47,149	0	47,149
095		095-COPS Contracts AO		22,763	0	22,763
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	5,033	0	5,033
002	022	002 - T&D Overtime Labour	022 - TP - Elec Contr.Equip.	0	0	0
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	18,453	0	18,453
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	0	0	0
066	043	066 - Other Goods & Services	043 - TP - Substn Dev.	15,870	0	15,870
001	044	001 - T&D Regular Labour	044 - TP - Substn.Transf.	34,557	0	34,557
002	044	002 - T&D Overtime Labour	044 - TP - Substn.Transf.	10,354	0	10,354
011	044	011 - Travel Expense	044 - TP - Substn.Transf.	2,990	0	2,990
013	044	013 - COPS Contracts	044 - TP - Substn.Transf.	69,000	0	69,000
041	044	041 - Meals & Entertainment	044 - TP - Substn.Transf.	1,495	0	1,495
001	086	001 - T&D Regular Labour	086 Commissioning	6,500	0	6,500
002	086	002 - T&D Overtime Labour	086 Commissioning	0	0	0
			Total Cost:	266,691	0	266,691
			Original Cost:	113,356		

Location: Distribution
CI# / FP#: 43287
Title: 2C-Port Hastings- Retire 2C-T1 & T2 and 69kV & 25kV Buses
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	001 Regular Labour						
1.1					$ -		
1.2	Electrician Labour (Wire Disconnection)	Person Day	[redacted]		$ 5,033.00		
1.3	Electrician Labour (Breakers)	Person Day			$ 18,453.00		
1.4	Electrician Labour (Transformer)	Person Day			$ 34,557.00		
1.5	Electrician Labour (Commissioning)	Person Day			$ 6,500.00		
				Sub-Total	$ 64,543.00		
2	002 Overtime Labour						
2.1							
2.2	Electrician Labour (Transformer)	Person Day	[redacted]		$ 10,354.00		
2.3							
				Sub-Total	$ 10,354.00		
4	013 COPS Contracts						
4.1	Transformer Loading, Transport Off Loading, Placement	Lot	1	69000	$ 69,000.00		
				Sub-Total	$ 69,000.00		
5	011 & 041 Travel and Meal Expenses						
5.1	Travel Expenses	Day	29	103.1	$ 2,990.00		
5.2	Meal Expenses	Day	29	51.6	$ 1,495.00		
5.3					$ -		
				Sub-Total	$ 4,485.00		
5	066 Other Expenses						
5.1	Boom Truck Rental	Hour	[redacted]		$ 6,800.00		
5.2	Transportation for Disposal (Oil, Breakers)	Lot			$ 7,070.00		
5.3	Gravel to fill Pole holes	Lot			$ 2,000.00		
				Sub-Total	$ 15,870.00		
6	094 Interest Capitalized						
6.1	Interest		0	0	$ -		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ -		
7	095 Administrative Overhead						
7.1	Contract AO		1	22,763.16	$ 22,763.16		
7.2	Labour AO		1	50,930.48	$ 50,930.48		
7.3	Vehicle AO		1	28,745.48	$ 28,745.48		
				Sub-Total	$ 102,439.12		
Cost Estimate				**Total**	$ 266,691.12		
8	**Original Cost**						
8.1					$ 113,356.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

CI Number: 43487

Title: **Add Breaker Back-Up (BBU) Transfer Trip (TT) at 81V-Annapolis Hydro and 12V-Lequille Hydro**

Start Date: 2013/02
Final Cost Date: 2013/12
Function: Transmission
Forecast Amount: $255,850

DESCRIPTION:

The scope of this project is to install circuitry to initiate and deliver two, breaker back-up, transfer trip signals, one at each of 81V-Annapolis Hydro (to Paradise) and at 12V-Lequille Hydro (to Paradise). In the event that either of the circuit breakers on the HV side of the step-up generator transformer at these two stations (81V-501 or 12V-501) cannot trip, any protection activated trip signal will be extended to line L-5026 circuit breaker at Paradise (11V-504). This trip will then be repeated to the breaker at Gulch Hydro (13V-516) on the opposite end of line L-5026. The repeated trip signal will be via an existing communication link for protection scheme on line L-5026, which uses a technology called mirrored bits. The communication links between each of 81V & 11V and 12V & 11V will be via new, licensed frequency radios.

Summary of Related CIs +/- 2 years:
No projects for 2011,2012, 2013, 2014 & 2015

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: System Protection

Why do this project?

This project is required to provide for a failure to open in the circuit breakers connecting each of 81V-G1 and 12V-G1 to the 69kV system. If these breakers fail to operate, there is no way to stop these generators from continuing to feed the fault and the generators and plants could be severely damaged.

Why do this project now?

On Nov 23, 2011, an incident occurred at the 81V-Annapolis Hydro station. The 81V-501 breaker locked out, into an inoperative state due to a low SF6 gas pressure condition which was incorrectly detected. At the end of the tidal cycle, the automated shutdown controller sent a trip to this circuit breaker, which did not open, and then proceeded to shut the wicket gates, to trip the field breaker and to apply brakes to the machine which was now running as a motor. A called-out employee was able to reach the site quickly and operated the breaker manually, rather than requesting a trip of the line L5026. This incident, along with another similar incident involving a generator a few years previous has revealed a gap in some of NS Power’s protection schemes for a generator connected with a circuit breaker on the HV side of the step-up transformer - especially at 69kV, where breaker back-up schemes were not implanted as standard practice.

Why do this project this way?

The installation of a breaker back up scheme to trip upstream breakers that are supplying the dynamic energy into a fault is the only way to mitigate this risk. In addition a simple wiring change will be made to cause generator, circuit breakers to be tripped due to a low SF6 gas pressure condition, rather than having their operation blocked.

CI Number : 43487 - Add Breaker Back-Up (BBU) Transfer Trip (TT) at 81V-annapolis Hydro and 12V-Lequille Hydro **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		949	0	949
092		092-Vehicle T&D Reg. Labour AO		9,545	0	9,545
094		094 - Interest Capitalized		3,604	0	3,604
095		095-COPS Overtime Labour AO		1,681	0	1,681
095		095-COPS Contracts AO		1,214	0	1,214
095		095 - T&CS Regular Labour AO		9,695	0	9,695
095		095-COPS Regular Labour AO		16,911	0	16,911
066	001	066 - Other Goods & Services	001 - TP - Land	2,000	0	2,000
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	3,691	0	3,691
002	022	002 - T&D Overtime Labour	022 - TP - Elec Contr.Equip.	0	0	0
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	28,923	0	28,923
013	022	013 - COPS Contracts	022 - TP - Elec Contr.Equip.	3,680	0	3,680
001	061	001 - T&D Regular Labour	061 - TP - Switched Telecomm. Sys	18,117	0	18,117
002	061	002 - T&D Overtime Labour	061 - TP - Switched Telecomm. Sys	4,602	0	4,602
012	061	012 - Materials	061 - TP - Switched Telecomm. Sys	110,814	0	110,814
001	085	001 - T&CS Regular Labour	085 Design	31,033	0	31,033
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
028	085	028 - Consulting	085 Design	8,050	0	8,050
001	086	001 - T&D Regular Labour	086 Commissioning	1,342	0	1,342
002	086	002 - T&D Overtime Labour	086 Commissioning	0	0	0
			Total Cost:	255,850	0	255,850
			Original Cost:			

Location:
CI# / FP#: 43487
Title: Add Breaker Backup at 81V and 12V
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	Person Day	[redacted]		$ 21,808.00		
1.2	Commissioning	Person Day	[redacted]		$ 1,342.00		
1.3			[redacted]		$ -		
1.4			[redacted]		$ -		
1.5			[redacted]		$ -		
1.6	Engineering (P.Eng)	hr	[redacted]		$ 20,680.13		
1.7	CADD Operators	hr	[redacted]		$ 4,830.97		
1.8	Technologists	hr	[redacted]		$ 5,521.90		
1.1					$ -		
				Sub-Total	$ 54,183.00		
2	**012 Materials**						
2.1	Radio Link, Converter, Alarm monitoring, Protection Panels	Lot	1	139737	$ 139,737.00		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 139,737.00		
3	**013 T&D Contracts**						
3.1	Install Control Cables	Lot	1	3680	$ 3,680.00		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 3,680.00		
4	**002 Overtime Labour**						
4.1	Electrician	Person Day	[redacted]		$ 4,602.00		
4.2							
4.3					$ -		
				Sub-Total	$ 4,602.00		
5	**028 Consulting**						
5.1	Consulting	Lot	1	8050	$ 8,050.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 8,050.00		
6	**066 Other Goods and Services**						
6.1	066 Other Goods and Services	Lot	1	2000	$ 2,000.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 2,000.00		
7							
7.1					$ -		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ -		
8	**094 Interest Capitalized**						
8.1	Interest	Lot	1		$ 3,603.75		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 3,603.75		
9	**095 Administrative Overhead**						
9.1	Labour AO	Lot	1	28286.69	$ 28,286.69		
9.2	Vehicle AO	Lot	1	10493.44	$ 10,493.44		
9.3	Contract AO	Lot	1	1214.04	$ 1,214.04		
				Sub-Total	$ 39,994.17		
Cost Estimate				**Total**	$ 255,849.92		
10	**Original Cost**						
10.1					$ -	No Original Cost	

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43291

Title: **Protection Risk Reduction 67N-Onslow 230KV**

Start Date: 2013/10
Final Cost Date: 2014/12
Function: Transmission
Forecast Amount: $2,416,341

DESCRIPTION:

This project is to upgrade the protection system at 67N-Onslow (230kV) to comply with Northeast Power Coordinating Council (NPCC) bulk power system protection risk reduction plan. The estimated useful life of protection systems is approximately 40 years.

Depreciation Class:
Transmission Plant Station Equipment

Summary of Related CIs +/- 2 years:
2013 43292 20H Brushy Hill Protection Upgrades 230kV $1,834,292
2014 CI TBD 3C-Port Hastings Upgrades 230kV $TBD
2015 CI TBD 88S-Lingan Upgrades 230kV $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: System Protection

Why do this project?

On August 30, 2010, NPCC requested a Mitigation Plan for bulk power system (BPS) facilities that lack a second set of protective relays on a BPS element and/or second battery at a BPS substation. Nova Scotia Power has determined that four 230kV substations fall under the Mitigation Plan for bulk power and they are 120H-Brushy Hill 230kV, 67N-Onslow 230kV, 3C-Port Hastings 230kV and 88S-Lingan 230kV substations.

Why do this project now?

Implementation of all redundant protection and a second battery is required to be completed by the end of 2016. Because this work is significant, NS Power has chosen to complete the four stations requiring this upgrade over the next four year period. NS Power is planning to complete 120H-Brushy Hill 230kV by end of 2013, 67N-Onslow to be completed in the end of 2014, 3C-Port Hastings to be completed by end of 2015 and 88S-Lingan by the end of 2016.

Why do this project this way?

There is no other technical solution to comply with the bulk power system protection risk reduction plan. This project is required to comply with the NPCC request dated August 30, 2010, to submit to NPCC a Mitigation Plan for bulk power system (BPS) facilities that lack a second set of protective relays on a BPS element and/or a second battery at a BPS substation.

CI Number : 43291 - Protection Risk Reduction 67N-Onslow 230KV | **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. | **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		179,111	0	179,111
094		094 - Interest Capitalized		72,417	0	72,417
095		095-COPS Contracts AO		[redacted]	0	[redacted]
095		095-COPS Regular Labour AO		317,344	0	317,344
012	003	012 - Materials	003 - TP - Bldg.,Struct.Grnd.	139,020	0	139,020
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
001	022	001 - T&D Regular Labour	022 - TP - Elec Contr.Equip.	77,479	0	77,479
012	022	012 - Materials	022 - TP - Elec Contr.Equip.	397,710	0	397,710
013	022	013 - COPS Contracts	022 - TP - Elec Contr.Equip.	[redacted]	0	[redacted]
066	022	066 - Other Goods & Services	022 - TP - Elec Contr.Equip.	0	0	0
001	023	001 - T&D Regular Labour	023 - TP - Power Equip.-Station S	10,107	0	10,107
012	023	012 - Materials	023 - TP - Power Equip.-Station S	89,080	0	89,080
013	023	013 - COPS Contracts	023 - TP - Power Equip.-Station S	[redacted]	0	[redacted]
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	55,587	0	55,587
012	043	012 - Materials	043 - TP - Substn Dev.	100,000	0	100,000
001	061	001 - T&D Regular Labour	061 - TP - Switched Telecomm. Sys	9,264	0	9,264
012	061	012 - Materials	061 - TP - Switched Telecomm. Sys	29,263	0	29,263
013	061	013 - COPS Contracts	061 - TP - Switched Telecomm. Sys	[redacted]	0	[redacted]
001	085	001 - T&D Regular Labour	085 Design	148,281	0	148,281
001	085	001 - Regular Labour (No AO)	085 Design	5,250	0	5,250
028	085	028 - Consulting	085 Design	[redacted]	0	[redacted]
066	085	066 - Other Goods & Services	085 Design	185,521	0	185,521
001	086	001 - T&D Regular Labour	086 Commissioning	133,702	0	133,702
013	087	013 - COPS Contracts	087 Field Super.& Ops.	[redacted]	0	[redacted]
			Total Cost:	2,416,341	0	2,416,341
			Original Cost:			

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 43291
Title: Protection Risk Reduction 67N-Onslow 230KV
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician/ Technician	Person Day	[redacted]		$ 286,138.80		
1.2	Engineering (P.Eng)	Hour	[redacted]		$ 92,120.00		
1.3	Project Support Labour (No AO)	Hour	[redacted]		$ 5,250.00		
1.4	Technologist	Hour	[redacted]		$ 25,900.00		
1.5	CADD	Hour	[redacted]		$ 30,261.00		
1.6					$ -		
				Sub-Total	$ 439,669.80		
2	**012 Materials**						
2.1	Battery Charger	Each	1	[redacted]			41348
2.2	Battery Bank	Each	1	[redacted]			41348
2.3	Protection Panel	Each	4	[redacted]			41348
2.4	Other Substation Materials			140,553.20	$ 140,553.20		
2.5	Primary Equipment Modifications	Lot	1	183,000.00	$ 183,000.00		
2.6	Communication Panel & Materials	Lot	1	26,000.00	$ 26,000.00		
2.7	Grounding Material			[redacted]			
2.8	Control Building & Trench Material			[redacted]			
2.9	Metal Fabrication Material			[redacted]			
				Sub-Total	$ 755,073.00		
3	**013 T&D Contracts**						
3.1	Control Building & Trench	Contract	1	[redacted]			41348
3.2	Site Supervisor	Hour	[redacted]		$ 60,130.40		
3.3	Lift Equipment/ Metal Fabrication	Contract	1	[redacted]			
				Sub-Total	$ 293,560.10		
4	**028 Consulting**						
4.1	Design Consultants	Hours	[redacted]		$ 76,800.00	[redacted]	
4.2							
4.3							
				Sub-Total	$ 76,800.00		
5	**066 Other Goods and Services**						
5.1	Project Contingency		1	185,521.00	$ 185,521.00		
5.2					$ -		
5.3					$ -		
5.4					$ -		
				Sub-Total	$ 185,521.00		
6	**094 Interest Capitalized**						
8.1	Interest		1	72,416.85	$ 72,416.85		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 72,416.85		
9	**095 Administrative Overhead**						
9.1	Contracts AO		1	96,845.43	$ 96,845.43		
9.2	Labour AO		1	317,343.76	$ 317,343.76		
9.3	Vehicle AO		1	179,111.32	$ 179,111.32		
				Sub-Total	$ 593,300.51		
Cost Estimate				**Total**	$ 2,416,341.26		
10	**Original Cost**						
10.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

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Mitigation Plan for NPCC Bulk Power System Protection Risk Reduction

This Plan is being submitted in accordance with the NPCC Request dated August 30, 2010 (reference Attachment) to submit to NPCC a Mitigation Plan for bulk power system (BPS) facilities that lack either or both of the following two attributes:

1. lack of a second set of protective relays on a BPS element,
2. the lack of a second battery at a BPS substation.

Mitigation Plan Scope of Work

After reviewing the Task Force on System Protection (TFSP) survey completed in 2007-2008, Nova Scotia Power has determined that the following 230 kV substations have BPS facilities that lack a second battery or a second set of protective relays on a BPS element.

At 120H Brushy Hill a second set of bus protection relays will be installed on bus 120H-B71 and bus 120H-B72 and transformer protections will be added to 120H-T71 and 120H-T72. A second DC supply will also be added to this substation which will include a 125 V battery, a charger and a DC distribution panel with transfer capability.

At 67N Onslow a second set of bus protection relays will be installed on bus 67N-B5, 67N-B7 and 67N-B9 and transformer protection will be added to 67N-T71. The DC supply for the B protection schemes will be modified to ensure compliance with NPCC Directory #4 Section 5.8.

At 3C Port Hastings a second set of bus protection relays will be installed on bus 3C-B71 and bus 3C-B72 and transformer protections will be added to 3C-T71 and 3C-T72. The DC supply for the B protection schemes will be modified to ensure compliance with NPCC Directory #4 Section 5.8.

At 88S Lingan a second set of bus protection relays will be installed on bus 88S-B71 and bus 88S-B72 and transformer protections will be added to 88S-T71, 88S-T72, 88S-GT1, 88S-GT2, 88S-GT3 and 88S-GT4. A second DC supply will also be added to this substation which will include a 125 V battery, a charger and a DC distribution panel with transfer capability.

The estimated completion dates for these projects are as follows:

120H Brushy Hill – Q4 2013
67N Onslow – Q4 2014
3C Port Hastings – Q4 2015
88S Lingan – Q4 2016

NPCC, Inc.
NORTHEAST POWER COORDINATING COUNCIL, INC.
1040 AVE OF THE AMERICAS, NEW YORK, NY 10018 TELEPHONE (212) 840-1070 FAX (212) 302-2782

August 30, 2010

Members, Northeast Power Coordinating Council, Inc.

Re: Approved Implementation Plan for Bulk Power System Protection Risk Reduction

Ladies and Gentlemen:

This is to inform you that the Reliability Coordinating Committee (RCC) at the June 9, 2010 meeting approved the attached Implementation Plan for the Bulk Power System Protection Risk Reduction. As required in the Implementation Plan, affected Facility Owner that has identified bulk power system (bps) facility(ies) lacking either or both of the following two attributes:

1. lack of a second set of protective relays on a bps element,
2. the lack of a second battery at a bps substation.

must establish a mitigation plan and submit that plan to the NPCC Task Force on System Protection (TFSP) within 18 months of the approval of the Implementation Plan or by December 9, 2011; the mitigation plan must identify the time-period needed to acquire and install equipment to bring those existing facility(ies) in conformance with the following, with explanations of any delays beyond five years. Delays beyond five years must be approved by the RCC.

- For those stations which have only a single battery bank, add a second battery bank in accordance with the requirements of Section 5.8 of Directory #4, and
- For those **elements** whose **protection** does not include two independent sets of **protective relays**, add a second set of **protective relays**, and associated auxiliary relays (if used), that meet the required operating time consistent with Section 5.5 of Directory #4. The second set of **protective relays** and associated auxiliary relays shall be physically separated from the existing **protective relays**.

If you have BPS facilities lacking one or both of two attributes identified above, please submit a mitigation plan by December 9, 2011. TFSP maintains a record of the survey completed in 2007-2008 of facilities which were identified to be lacking one or both of these attributes and would be glad to review your facilities on the list. Your prompt attention and response to this request will be appreciated. Mitigation plan should be submitted to NPCC to the attention of Mr. Quoc Le at quoc@npcc.org.

Please do not hesitate to contact Quoc at 212-840-1070, Extension 4908 with any questions regarding this. Thank you for your assistance in this matter.

Yours very truly,

Bryan

Bryan Gwyn, Chairman
Task Force on System Protection

Attachment (1):
- Approved Implementation Plan for Bulk Power System Risk Reduction

CC: Members, Task Force on System Protection
Members, Reliability Coordinating Committee

Implementation Plan for Bulk Power System Protection Risk Reduction

RCC Approved - June 9, 2010

I. Introduction

At the request of the RCC, an assessment of all NPCC BPS facilities was conducted in 2007-2008. The result of this assessment was presented to the RCC at the March 4, 2009 and September 10, 2009 meetings. The predominant risk presented was judged to be due to the lack of two attributes: specifically, lack of a second set of protection relays, and the lack of a second battery. This implementation plan is intended to mitigate the identified higher risk protection attributes at these facilities but does not necessary imply conformance with all provisions of Directory 4.

II. Facility Owner Mitigation Plan

An affected Facility Owner that has identified BPS facility(ies) lacking either of the two attributes above, must establish a mitigation plan and submit that plan to the TFSP within 18 months of the approval of this Implementation Plan by the RCC; the mitigation plan must identify the time-period needed to acquire and install equipment to bring those existing facility(ies) in conformance with the following, with explanations of any delays beyond five years. Delays beyond five years must be approved by the RCC.

- For those stations which have only a single battery bank, add a second battery bank in accordance with the requirements of Section 5.8 of Directory #4, and
- For those **elements** whose **protection** does not include two independent sets of **protective relays**, add a second set of **protective relays**, and associated auxiliary relays (if used), that meet the required operating time consistent with Section 5.5 of Directory #4. The second set of **protective relays** and associated auxiliary relays shall be physically separated from the existing **protective relays**.

The affected Facility Owner must submit a Periodic Progress Report (see III Below) to the TFSP to demonstrate efforts and schedules to attain conformance with respect to the above attributes. Deviations from previously submitted schedules resulting in extension of the mitigation dates will be reported to the TFSP, who will submit the information to the RCC along with the Facility Owner’s explanations for the delays. Any previously approved plans with delays beyond five years must be re-approved by the RCC.

III. Periodic Progress Report

TFSP will report to the RCC regarding receipt of all necessary mitigation plans.

The Facility Owner must provide annual progress reports to the TFSP for monitoring of project schedules.

TFSP will forward a summary report to the RCC annually on the progress of the implementation plans, until those plans are complete.

Developed by Task Force on System Protection

Distribution

CI Number: 43258

Title: **2013 Off-Road to Roadside**

Start Date: 2013/04
Final Cost Date: 2013/12
Function: Distribution
Forecast Amount: $1,081,638

DESCRIPTION:

The Build-to-Roadside program is a multi-year program to relocate distribution line from off road to the roadside in various locations throughout the Province. The program is part of the overall customer reliability investment. A list of lines with off road sections that should be moved to roadside was developed to form the individual projects within this program. As detailed scoping is completed on a line, including obtaining NS Power easements, Aliant easements, necessary permits and other documentation, these projects are brought forward for execution. The following lines were identified as having off road sections that will have favorable reliability impacts when they are brought to roadside:

73W-411 Upper Branch Rd/Wagner Rd - 3.15 km
57C-426J Country Harbour Phase 2 - 4.1 km
57C-426J Country Harbour Phase 3 - 1.5 km
57C-426GA Goldboro Phase 3 - 4.6 km
57C-422 Salmon River Lake - 1.2 km
100C-422 Mulgrave Phase 2 - 3 km
590C-311 Lakeshore Dr - 5 km
4C-432 – St. Andrews - 2 km
58C-405 Margaree Forks - 4.5km

The estimated useful life of a distribution line is approximately 40 years.

Depreciation Classes:
Distribution Land Rights
Distribution Poles and Fixtures
Distribution Overhead Conductors and Devices

Summary of Related CIs +/- 2 years:
2011 Off Road to Roadside CI# 40227 - $2,500,000
2012 Off Road to Roadside CI# 41349 - $884,869
2014 CI TBD Off Road to Roadside $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Outage Performance

Why do this project?

This project will provide improved access to distribution circuits which are currently located in off road rights of way. Providing easier access to the distribution lines will reduce the time to identify the location of the fault during outage events improving the reliability of these feeder sections. Having the distribution line roadside also makes the regular maintenance activities more cost effective.

Why do this project now?

Moving distribution lines to roadside will improve the reliability of the system by reducing exposure of the physical plant to outages, reducing time for fault locating, and reducing restoration time.

Why do this project this way?

Relocating off road sections to the roadside improves access to the distribution plant and reduces the restoration time during outage events. The labour portion for this project is being sourced trough NS Power's existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 43258 - 2013 Offroad-to-Roadside

Project Number

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin.

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		46,595	0	46,595
094		094 - Interest Capitalized		17,924	0	17,924
095		095-COPS Regular Labour AO		82,556	0	82,556
095		095 - T&CS Regular Labour AO		547	0	547
095		095-COPS Contracts AO		173,633	0	173,633
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	2,500	0	2,500
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	64,753	0	64,753
002	035	002 - T&D Overtime Labour	035 - DP - Wood Poles	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	53,100	0	53,100
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	42,803	0	42,803
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	35,100	0	35,100
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	[redacted]	0	[redacted]
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	2,195	0	2,195
002	040	002 - T&D Overtime Labour	040 - DP - O/H Cond.Devices	0	0	0
012	040	012 - Materials	040 - DP - O/H Cond.Devices	1,800	0	1,800
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	[redacted]	0	[redacted]
066	040	066 - Other Goods & Services	040 - DP - O/H Cond.Devices	22,000	0	22,000
001	085	001 - T&CS Regular Labour	085 Design	1,750	0	1,750
001	085	001 - Regular Labour (No AO)	085 Design	1,800	0	1,800
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
011	085	011 - Travel Expense	085 Design	250	0	250
028	085	028 - Consulting	085 Design	2,500	0	2,500
041	085	041 - Meals & Entertainment	085 Design	250	0	250
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	3,263	0	3,263
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	1,081,638	0	1,081,638
			Original Cost:	309,409		

Location: Distribution
CI# / FP#: 43258
Title: 2013 Offroad To Roadside
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (No AO)	Lot	1	$ 1,800.00	$ 1,800.00		
1.2	Power Line Technician	Person Day	[redacted]		$ 109,750.40		
1.3	Site Supervision Labour	Lot	1	$ 3,263.08	$ 3,263.08		
1.4	Engineering Design Labour	Lot	1	$ 1,750.00	$ 1,750.00		
1.5					$ -		
				Sub-Total	$ 116,563.48		
2	**012 Materials**						
2.1	Poles	Lot	1	53100	$ 53,100.00		
2.2	Insulators, Cut-outs, etc	Lot	1	1800	$ 1,800.00	Work Order Generated	
2.3	Conductor	Lot	1	35100	$ 35,100.00		
2.4					$ -		
				Sub-Total	$ 90,000.00		
3	**013 T&D Contracts**						
3.1	EUS Labour	hour	[redacted]		$ 526,320.00		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 526,320.00		
4	**011 Travel Expenses**						
4.1	Travel	lot	1	250	$ 250.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 250.00		
5	**041 Meals and Entertainment**						
5.1	Meals	lot	1	250	$ 250.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 250.00		
6	**020 Royalties, Easements**						
6.1	Easements	Lot	1	2500	$ 2,500.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 2,500.00		
7	**066 Other Goods and Services and 028 Consulting**						
7.1	Contingency	Lot	1	22000	$ 22,000.00		
7.2	Consulting	Lot	1	2500	$ 2,500.00		
7.3					$ -		
				Sub-Total	$ 24,500.00		
8	**094 Interest Capitalized**						
8.1	Interest		1	17923.56	$ 17,923.56		
8.2							
8.3							
				Sub-Total	$ 17,923.56		
9	**095 Administrative Overhead**						
9.1	Contract AO		1	173632.95	$ 173,632.95		
9.2	Vehicle AO		1	46595.42	$ 46,595.42		
9.3	Labour AO		1	83103.04	$ 83,103.04		
9.4							
				Sub-Total	$ 303,331.41		
Cost Estimate				**Total**	$ 1,081,638.45		
10	**Original Cost**						
10.1					$ 309,409.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43126

Title: **13V-303 Bear River Targeted Feeder Replacements**
Start Date: 2013/02
Final Cost Date: 2013/04
Function: Distribution
Forecast Amount: $798,977

DESCRIPTION:

This project is part of a program to improve customer service and reliability, as measured by System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI) performance and deteriorated plant incidents on selected feeders throughout the Province. Specifically, deteriorated poles and conductor, porcelain arrestors, cutouts, rusty transformers and guys will be replaced.

Summary of Related CIs +/- 2 years:
No projects in 2011, 2012, 2013, 2014 and 2015

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Outage Performance

Why do this project?

This work is being undertaken as part of the overall customer reliability improvement investment. This is year four of a five year (2010-2014) plan to improve reliability to NS Power's customers. Distribution equipment (e.g. poles, conductor, cutouts, and transformers) failures are a primary driver of customer outages. This project will address distribution equipment issues on feeder section 13V-303, out of the Gulch Hydro Substation. This feeder section, which is approximately 167 km in length, was selected due to past performance, customer density and feeder length.

Why do this project now?

This feeder is included in the 2013 Reliability Investment Plan based on past performance, customer density and feeder length. It is expected that targeted replacements on 13V-303 will result in annual savings of approximately 1,043 customer hours of interruption.

Why do this project this way?

This project will address the distribution equipment weaknesses on this feeder. A portion of the labour associated with this project is being sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 43126 - 13V-303 Bear River Targeted Feeder Replacements

Project Number

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin.

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		888	0	888
095		095-COPS Contracts AO		180,942	0	180,942
095		095-COPS Regular Labour AO		1,573	0	1,573
013	002	013 - COPS Contracts	002 - DP - Land Rights	[redacted]	0	[redacted]
012	004	012 - Materials	004 - DP - Misc.Equipment	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	41	0	41
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
012	038	012 - Materials	038 - DP - Insulators	48,330	0	48,330
013	038	013 - COPS Contracts	038 - DP - Insulators	[redacted]	0	[redacted]
012	039	012 - Materials	039 - DP - O/H Cond.	5,000	0	5,000
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	[redacted]	0	[redacted]
012	040	012 - Materials	040 - DP - O/H Cond.Devices	1,463	0	1,463
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	[redacted]	0	[redacted]
012	041	012 - Materials	041 - DP - O/H Line Transf.	3,617	0	3,617
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	[redacted]	0	[redacted]
012	052	012 - Materials	052 - DP - Services	5,219	0	5,219
001	085	001 - Regular Labour (No AO)	085 Design	1,273	0	1,273
001	085	001 - T&D Regular Labour	085 Design	2,154	0	2,154
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
			Total Cost:	798,977	0	798,977
			Original Cost:	46,719		

Location: Distribution
CI# / FP#: 43126
Title: 13V-303 - Bear River - Targeted Feeder Replacements
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (No AO)	Lot	1	$ 1,273.42	$ 1,273.42		
1.2	Design Labour	Lot	1	$ 2,153.76	$ 2,153.76		
1.3							
1.4							
				Sub-Total	$ 3,427.18		
2	**012 Materials**						
2.1	Standard material Cutouts, LA, Transformers and Insulators	Lot	1	63670.93	$ 63,670.93	Work Order Generated	
2.2					$ -		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 63,670.93		
3	**013 T&D Contracts**						
3.1	EUS	Hour	[redacted]	[redacted]	$ 540,975.37	Contract Rate 2013	
3.2	Tree Trimming	Lot	1	[redacted]	[redacted]		
3.3	Site Remediation	Lot	1	[redacted]	[redacted]		
				Sub-Total	$ 548,475.37		
4	**094 Interest Capitalized**						
4.1					$ -		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ -		
5	**095 Administrative Overhead**						
5.1	Contract AO		1	$ 180,942.03	$ 180,942.03		
5.2	Labour AO		1	$ 1,573.32	$ 1,573.32		
5.3	Vehicle AO		1	$ 888.00	$ 888.00		
				Sub-Total	$ 183,403.35		
Cost Estimate				**Total**	$ 798,976.83		
6	**Original Cost**						
6.1					$ 46,718.63		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43201

Title: **2013 Halifax Underground Feeder Replacements**

Start Date: 2013/05
Final Cost Date: 2013/12
Function: Distribution
Forecast Amount: $770,794

DESCRIPTION:

This project is required to replace 2.2 km of 3 phase 25kV underground cable on the 1H-403 feeder between Scotia Square and Metro Center and a 1.7 km loop (also 1H-403) both ends of which are connected to the Metro Center switching center. This project is being completed by NS Power personnel.

Summary of Related Projects +/- 2 years:
2011 CI 40220 Halifax Underground Cable Replacement $418,861
2012 CI 41383 Halifax Underground Cable Replacement $596,760
2014 CI TBD Halifax Underground Cable Replacement $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Deteriorated Conductor

Why do this Project?

This work is being undertaken as part of the overall customer reliability improvement investment. This is year four of a five year (2010-2014) plan to improve reliability to NS Power's customers. This project is required to replace deteriorated underground 25kV cables and accessories in downtown Halifax.

Why do this project now?

This project is part of a plan to begin replacing cables installed 35 years ago, which have now reached the end of their useful life. The 1H-403 feeder serves a number of large customers in the downtown core area of Halifax such as Metro Center, Police Station, Marriot Hotel, Prince George Hotel, Halifax Library as well as a number of large residential and office buildings.

Why do this project this way?

Due to the age of the underground cables, a five year (2010-2014) replacement plan (Attachment 1) was developed and implemented. This is the most cost effective option to replace these assets.

CI Number : 43201 - 2013 Halifax Underground Feeder Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		59,588	0	59,588
094		094 - Interest Capitalized		18,067	0	18,067
095		095-COPS Regular Labour AO		105,575	0	105,575
095		095 - T&CS Regular Labour AO		3,149	0	3,149
095		095-COPS Contracts AO		32,990	0	32,990
001	046	001 - T&D Regular Labour	046 - DP - U/G Conductor	144,525	0	144,525
012	046	012 - Materials	046 - DP - U/G Conductor	291,000	0	291,000
013	046	013 - COPS Contracts	046 - DP - U/G Conductor	100,000	0	100,000
001	085	001 - Regular Labour (No AO)	085 Design	5,820	0	5,820
001	085	001 - T&CS Regular Labour	085 Design	10,080	0	10,080
			Total Cost:	770,794	0	770,794
			Original Cost:	117,701		

Location: Distribution
CI# / FP#: 43201
Title: Halifax Underground Feeder Replacements
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1							
1.2	Project Support Labour (No AO)	Lot	1	$ 5,820.00	$ 5,820.00		
1.3	NSP T&D Regular Labour	Lot	[redacted]		$ 144,525.00		
1.4	NSP Design Labour	Lot	1	$ 10,080.00	$ 10,080.00		
1.5							
1.6							
				Sub-Total	$ 160,425.00		
2	**012 Materials**						
2.1							
2.2	Underground cable, terminations etc	Lot	1	$ 291,000.00	$ 291,000.00		
2.3					$ -		
2.4					$ -		
2.5					$ -		
				Sub-Total	$ 291,000.00		
3	**013 Contracts**						
3.1	Flagging, Boom Truck Rental	Lot	1	$ 100,000.00	$ 100,000.00		
3.2							
3.3					$ -		
				Sub-Total	$ 100,000.00		
4	**094 Interest Capitalized**						
4.1	Interest Capitalized	lot	1	$ 18,067.00	$ 18,067.00		
4.2							
4.3							
				Sub-Total	$ 18,067.00		
5	**095 Administrative Overhead**						
5.1	COPS Contracts AO	lot	1	$ 32,990.00	$ 32,990.00		
5.2	COPS Regular Labour AO	lot	1	$ 105,575.00	$ 105,575.00		
5.3	T&CS Regular Labour AO	lot	1	$ 3,149.00	$ 3,149.00		
5-Jan	Vehicle T&D Reg. Labour AO	lot	1	$ 59,588.00	$ 59,588.00		
				Sub-Total	$ 201,302.00		
Cost Estimate				**Total**	$ 770,794.00		
6	**Original Cost**						
6.1					$ 117,701.00		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

PROJECT DESCRIPTION

Halifax Feeder Cable Replacement 2013

Year 4 of 5

Aleksei Kovalko
June 14, 2012

Table of Contents

1.0 Summary

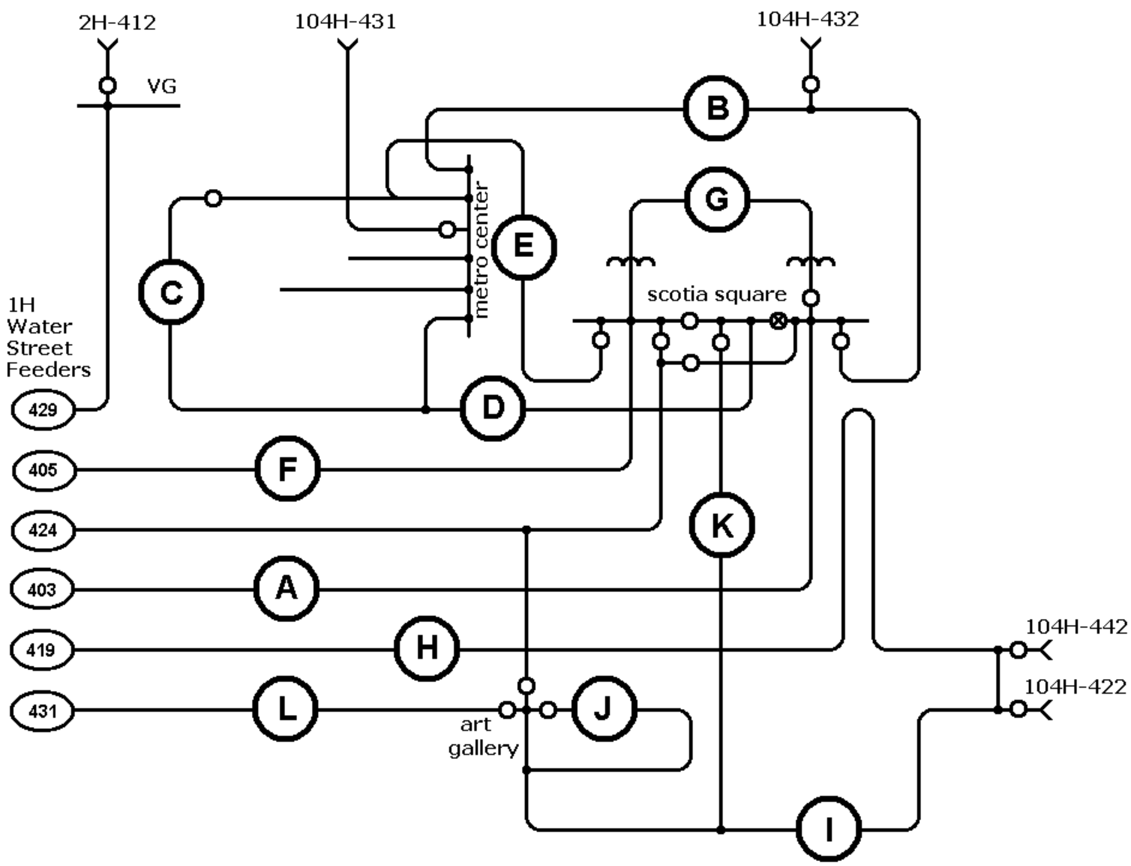
This project is a part of the five year plan to replace deteriorated underground 25kV cables and accessories in the Halifax Underground System. Cables installed in the early 1970's have now reached the end of their useful life estimated to be 35 years.

The Halifax underground system has been inventoried and studied in detail in the "Distribution Capital Investment Report Halifax 25 kV Underground System" by Aleksei Kovalko. This report recommends that the replacement project be carried out over the next 5 years and the required expenditures have been prioritized. This report has considered the age of plant, the loading of the system from PI data and the reliability to customers connected to the underground system. Consideration has been given to prolonging cable life by injection of chemicals into existing cables.

2.0 Overview of the Five Year Plan

Year 1, 2 and 3 – replace radial sections of the feeders 1H-403, 405, 419 and 431
Year 4 and 5 – replace loops and ties of the feeders 1H-403, 405 and 419

Fig.1 Feeder Sections for Replacement



2010

Section A: 1H-403 – radial section between 1H and 28H-416 Scotia Square (1,400 m)

Section F: 1H-405 – radial section between 1H and 28H-417 Scotia Square (1,440 m)

Old cable removals: Three out of service feeders 1H-243, 1H-246 and 1H-247 are to be removed between 1H and MH46 on Granville St (1000 m)

2011

Section H: 1H-419 - radial section between 1H and L431-401 Proctor St. (2,140 m)

Section I: 1H-419 – first half of the radial section between L431-404 and L431-211 Art Gallery Vault (645 m)

2012

Section L: 1H-431 – radial section between 1H and Art Gallery Vault (2,230 m)

Section I: 1H-419 – second half of the radial section between L431-404 and L431-211 Art Gallery Vault (645 m)

2013

Section B: 1H-403 – North Loop from 28H-410 to L431-229 Metro Center (2,240 m)

Section C: 1H-403 – Metro Center Loop from L431-230 to L431-232 (1,700 m)

2014

Section D: 1H-403 – Scotia Square 28H-415 to Grand Parade Vault (380 m)

Section E: 1H-403 – Scotia Square 28H-411 to Metro Center L431-230 (410 m)

Section G: 1H-405 – 23kV loop (1,900 m)

Section K: 1H-419 – Tie to Scotia Square (240 m)

3.0 2013 Plan

Step 1 - 1H-403 – North Loop from 28H-410 to L431-229 Metro Center (2,240 m)

This feeder section will include the following route:
Scotia Square 28H-410, MH32, MH39, MH41, MH42, MH43, MH126, MH43, MH102, MH103, Police Station, Citadel Hotel, MH103, MH102, MH43, MH42, MH41, MH39, MH38, MH40, MH38, MH116, MH38, MH37, MH36, Metro Center L431-229.

Step 2 - 1H-403 – Metro Center Loop from L431-230 to L431-232 (1,700 m)

This feeder section will include the following route:
Metro Center L431-230, MH36, MH110, MH114, Prince George vault, MH114, MH124, Cambridge vault, MH124, MH131, MH132, MH117, MH115, MH109, Grand Parade vault, MH33, MH34, MH35, MH123, MH35, MH36, Metro Center L431-232.

4.0 Labor

4.1 Basic Assumptions:

- One underground crew includes 4 technicians.

- A basic length of 3 phase cable would normally consist of 1, 2 or 3 runs between two electrically adjacent cable accessories. The cable runs can be: manhole-to-manhole, manhole-to-vault, vault-to-vault and in some cases riser pole to manhole.

- One crew can install in one regular day:
  a) one basic length of three 750 kcmil cables, no terminations *
  b) 2 basic lengths of triplexed cable, no terminations.
  c) 1 basic length of triplexed cable and terminate one end.
  d) 6 cable terminations
  e) one primary service loop (one basic length), terminate both ends reconnect.

- Also one crew can do in one regular day:
  a) Remove three old cables from one manhole-to-manhole length. Two manholes to be entered, switching included.
  b) Switch from old to new pre-installed and pre-terminated length of cable, remove the old cable. Phase the cable.

- For simplicity the above installation steps can be further combined into person-days (PD) per basic length of cable (installation + termination + switching + removal):
  a) 750 kcmil three 1 phase cables: [redacted]

- One eight hour person-day with overhead is calculated as follows:
  [redacted]

- As a rule of thumb, every second manhole shoukld require cable splicing.

* - 1.5 crew (6 people) is required for pulling two MH-to-MH lengths at once.

4.2 Labor Estimates:

Cable removal – 144 PD
Cable installation – 192 PD
Terminations – 93 PD
Total – 429 PD

5.0 Materials

Table 5.1
Per unit cost of materials:

#	Description	NSPI Code	$$
1	Primary cable 750 kcmil Al, 28 kV	113418	$20/m
2	Basic Shielded Elbow 25 kV	114627	$76.87/ea
3	Cable Adapter #750, Compact	137137	$15.84/ea
4	Connecting Plug 25 kV	116390	$79.26/ea
5	Basic Insulating Plug	122317	$46.29/ea
6	Conductor Contact, #750 Compact	156260	$33.17/ea
7	Constant Force Spring	114624	$13.56/ea
8	Braid Flexible Tinned	124141	$7.98 /ft
9	Arm, Cable support 10”	157934	$23/ea
10	Arm, Cable support 14”	157935	$26/ea
11	Termination Kit. (above items 2, 3, 5, 6)	160730	$132/ea
12	Grounding Kit for LC shield cable	160780	$46/ea

Table 5.2
Schedule of materials for one three phase separable deadfront cable-to-cable connection:

#	Description	NSPI Code	QTY
1	Termination Kit (see Table 5.1 for details)	160730	6
2	Connecting Plug 25 kV	116390	3
3	Grounding Kit for LC shield cable	160780	6

Table 5.3
Schedule of materials for one three phase deadfront switch-to-cable connection:

#	Description	NSPI Code	QTY
1	Termination Kit (see Table 5.1 for details)	160730	3
2	Grounding Kit for LC shield cable	160780	3

The materials for this project will be ordered based on the following considerations:

a. Ten percent is added to known cable length for making terminations and waste.
b. Sixteen (16) three phase cable-to-cable splices are required
c. Fourteen (14) three phase cable-to-equipment connections are required
d. Each underground manhole or vault will require two cable support brackets per feeder. There are two bracket sizes: 10 inches and 14 inches. A 10 inch bracket will hold 3 cables; 14 inch bracket will hold either three cables or three T-splices.

Table 5.4
Materials to be ordered in October - November 2011

#	Description	NSPI Code	QTY
1	Cable XLPE, LC shield, #750, aluminum	113418	13,000 m
2	Termination Kit (see Table 5.1 for details)	160730	186
3	Connecting Plug 25 kV	116390	39
4	Grounding Kit for LC shield cable	160780	186
5	Multi-mount cable support bracket, Underground Devices Inc, 14 inch, MM14	157935	80

DISTRIBUTION CAPITAL INVESTMENT REPORT
HALIFAX 25 kV UNDERGROUND SYSTEM

Draft
October 05, 2009

DRAFT

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APPENDIX A – Cable Lengths and Available Ducts
APPENDIX B – Primary Service Cables
APPENDIX C – Splices and Terminations
APPENDIX D – Art Gallery Tie (Details)
APPENDIX E – Deadfront Splice Specifications for 750 kcmil Cable

DRAFT

1.0 SUMMARY

Objective

The purpose of this report is to identify the requirements necessary to perform the cable replacement program in Downtown Halifax.

Scope

The scope of the report is limited to 25 kV feeders interconnected around the pole-free area of Downtown Halifax. The main components of the report are: overview of the present system configuration, review of the historic load check, cable inventory and categorization, review of manhole configurations and availability of spare ducts, basic feeder contingency assessment, system improvement proposals, budgeting and timelines. The existing 4 kV underground distribution system, substation contingencies and justifications for new feeder(s) are not covered in the report.

Recommendations

This report recommends that the replacement project be carried out over the next 5 years. The required expenditures have been prioritized. This report has considered the age of plant, the loading of the system from PI data and the reliability to customers connected to the underground system. Consideration has been given to prolonging cable life by injection of chemicals into existing cables.

Also, the report recommends two system improvement options that are necessary to improve the existing switching flexibility by establishing two new tie links. These changes should be made prior to the cable replacement program.

2.0 PRESENT SYSTEM CONFIGURATION

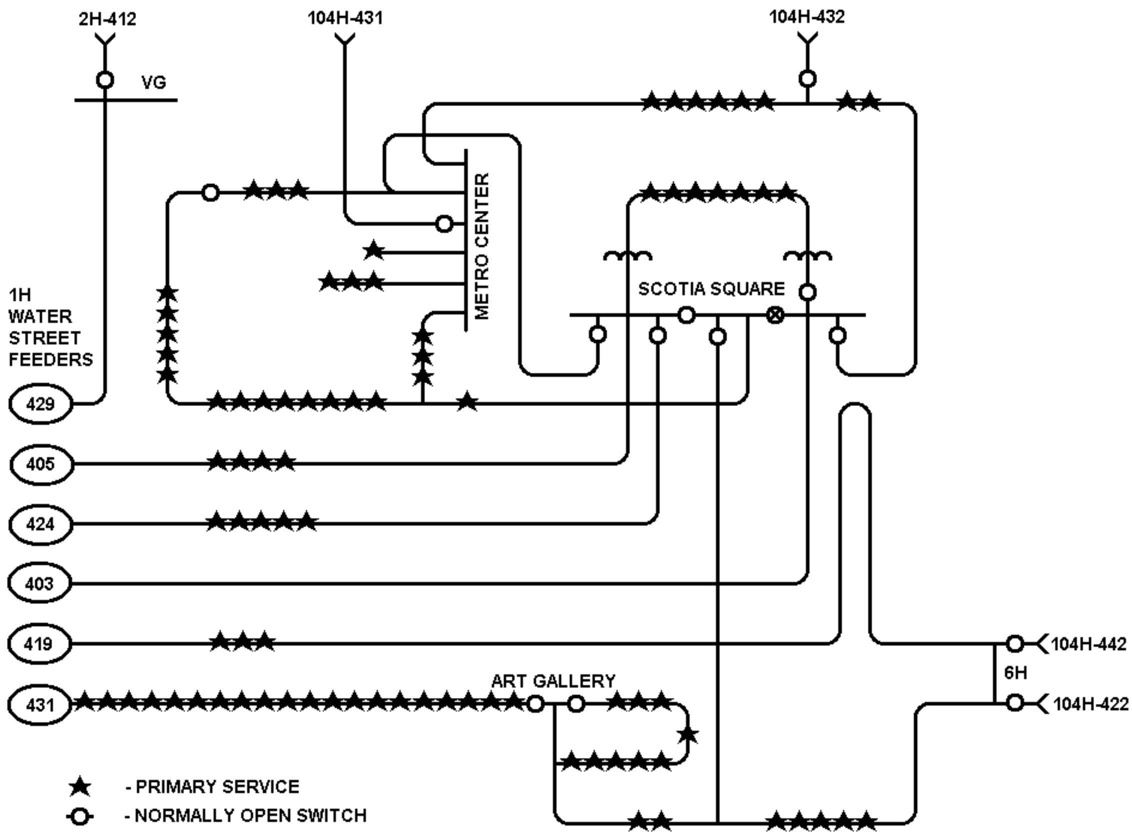


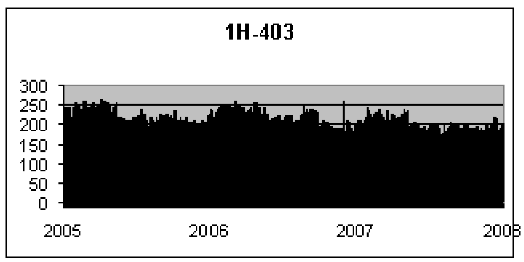
Fig. 2.1 Simplified Feeder Diagram

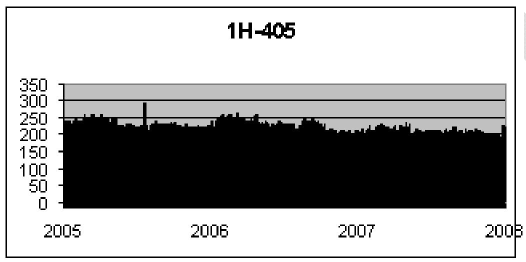
The diagram on Fig. 2.1 is a simplified combination of an electrical single line diagram and a geographical layout of the Halifax UD system. For simplicity, only open points are shown (except for the one at Scotia Square).

2.1 UNDERGROUND FEEDER PROFILES

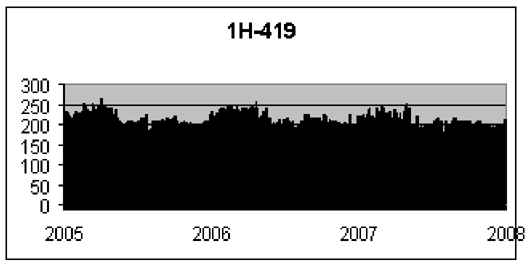
The feeder profiles below describe each of the six underground feeders in a uniform format that will allow for easy comparison and quick reference further in the report. The underground feeders are: 1H-403, 1H-405, 1H-419, 1H-424, 1H-429 and 1H-431

1 of 6

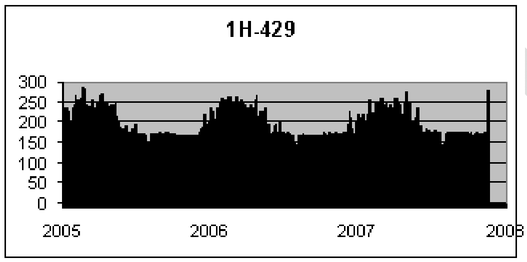
1H-403 FEEDER PROFILE			
Scotia Square / Metro Center			
Total feeder length (including services)	7.8 km		
Built	1970’s		
Route	Water, Sackville, Granville, Duke, 28H, Barrington, Agryle, Grafton, Market, Brunswick, Cogswell.		
Installed MVA	23		
Interties with feeders	1H-405, 1H-419, 104H-432, 104H-431		
Loops	Two		
Stepdowns	689H		
Primary services	CS431-048, 170, 139, 197, 184, 185, 198, 487, 510, 428, 036, 429, 637, 531, 430, 150, 227, 211, 162, 154, 001, 182, 270, 426, 046, 144, 143, 265, 216, 244, 573, 402		
Load profile for the last 3 years ending June 1, 2008.			
Underground Cable	Part of feeder	Conductor size [kcmil],[AWG]	Length, 3ph [m]
	Main radial	750	1780
	Loops	750	2240
		500	180
		350	1550
	Ties	750	230
		500	180
	Primary services	750	90
		350	100
		3/0	1110
		1/0	470
		#1	100

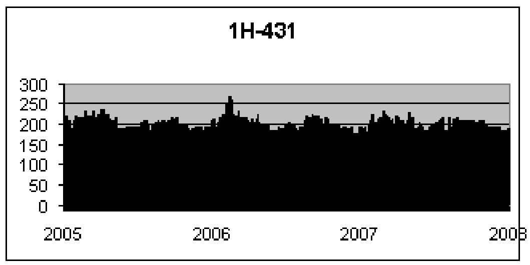
<table>
<tr><th colspan="4">1H-405 FEEDER PROFILE</th></tr>
<tr><th colspan="4">Scotia Square</th></tr>
<tr><td>Total feeder length (including services)</td><td colspan="3">3.8 km</td></tr>
<tr><td>Built</td><td colspan="3">1970’s</td></tr>
<tr><td>Route</td><td colspan="3">Water, Sackville, Granville, Duke, Scotia Square, Market, Cogswell</td></tr>
<tr><td>Installed MVA</td><td colspan="3">14 (approx.)</td></tr>
<tr><td>Interties with feeders</td><td colspan="3">1H-403, 1H-424</td></tr>
<tr><td>Loops</td><td colspan="3">One</td></tr>
<tr><td>Stepdowns</td><td colspan="3">28H-T26</td></tr>
<tr><td>Primary services</td><td colspan="3">CS431-007, 427, 005, 012, 507, 508, 481, 506</td></tr>
<tr><td>Load profile for the last 3 years ending June 1, 2008.</td><td colspan="3">


</td></tr>
<tr><td></td><td colspan="3"></td></tr>
<tr><td rowspan="8">Underground Cable</td><td>Part of feeder</td><td>Conductor size [kcmil],[AWG]</td><td>Length, 3ph [m]</td></tr>
<tr><td>Main radial</td><td>750</td><td>1470</td></tr>
<tr><td rowspan="4">23 kV loop</td><td>750</td><td>160</td></tr>
<tr><td>350</td><td>1380</td></tr>
<tr><td>4/0</td><td>180</td></tr>
<tr><td>#1</td><td>340</td></tr>
<tr><td rowspan="2">Primary services</td><td>3/0</td><td>170</td></tr>
<tr><td>#1</td><td>10</td></tr>
</table>

1H-419 FEEDER PROFILE			
Joseph Howe Bldg./ Proctor Street			
Total feeder length (including services)	5.4 km		
Built	1970's		
Route	Water, Sackville, Granville, Duke, 28H, Hollis, 6H, Upper Water		
Installed MVA	14		
Interties with feeders	1H-403, 1H-431, 104H-422, 104H-442		
Loops	One		
Stepdowns	622H		
Primary services	CS431-351, 138, 196, 053, 268, 183, 272, 140, 004, 142, 047, 279, 011, 141, 169		
Load profile for the last 3 years ending June 1, 2008.			
Underground Cable	Part of feeder	Conductor size [kcmil],[AWG]	Length, 3ph [m]
	Main radial	750	2140
	Loop	750	1290
		4/0	490
		3/0	640
	Tie	750	240
	Primary services	750	30
		3/0	100
		#1	50

1H-424 FEEDER PROFILE			
Water Street/Scotia Square			
Total feeder length (including services)	2.0 km		
Built	2003		
Route	Water, Granville, Duke, 28H		
Installed MVA	3.9		
Interties with feeders	1H-405		
Loops	N/A		
Stepdowns	N/A		
Primary services	CS431-516, 493, 247, 485, 566, 567		
Load profile	No Load Profile Available		
Underground Cable	Part of feeder	Conductor size [kcmil],[AWG]	Length, 3ph [m]
	Main radial	750	1600
	Primary services	350	270
		3/0	350
		#1	150

1H-429 FEEDER PROFILE			
V.G. Hospital			
Total feeder length (including services)	2.2 km		
Built	1990's		
Route	Water, Morris, 10H		
Installed MVA	11.2		
Interties with feeders	2H-412		
Loops	N/A		
Stepdowns	10H-T1 VG - North Bus		
Primary services	N/A		
Load profile for the last 3 years ending June 1, 2008.			
Underground Cable	Part of feeder	Conductor size [kcmil],[AWG]	Length, 3ph [m]
	Main radial	750	2200

<table>
<tr><th colspan="4">1H-431 FEEDER PROFILE</th></tr>
<tr><th colspan="4">Downtown U/G</th></tr>
<tr><td>Total feeder length (including services)</td><td colspan="3">3.9 km</td></tr>
<tr><td>Built</td><td colspan="3">1970's</td></tr>
<tr><td>Route</td><td colspan="3">Morris, Hollis, Salter, Water, Bedford Row, Prince</td></tr>
<tr><td>Installed MVA</td><td colspan="3">17.5</td></tr>
<tr><td>Interties with feeders</td><td colspan="3">1H-419, 1H-415(o/h), 1H-427(o/h)</td></tr>
<tr><td>Loops</td><td colspan="3">N/A</td></tr>
<tr><td>Stepdowns</td><td colspan="3">610H Bedford Row</td></tr>
<tr><td>Primary services</td><td colspan="3">CS431-205, 345, 554, 002, 497, 498, 148, 580, 674, 165, 049, 261, 217, 220, 271, 401, 608, 450, 054</td></tr>
<tr><td>Load profile for the last 3 years ending June 1, 2008.</td><td colspan="3">
</td></tr>
<tr><td></td><td colspan="3"></td></tr>
<tr><td rowspan="4">Underground Cable</td><td>Part of feeder</td><td>Conductor size [kcmil],[AWG]</td><td>Length, 3ph [m]</td></tr>
<tr><td>Main radial</td><td>750</td><td>2130</td></tr>
<tr><td rowspan="2">Primary services</td><td>3/0</td><td>280</td></tr>
<tr><td>350</td><td>270</td></tr>
</table>

2.2 LOAD CHECK SUMMARY

FEEDER PEAK LOAD HISTORY 2004 - 2008

Halifax peninsular feeders of interest		2008*		2007		2006		2005		2004	
		PI	Load Check	PI	Load Check	PI	Load Check	PI	Load Check	PI	Load Check
Underground feeders	1H- 431	230	213	250	223	270	298	240	286	240	303
	1H-419	220	-	250	196	260	230	260	240	290	258
	1H-403	220	203	240	222	260	273	270	227	270	250
	1H-405	220	210	250	220	270	275	270	283	255	230
	1H-424**	-	60	-	70	-	70	-	70	-	80
	1H-429	180	-	270	184	270	257	280	261	260	247
Overhead Feeders intertied with u/g feeders	1H-415	360	-	375	283	340	326	390	320	350	240
	1H-427	230	230	260	238	260	267	260	220	250	220
	104H-413	250	253	250	330	280	330	250	360	340	350
	104H-431	350	350	260	243	270	271	280	250	340	330
	104H-432	280	343	275	365	280	288	350	351	160	271
	104H-422	230	206	300	253	275	277	275	280	230	267
	104-442	280	284	290	309	240	287	270	253	310	309
	2H-412	350	331	350	345	350	334	350	357	330	332
	2H-413	300	295	300	336	290	242	260	379	300	255

* - Period ending June 1, 2008
** - Evaluated based on installed kVA

3.0 FEEDER CONTINGENCIES

The purpose of this contingency categorization is to help identify feeders with switching limitations and to help draw the line between “Possible” and “Practical” as applied to a planned power outage to a part of the system. In other words even if the power can be restored after a system failure, the same technique may not always be justifiable for a planned outage.

3.1 CONTINGENCY DEFINITIONS

Contingency A – Transferring open point(s) in the loop of the same feeder. This is the preferred way of managing planned and unplanned outages.

Contingency B – Simple switching by transferring open point between two adjacent feeders of the same source (substation). Backup feeder loading is a possible limiting factor.

Contingency C – Transferring open point between two feeders from two independent substations. Limiting factors: feeder loading, substation capacity, temporary abnormal configuration of the backup feeder, possible issues with paralleling, more complicated switching procedures.

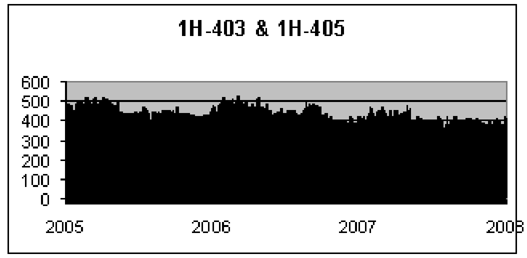
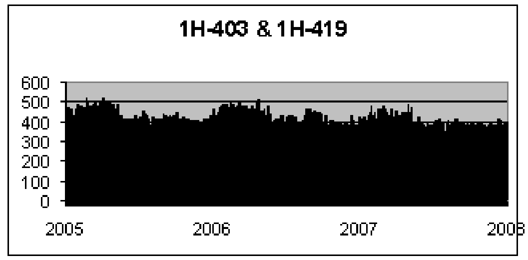
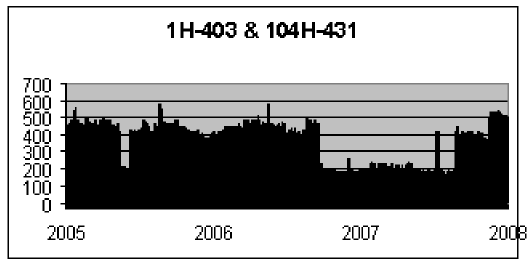
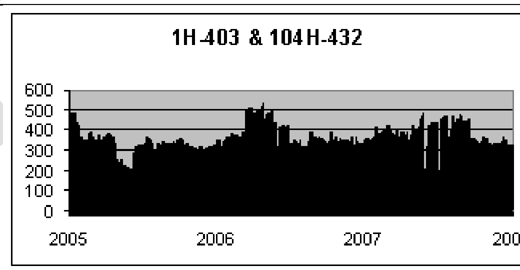
Contingency D – Cascade offloading. (a) Same as Contingency B or C but the backup feeder needs to be offloaded first to a third feeder. (b) Splitting load between two adjacent feeders.

3.2 CONTINGENCY OPTIONS

The following summaries are to give an overview of the available switching options. Contingency A options are only available for feeders with loops and only for the loop part of the feeder. This option is not shown in the summaries.

Contingency D options are only shown for the feeders with limited switching options B and C.

Not all of the D- options can be shown due to a high number of open/closed switch combinations.

1H-403 CONTINGENCY OPTIONS		
Backup feeder	**1H-405**	
Total load [A]	490/440	
Switching device	L431-412	
Contingency type	B	
Comment	This option can be marginal during summer peaks	
Backup feeder	**1H-419**	
Total load [A]	490/420	
Switching device	28H-413	
Contingency type	B	
Comment	Very similar to 1H-405	
Backup feeder	**104H-431**	
Total load [A]	500/465	
Switching device	L431-233 Metro Center	
Contingency type	C	
Comment	Combined load can be close to 500 A -load check is recommended	
Backup feeder	**104H-432**	
Total load [A]	575/570	
Switching device	D4A15364	
Contingency type	C	
Comment	Available but load check is recommended	
Backup feeder	**1H-419** offloaded to 1H-431 sw# L431-177	No Profile Available
Total load [A]	310/350 estimated	
Switching device	28H-413	
Contingency type	D	
Comment	Limiting factor: 1H-431 peaks at 430/380	
Backup feeder	Split between **104H-431 & 104H-432**	No Profile Available
Total load [A]	TBD as required	
Switching device	TBD as required	
Contingency type	D	
Comment	Available	

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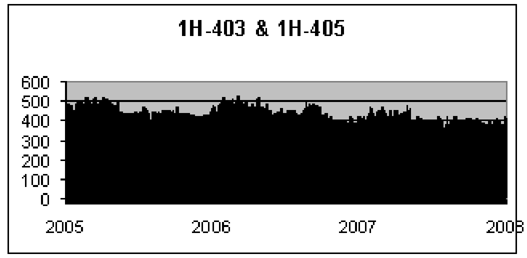
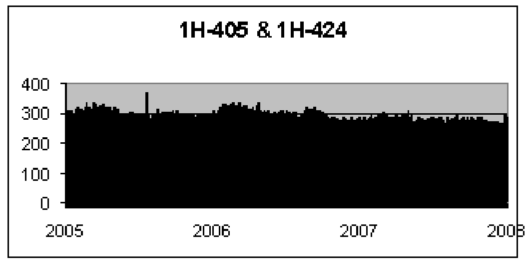
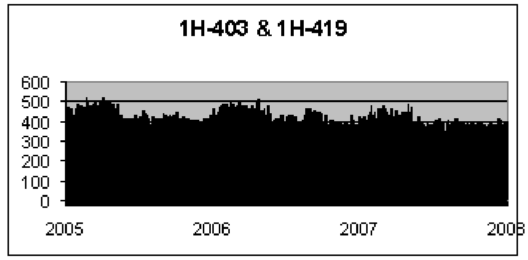
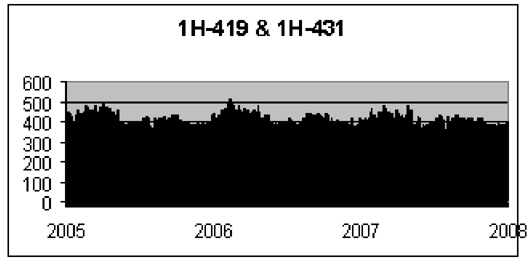
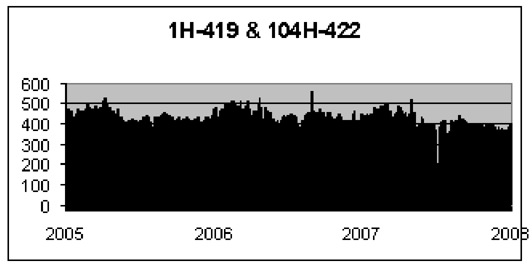
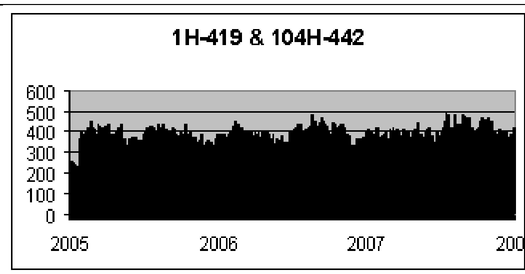
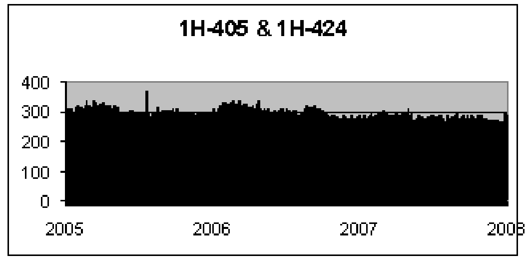
1H-405 CONTINGENCY OPTIONS		
Backup feeder	**1H-403**	
Total load [A]	490/440	
Switching device	L431-412	
Contingency type	B	
Comment	This option can be marginal during summer time	
Backup feeder	**1H-424**	
Total load [A]	290/320	
Switching device	28H-447	
Contingency type	B	
Comment	Available. 1H-424 load is estimated to be 70 A.	

1H-419 CONTINGENCY OPTIONS		
Backup feeder	**1H-403**	
Total load [A]	490/320	
Switching device	28H-413	
Contingency type	B	
Comment	Possible but load check is recommended before switching	
Backup feeder	**1H-431**	
Total load [A]	510/440	
Switching device	L431-210 Art Gallery	
Contingency type	B	
Comment	Load check is recommended before switching	
Backup feeder	**104H-422**	
Total load [A]	600/500	
Switching device	6H-410	
Contingency type	C	
Comment	Most of the time >400 A. Marginal	
Backup feeder	**104H-442**	
Total load [A]	560/490	
Switching device	6H-430	
Contingency type	C	
Comment	Available, but load check is recommended before switching	
Backup feeder	Split between 1H-431 & one the above	No Profile Available
Total load [A]	TBD as required	
Switching device	TBD as required	
Contingency type	D	
Comment	Available	

4 of 6

1H-424 CONTINGENCY OPTIONS		
Backup feeder	**1H-405**	
Total load [A]	290/320	
Switching device	28H-447	
Contingency type	B	
Comment	1H-424 load is estimated to be 70 A.	

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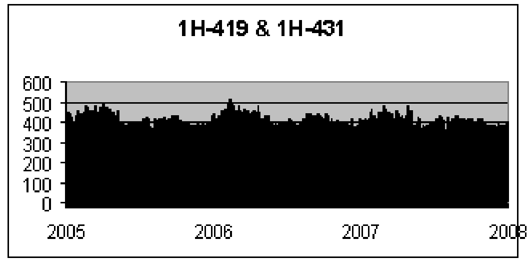
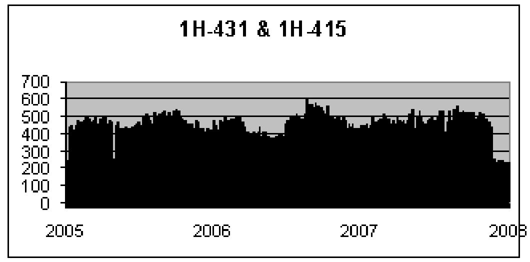
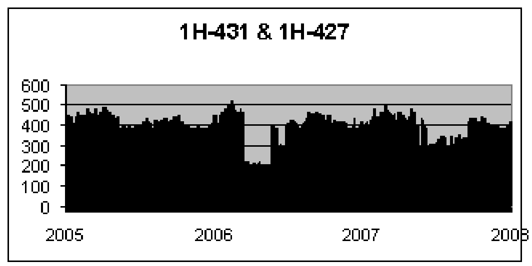
1H-429 CONTINGENCY OPTIONS		
Backup feeder	Split between 2H-412 and 104H-413	1H-429 is an express feeder to the stepdown 10H-T1 North Bus of VG Hospital. At full capacity the load is 260A.
Total load [A]	TBD as required	
Switching device	TBD as required	
Contingency type	D	
Comment	This backup option can be marginal during summer peaks.	

1H-431 CONTINGENCY OPTIONS		
Backup feeder	**1H-419**	
Total load [A]	510/440	
Switching device	L431-210 Art Gallery	
Contingency type	B	
Comment	Load check is recommended before switching	
Backup feeder	**1H-415**	
Total load [A]		
Switching device	D431-184 Hollis/Morris	
Contingency type	B	
Comment	The intertie switch is close to the substation. Very limited backup options for 1H-431	
Backup feeder	**1H-427**	
Total load [A]		
Switching device	D431-266 Hollis/Morris	
Contingency type	B	
Comment	The intertie switch is close to the substation. Very limited backup options for 1H-431	

3.3 OBSERVATIONS

<u>1H-403</u>
There are several switching options but none of them are straightforward. All of the options can be marginal during summer peaks.

<u>1H-405</u>
Feeder 1H-424 is a reliable backup for 1H-405.

<u>1H-419</u>
There are several options. During summer time the simple options become questionable. Splitting the load between 1H-431 and 1H-403 or 104H-422 would be the next option.

<u>1H-424</u>
Feeder 1H-405 is a reliable backup for 1H-424. New feeder.

<u>1H-429</u>
Complicated switching to offload the 10H-T1 transformer between 2H-412 and 104H-413. The load situation at 4 kV is expected to improve and therefore the above offloading should become more reliable. There is a suspicion of a collapsed ductbank on Morris St. The work to clarify on this issue is in progress (Summer 2008). This feeder is relatively new.

<u>1H-431</u>
The only simple backup option for this feeder is 1H-419. This option becomes questionable during summer months. For improved switching flexibility this feeder may require additional intertie. See 4.1 for details. This may be especially important considering the overhead section of the feeder that is exposed at the intersection of Hollis and Morris St.

To summarize the above:
- Feeders 1H-405 and 1H-424 have reliable backup.
- Feeders 1H-403, 1H-419 and 1H-429 have conditional backup options. An effort should be made to improve it.
- Feeder 1H-431 has a questionable backup option. There is a risk of extended outage. Additional backup alternative(s) need to be developed.

4.0 SYSTEM IMPROVEMENTS

4.1 ART GALLERY TIE

To improve the backup options for feeders 1H-431 and 1H-419 a new tie connection is recommended between the Art Gallery vault and feeder 1H-424 in manhole #13 on Lower Water Street. This will create a simple and reliable contingency option for the above two feeders which can also be used for a cable replacement/injection or cable treatment program.

The new feeder configuration will require extending nine 100 mm ducts (3-in, 3-out, 3-spare) from MH56 to the Art Gallery vault. See Fig. 4.2 and Appendix 4 for more details. There are ducts available in the existing ductbank between MH13 and MH56 to install six 750 kcmil cables. The total length of the new cable extension is approximately 60 meters.

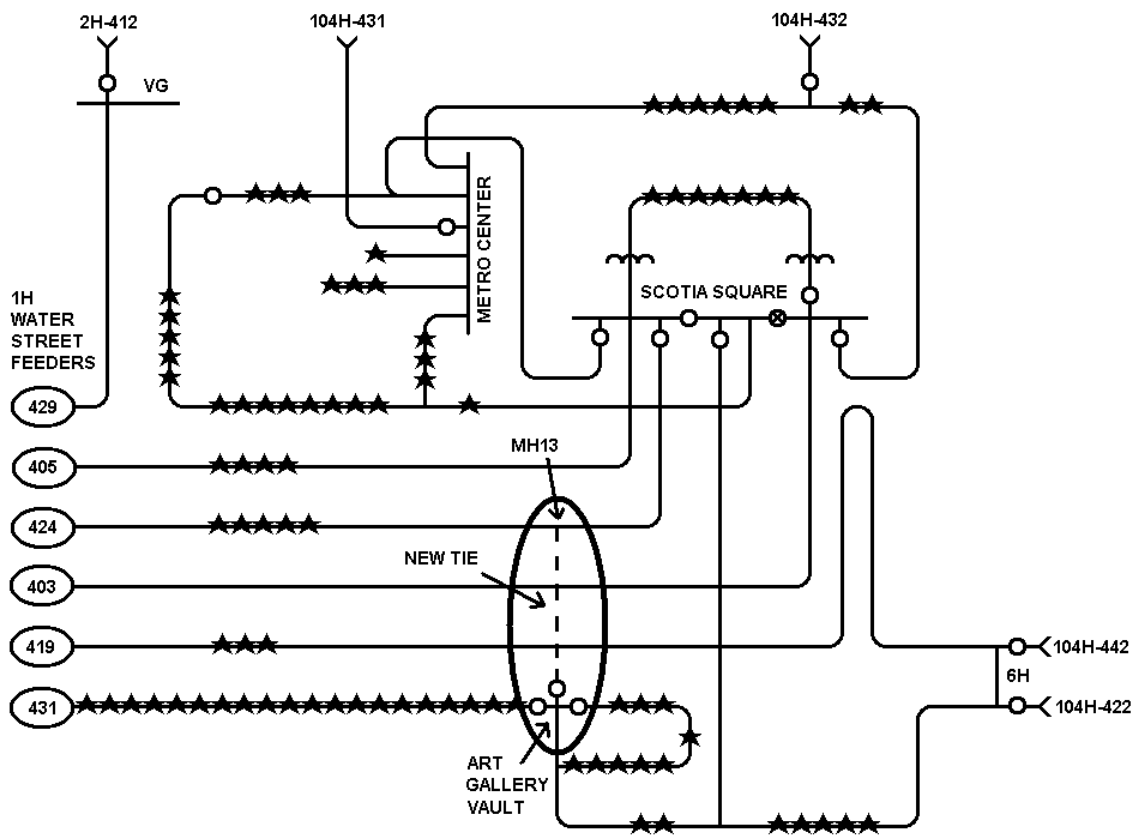


Fig. 4.1 New intertie between Art Gallery vault and MH13

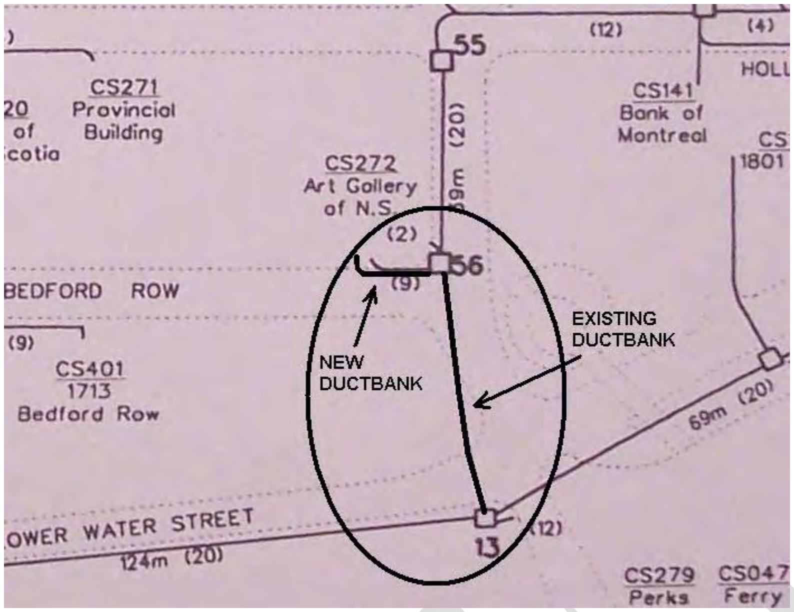


Fig. 4.2 Ductbank Layout

4.2 SCOTIA SQUARE TIE

The main purpose of this proposal is to improve the backup options of the feeder 1H-403. The idea is to use the existing 3-way Vista switch at the Scotia Square vault as a universal tie for 1H-403, 1H-405 and 1H-424 feeders that will allow paralleling them in any combination. At the moment the switch is underutilized and is serving as a connection point between 1H-405 and 1H-424.

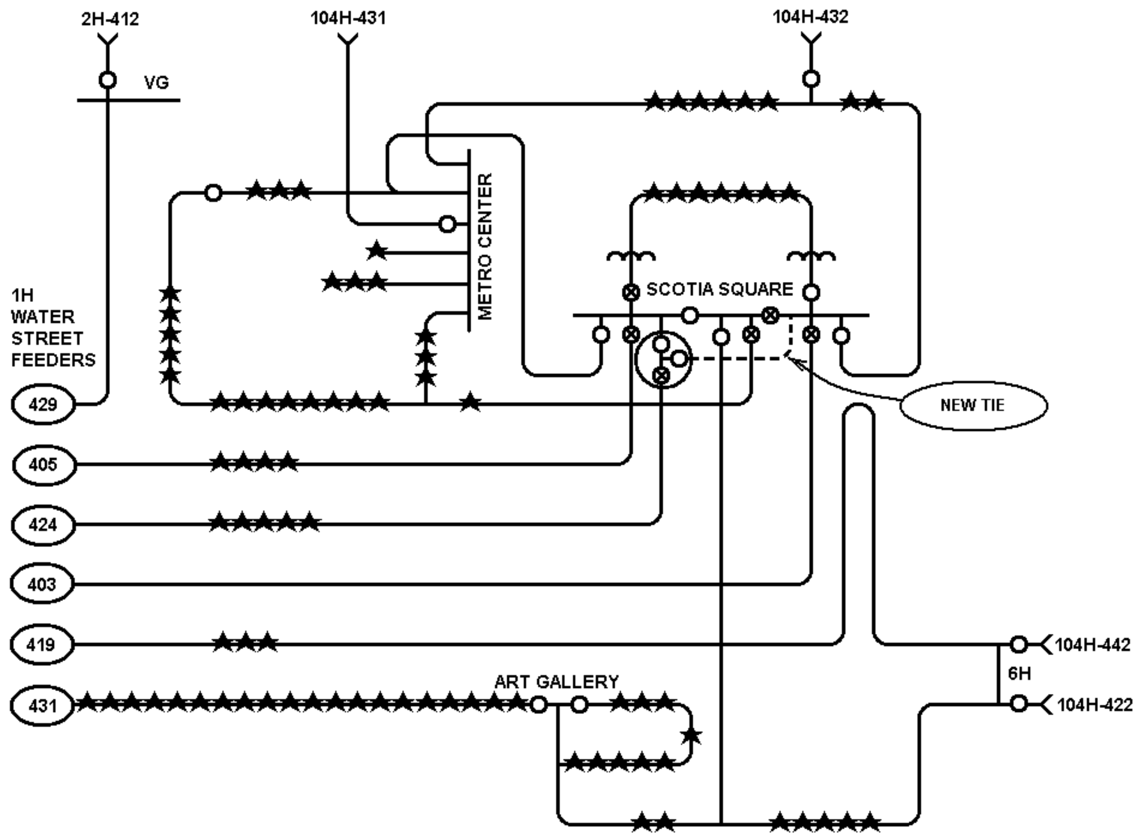


Fig. 4.7 New Connection in the Scotia Square vault

Fig. 4.8

Fig. 4.9

The switch 28H-449 can be connected to one of the following devices that are on the same bus of the 28H substation: 28H-410, 28H-416, 28H-414 or 28H-445
The exact point of connection needs to be determined.

4.3 OTHER SYSTEM IMPROVEMENT OPTIONS

4.3.1 Configuration Improvements of 1H-431

Converting the o/h portion of the feeder 1H-431 would benefit the reliability of the Halifax underground system. There are six riser poles around the intersection of Hollis and Morris Streets that are exposed to traffic and weather. Also, there is a number of flying taps (two sets), quick sleeves, inline switches, communication loops and 4 kV lines sharing the same poles. The top circuits on each of the three poles on Fig. 4.10 are the feeder 1H-431.

Fig. 4.10 Intersection of Hollis and Morris St.

This project would mostly involve extending the ductbank on Hollis Street from manhole #59 (Bushop/Hollis) to #60 (Morris/Hollis) which are approximately 120 meters apart and a new manhole in the middle of the block with a submersible switch in it. The switch is required for two primary services: Waterford Apartments CS431-554 and Prince Matthew's Apartments CS431-480 and also to replace the functionality of the existing set of inline switches D431-394. Two or three overhead services would have to be converted as well.

This part of the feeder is situated within the boundaries of the existing pole-free area. This conversion would have to be supported by the HRM as a continued commitment of the current cost sharing agreement with NSPI. A new development in the area may help to trigger this process.

4.3.2 Cable Upgrades

There are two potential bottlenecks in the existing system that may be considered for an upgrade. The purpose is to increase the conductor size to the full size feeder (750 kcmil) between the Metro Center and Scotia Square and between the riser pole on Cogswell St (feeder 104H-432) and Scotia Square.

See paragraphs 5.3.1 (B) and 5.3.1 (E) further in the text for details. With the existing ductbank configuration only one of the two can be implemented.

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5.0 CABLE REPLACEMENT

5.1 Cable Lengths

Table 5.1

Total Feeder Section Lengths [m]							
Part of Feeder	Cable Size	1H Underground Feeders					
		403	405	419	424	429	431
Radial	750	1780	1440	3430	1600	2200	2130
	500	-	-	-	-	-	-
Loop	750	2240	160	-	-	-	-
	500	180	-	-	-	-	-
	350	1550	1380	-	-	-	-
	4/0	-	180	490	-	-	-
	3/0	-	-	640	-	-	-
	#1	-	170	-	-	-	-
Tie	750	230	-	240	-	-	-
	500	-	180	-	-	-	-
Primary Service	350	100	-	-	-	-	-
	3/0	1260	130	100	350	-	270
	#1	-	10	50	-	-	280
Total without/with services		5980/ 7340	3510/ 3650	4800/ 4950	1600/ 1950	2200	2130/ 2680

Note:

1. The above numbers are 3 phase lines, not individual conductors
2. For detailed summary on feeder sections see Appendix A
3. For detailed summary on primary service cables see Appendix B

Summary:

The total length underground feeders including primary services (6 feeders): 22770 m
Same for the feeders over 30 years old (4 feeders) – 18620 m
This includes the feeder sections:

a) Radial – 8780 m
b) Loops – 6990 m
c) Ties – 650 m
d) Primary services – 2200 m

5.2 Cable Accessories

The following cable accessories will be referenced to in tables 5.2, 5.3 and Appendix C:
S – Splice, general.
T – 600 A deadbreak termination
LF – Life front termination
L – 200 A loadbreak elbow
SA – Support arm, 14" multi-mount, Underground Devices Inc, MM14,

Table 5.2

Accessories per Feeder								
Cable Accessory	1H-403		1H-405		1H-419		1H-431	
	Feeder	Service	Feeder	Service	Feeder	Service	Feeder	Service
S	9	-	9	-	9	-	2	-
T	31	27	24	9	20	13	21	14
LF	31	7	36	-	15	4	2	4
L	0	33	-	9	-	11	-	14
SA*	60	-	34	-	60	-	26	-

* - the number of support arms is estimated based on the approximate number of passes through manholes for feeder cables only.

Table 5.3

Total Accessories		
Cable Accessory	Feeder	Service
S	25	-
T	96	67
LF	84	15
L	0	67
SA	180	-
Total	385	149

Note that the accessories are shown here as three phase devices, therefore for the actual number of single phase units needs to be tripled.

5.3 Feeder Sections

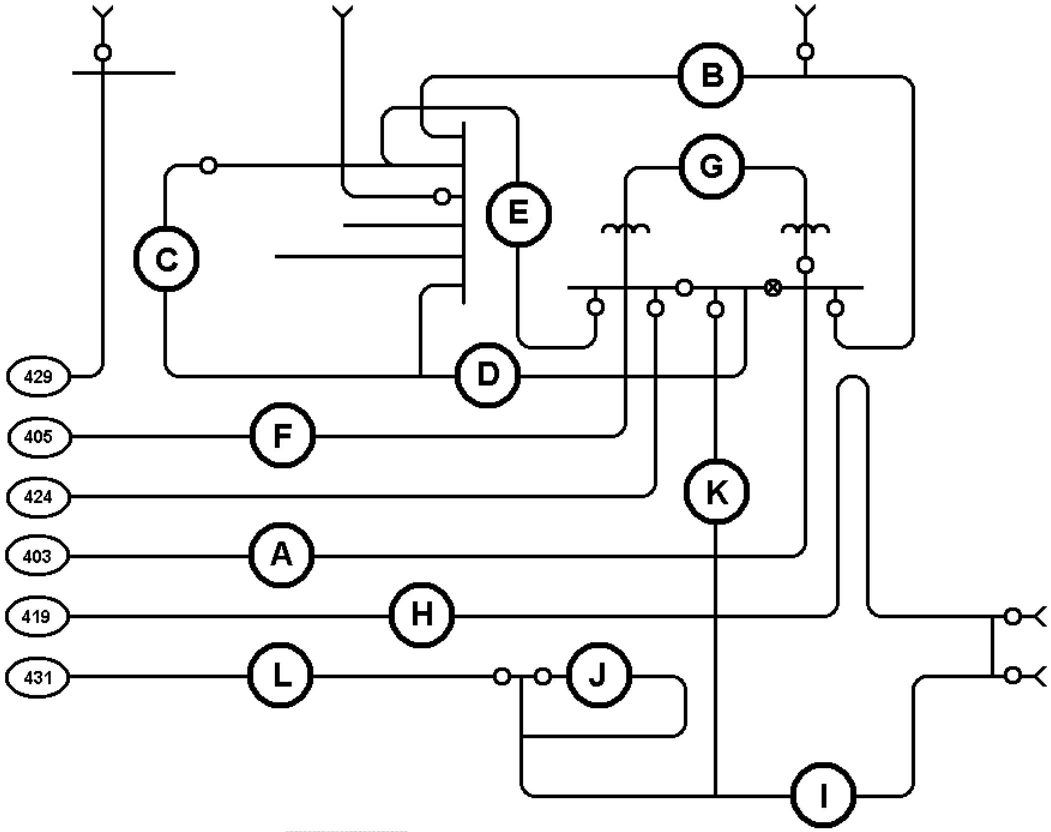

Fig. 5.3 Feeder Sections for Replacement

5.3.1 FEEDER 1H-403 (A, B, C, D, E)

(A) 1H-403 – Main Radial from 1H to 28H-416

The replacement of this part of the feeder can be approached in two ways:

Option 1
Use an alternative supply for 1H-403 (See 3.2 Contingency Options). Deenergize the radial part of the feeder between 1H and 28H-416 (approx. 1.4 km) and replace it.

Option 2
Remove the old 4 kV cables 1H-243, 1H-246 and 1H-247 (#500, 3 phase PILC) along the Lower Water, Sackville and Granville Streets between 1H and MH46 (1 km). Install new cables in the freed-up ducts while the existing feeder cables are still in service. Then extend the new cables from MH46 to MH47 and further to MH125 and MH26. This is approximately 90 % of the radial section of the feeder. The remaining short run from MH26 – MH28 – MH32 to 28H does not have enough free ducts. Therefore, one of the alternative supplies will be used for the duration of the cable replacement.

Advantages of this option: a) minimizes the use of alternative supply b) one kilometer of ducts becomes available for cascade replacement of two more feeders c) old equipment is removed and salvaged.

This cable may contain PCB. Federal and provincial legislation and regulations regulate the management of PCBs. Refer to the Environmental Management Strategy for Oil-Filled Equipment ENV-2.05 (Environmental Binder) for proper procedures.

(B) 1H-403 – North Loop from 28H-410 to L431-229 Metro Center
There are three sizes of conductors in the loop: 350, 500 and 750 kcmil. It may be beneficial to upgrade a part of the loop between MH102 on Cogswell St and 28H to 750 kcmil to create a full size tie between feeder 104H-422 (SW# D4A15363) and 28H-410 in Scotia Square. There are two conditions for this upgrade:
1) Some cables would have to be swapped in MH43 to make this tie "service free". This will transfer the cs431-265 service to another shoulder of the same loop that has multiple primary services and will remain 350 kcmil.
2) There are only two free ducts available between 28H and MH32. The upgrade is still possible but this option needs to be further investigated.

(C) 1H-403 –Metro Center Loop from L431-230 to L431-232
This part of the feeder has enough spare ducts to pre-install the new switch-to-switch sections while the old cable remains in service. The switching between the old and new cable can be done without taking outages to the customers.

(D) 1H-403 – 28H-415 to Grand Parade Vault
This is a normal feed for the Metro Center loop. There are not enough spare ducts to install the replacement cable ahead of time. One of the two available backup options has to be used for the duration of the cable replacement or injection.

(E) 1H-403 – 28H-411 to L431-230 Metro Center – Tie with 1H-405
There are two sizes of conductors (500 and 750 kcmil) used in this tie. The 500 kcmil section should be upgraded to the standard 750 kcmil size. There are only two free ducts available between 28H and MH32 to exit the Scotia Square vault. The cable upgrade is possible but this option needs to be further investigated.

With the existing ductbank configuration, the two cable upgrades (B) and (E) are mutually exclusive therefore:
a) Only one of the two may be selected
b) Possibility of adding more ducts between 28H vault and MH32 to be explored

5.3.2 FEEDER 1H-405 (F, G)

(F) 1H-405 – Main Radial from 1H to 28H-417
This part of the feeder is very similar to 1H-403 (A) and can be approached in the same way. See section (A) options for details. The removal of the old 4 kV feeder cables will also benefit the 1H-405 feeder replacement.

(G) 1H-405 – 23 kV Loop
The old multi-loop configuration was recently changed. The exact configuration of the present system may need to be updated on the single line diagrams. The upcoming cable replacement may also be used as an opportunity to further optimize the existing 23 kV loop system.

5.3.3 FEEDER 1H-419 (H, I, J)

(H) 1H-419 – to L431-401 Proctor Street
The replacement of this section can be combined with the removal of the old 4 kV cables (See 5.1 Option 2). This section can be backfeed from 104H-422 or 104H-442.

(I) 1H-419 – L431-404 Proctor Street to L431-211 Art Gallery Vault
The layouts of manholes MH90, MH91 and MH92 need to be verified and completed.

(J) 1H-419 Loop from L431-211 to L431-209 Art Gallery Vault
This is a normal underground loop. There is no foreseeable reason for cable size upgrades or configuration change.

(K) 1H-419 MH22 to 28H-413
This is a normally open tie with the feeder 1H-403. There are no primary services on this feeder section. The replacement should be straightforward.

5.3.4 FEEDER 1H-431 (L)
(L) 1H-431 to Art Gallery Vault
The records on the available spare ducts are inconsistent. A detailed scoping is required. The system improvement option 4.1 is recommended for better contingency arrangements.

5.4 Budgeting for Cable Replacement

5.4.1 Estimates and Assumptions

Labour:

- One underground crew includes 3 technicians.
- A basic length of 3 phase cable would normally consist of 1, 2 or 3 runs between two electrically adjacent cable accessories. The cable runs can be: manhole-to-manhole, manhole-to-vault, vault-to-vault and in some cases riser pole to manhole.
- One crew can install in one normal day:
  - a) one basic length of three 750 kcmil cables, no terminations.
  - b) 2 basic lengths of triplexed cable, no terminations.
  - c) 1 basic length of triplexed cable and terminate one end.
  - d) 6 cable terminations
  - e) one primary service loop (one basic length), terminate both ends reconnect.
- One crew can remove in one normal day:
  - a) three old PILC cables from three manhole-to-manhole lengths. Four manholes to be entered. This is mostly applicable to the three old feeders between 1H and MH46.
  - b) switch from old to new pre-installed and pre-terminated length of cable, remove the old cable. Phase the cable.
- For simplicity the above installation steps can be further combined into mandays per basic length of cable (installation + termination + switching + removal):
  - a) 750 kcmil three 1 phase cables: [redacted]
  - b) <750 kcmil 3 phase cable installation: [redacted]

- One eight hour manday (2010) with overhead is calculated as follows:

  [redacted]

- One eight hour overtime manday is calculated:

  [redacted]

- Unless specified, no overtime rates have been used for calculations.

Materials:

- Primary cable:	750 kcmil Al, 28 kV	- $25/m
	350 kcmil Al, 28 kV, 3 phase	- $40/m
	3/0 Al, 28 kV, 3 phase	- $35/m
	#1 Al, 28 kV, 3 phase	- $30/m
- Splice	750/750	- $200 each
- T-Connector 600 A	(See Appendix E for details)	- $239 each
- Loadbreak elbow 200 A		- $55 each
- Synthetic terminator	-	$170 each
- Support arm 14” complete with masonry fasteners and tie wraps for cable		- $50 each

5.4.2 Feeder Replacement Estimates

Table 5.4

Materials and Labour for Cable Replacement Option Excluding Primary Services			
Feeder	Cable (refer to feeder profiles 2.2)	Accessories (refer to 5.2)	Labour (refer to 5.4.1)
1H-403	750 kcmil: 4250 x 1.1* x 25 x 3 = $325,625 350 kcmil: 1550 x 1.1 x 40 = $68,200 Other sizes: 360 x 1.1 x 35 = $13,860 **Total: $407,685**	S: 9 x 6**x 239 = $12,906 T: 31 x 3 x 239 = $22,227 LF: 31 x 3 x 170 = $15,810 SA: 60 x 50 = $3,000 **Total: $53,943**	750 kcmil: [redacted] <750 kcmil***: [redacted] [redacted]
1H-405	750 kcmil: 1630 x 1.1 x 25 x 3 = $134,475 350 kcmil: 1380 x 1.1 x 40 = $60,720 Other sizes: 520 x 1.1 x 35 = $20,020 **Total: $215,215**	S: 9 x 6 x 239 = $12,906 T: 24 x 3 x 239 = $17,208 LF: 36 x 3 x 170 = $18,360 SA: 34 x 50 = $1,700 **Total: $50,174**	750 kcmil: 7 runs = [redacted] <750 kcmil: 6 runs = [redacted] [redacted]
1H-419	750 kcmil: 3430 x 1.1 x 25 x 3 = $302,775 Other sizes: 1130 x 1.1 x 35 = $43,505 **Total: $346,280**	S: 9 x 6 x 239 = $12,906 T: 20 x 3 x 239 = $14,340 LF: 15 x 3 x 170 = $7,650 SA: 60 x 50 = $3,000 **Total: $37,896**	750 kcmil: 17 runs = [redacted] <750 kcmil: 8 runs = [redacted] [redacted]
1H-431	750 kcmil: 2130 x 1.1 x 25 x 3 = $175,725 **Total : $175,725**	S: 2 x 6 x 239 = $2,868 T: 21 x 3 x 239 = $15,057 LF: 2 x 3 x 170 = $1,020 SA: 26 x 50 = $1,300 **Total: $20,245**	750 kcmil cable: 14 runs = [redacted] [redacted]

* - 10% of length is added for splicing loops and waste.

** - 600 A deadbreak elbows are used for splicing cables.

*** - In this context: 3 phase cable size between #1 and 350 kcmil

Total: [redacted]

Note that the system improvement items (4.0), old 4 kV cable removals (5.3.1 A) and proposed conductor upgrades for 1H-403 (5.3.1 B, E) are not included in the above estimate.

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5.4.3 Service Replacement Estimates

Table 5.5

Materials and Labour for Replacing Primary Service Cables			
Feeder	Cable (refer to feeder profiles 2.2)	Accessories (refer to 5.2)	Labour (refer to 5.4.1)
1H-403	750 kcmil: 100 x 1.1* x 25 x 3 = $8,250 350 kcmil: 100 x 1.1 x 40 = $4,400 Other sizes: 1680 x 1.1 x 35 = $64,680 **Total: 72,930**	T: 27 x 3 x 239 = $19,359 LF: 7 x 3 x 170 = $3,570 L: 33 x 3 x 55 = $5,445 **Total: $28,374**	32 services = [redacted] [redacted]
1H-405	3/0: 170 x 1.1 x 35 = **$6,545**	T: 9 x 3 x 239 = $6,453 L: 9 x 3 x 55 = $1,485 **Total: $7,938**	8 services = [redacted] [redacted]
1H-419	750 kcmil: 30 x 1.1 x 25 x 3 = $2,475 3/0 & #1: 140 x 1.1 x 35 = $5,390 **Total: $7,865**	T: 13 x 3 x 239 = $9,321 LF: 4 x 3 x 170 = $2,040 L: 11 x 3 x 55 = $1,815 **Total: $13,176**	15 services = [redacted] [redacted]
1H-431	350 kcmil: 270 x 1.1 x 40 = $11,880 3/0 & #1: 480 x 1.1 x 35 = $18,480 **Total: $30,360**	T: 14 x 3 x 239 = $10,038 LF: 4 x 3 x 170 = $2,040 L: 14 x 3 x 55 = $2,310 **Total: $14,388**	19 services = [redacted] [redacted]

* - 10% of length is added for splicing loops and waste.

[redacted]

Table 5.6

Materials and Labour for Replacing Primary Service Cables 50% Overtime			
Feeder	Cable (refer to feeder profiles 2.2)	Accessories (refer to 5.2)	Labour (refer to 5.4.1)
1H-403	750 kcmil: 100 x 1.1* x 25 x 3 = $8,250 350 kcmil: 100 x 1.1 x 40 = $4,400 Other sizes: 1680 x 1.1 x 35 = $64,680 **Total: 72,930**	T: 27 x 3 x 239 = $19,359 LF: 7 x 3 x 170 = $3,570 L: 33 x 3 x 55 = $5,445 **Total: $28,374**	32 services = [redacted] [redacted]
1H-405	3/0: 170 x 1.1 x 35 = **$6,545**	T: 9 x 3 x 239 = $6,453 L: 9 x 3 x 55 = $1,485 **Total: $7,938**	8 services = [redacted] [redacted]
1H-419	750 kcmil: 30 x 1.1 x 25 x 3 = $2,475 3/0 & #1: 140 x 1.1 x 35 = $5,390 **Total: $7,865**	T: 13 x 3 x 239 = $9,321 LF: 4 x 3 x 170 = $2,040 L: 11 x 3 x 55 = $1,815 **Total: $13,176**	15 services = [redacted] [redacted]
1H-431	350 kcmil: 270 x 1.1 x 40 = $11,880 3/0 & #1: 480 x 1.1 x 35 = $18,480 **Total: $30,360**	T: 14 x 3 x 239 = $10,038 LF: 4 x 3 x 170 = $2,040 L: 14 x 3 x 55 = $2,310 **Total: $14,388**	19 services = [redacted] [redacted]

* - 10% of length is added for splicing loops and waste.

[redacted]

5.5 Salvage

Aluminum

Table 5.7

Theoretical Weight of Aluminum Wire			
Wire size	Diameter [mm]	Cross-section [mm2]	Weight [kg/km]
750	22	380	1026
500	18	253	683
350	15	177	478
4/0	11.7	107	289
3/0	10.4	85	230
#1	7.4	42	113

Table 5.8

Aluminum Salvage Weight by Feeder [kg]					
	Cable Size	1H-403	1H-405	1H-419	1H-431
Feeder	750	13,080	4,926	11,295	6,555
	500	369	369	-	-
	350	2,223	1,977	-	-
	4/0	-	156	426	-
	3/0	-	-	441	-
	#1	-	57	-	-
Service	350	144	-	-	-
	3/0	849	90	69	186
	#1	-	-	18	96

Note: concentric neutral material is not accounted for

Salvage value of aluminum: $1.5/kg:

a) Feeder cables 750 kcmil = $54,000
b) Feeder cables <750 kcmil = $9,000
c) Services, all sizes = $2,200

Copper

The salvage value of copper: $5.00/kg. The removal of 3 km of 3 ph 500 kcmil PILC cable (5.3.1 Option 2) should produce 10 tons of salvageable copper, which is approximately $50,000.

The total salvage value of the cables proposed for removal under this project is expected to be $110,000.

6.0 CABLE INJECTION

6.1 Description

The cable injection option will be calculated for 750 kcmil cable only. The smaller conductor sizes for both feeder and services are considered for replacement. See Table 6.1 for summaries.

Table 6.1

Three phase line to be injected/replaced [m]			
	Feeder Injection 750 kcmil	Feeder Replacement <750 kcmil	Service Cable Replacement
1H-403	4,250	1,730	1,360
1H-405	1,680	1,910	140
1H-419	3,650	1,130	150
1H-431	2,130	0	550
Total	**11,710**	**4,770**	**2,200**

For feeder cables the injection will have to be done with de-energized cables. The injection and material installation crew would normally include 3 technicians. Time to inject will be dependent on the characteristics of the cable and type of conductors. The first draft work schedule implies up to 10 hours/day and 7 days/week. Labour fees for cable testing (TDR and pressure test) and cable injection are included in the injection price. The actual cable length is to be confirmed with TDR. Once injected the cables are protected by a 20 year warranty.

6.2 Scope

Following is a planned scope of injection work grouped by feeder# and section# (see Fig. 5.3). The sections will be (a) terminated at switching devices using livefront or deadfront terminations and (b) spliced using 600A deadbreak T-body, therefore each section will require 6 terminations. All terminations are in manholes and vaults. Some of the basic section lengths below are assumed to be equal for simplicity, but the total lengths should be fairly accurate.

Feeder 1H-403 (4250 m)
Section A: 230+230+230+230+230+230=1400 m
Section B: 160+150+230=540 m
Section C: 210+220+160+220+140+80+280+120+120+150=1700 m
Section D: 190+190=380 m
Section E: 230 m
Three phase cable sections: **22**
Terminations: 22 x 6 = **132**

Feeder 1H-405 (1680 m)
Section F: 230+230+230+230+230+270=1440
Section G: 240

Three phase cable sections: **7**
Terminations: **42**

Feeder 1H-419 (3670 m)
Section H: 228+228+228+228+228+200+200+200+200+200=1140 m
Section I: 156+156+156+110+190+240+190=1290 m
Section K: 240 m
Three phase cable sections: **18**
Terminations: **108**

Feeder 1H-431 (2130 m)
Section L: 190+190+150+90+100+160+170+170+190+110+100+180+160+160=2130 m
Three phase cable sections: **14**
Terminations: **84**

Summary:
Three phase cable sections: **61** (183 1ph 750 kcmil cables)
Total 3 ph. length: **11,710 m**
Terminations: **366** (306 T-bodies + 60 misc. live front terminations)

6.3 Cable Replacement Part of the Cable Injection Option

The cables other than 750 kcmil will be replaced as follows

Table 6.2

Materials and Labour for Cable Replacement Excluding 750 kcmil Feeder Cables and Primary Services			
Feeder	Cable (refer to feeder profiles 2.2)	Accessories (refer to 5.2)	Labour (refer to 5.4.1)
1H-403	350 kcmil: 1550 x 1.1* x 40 = $68,200 Other sizes: 360 x 1.1 x 35 = $13,860 **Total: $82,060**	T: 13 x 3 x 239 = $9,321 LF: 23 x 3 x 170 = $11,730 SA: 60 x 50 = $3,000 **Total: $24,051**	<750 kcmil**: 13 runs =[redacted] [redacted]
1H-405	350 kcmil: 1380 x 1.1 x 40 = $60,720 Other sizes: 520 x 1.1 x 35 = $20,020 **Total: $80,740**	T: 32 x 3 x 239 = $22,944 LF: 32 x 3 x 170 = $16,320 SA: 34 x 50 = $1,700 **Total: $40,964**	<750 kcmil: 6 runs =[redacted] [redacted]
1H-419	Other than 750 kcmil sizes: 1130 x 1.1 x 35 = **$43,505**	T: 7 x 3 x 239 = $5,019 LF: 10 x 3 x 170 = $5,100 SA: 60 x 50 = $3,000 **Total: $13,119**	<750 kcmil: 8 runs =[redacted] [redacted]
1H-431	N/A	N/A	N/A

* - 10% of length is added for splicing loops and waste.

** - In this context: 3 phase cable size from #1 to 350 kcmil

[redacted]

6.4 Injection Estimates

[redacted]

The Total price with 24.46% of contractor's overhead: [redacted]

One of the NSPI underground crews will be involved with the contractor for the duration of the project which is estimated to be 8 weeks.

[redacted]

The Total contractor’s price: [redacted]
Same with 24.42% of contractor’s overhead: [redacted]

7.0 Cable Replacement vs. Cable Injection

Table 7.1

Replacement of 750 kcmil Cable Only			
Feeder	Cable (Table 5.4)	Accessoties	Labour
1H-403	**$325,625**	Splices:19x1,432=$27,208 Brackets:19x50=$950 Total: **$28,158**	[redacted]
1H-405	**$130,475**	Splices:7x1,432=$10,024 Brackets: 7x50=$350 Total: **$10,374**	[redacted]
1H-419	**$302,775**	Splices: 17x1,432=$24,344 Brackets: 17x50=$850 Total: **$25,194**	[redacted]
1H-431	**$175,725**	Splices: 14x1,432=$20,048 Brackets: 14x50=$700 Total: **$20,748**	[redacted]
Total:	**$934,600**	**$84,474**	**$325,242**

Table 7.2

Cable Replacement vs. Cable Injection Budget Summaries 750 kcmil only						
	Cable Replacement (Table 7.1)		CableCure [redacted]		Cable Injection [redacted]	
	$	Comment	$	Comment	$	Comment
NSPI Labour	325,242	replace radial feeder cables	114,120	working with [redacted]	114,120*	working with [redacted]
Materials	1,019,074	750 kcmil cables	N/A	N/A	N/A	N/A
Cable Injection with OH 25%	N/A	N/A	927,582	Injecting cables, 3x12km	709,194	Injecting cables, 3x12km
Salvage	+60,000	Al	N/A		N/A	
	+50,000	Cu	N/A		N/A	
Total:	**$1,234,316**		**$1,041,702**		**$823,314**	

* -3 technicians, [redacted], regular time [redacted]

Calculating net present values for projects with different life spans can lead to incorrect decisions unless adjustments are made. One of the accepted techniques for dealing with this problem is the Replacement Chain Method which transforms the decision variable (NPV) into a common metric for projects of different life spans. NPV in itself does not accomplish this.

Table 7.3

Cable Replacement vs. Cable Injection – Compare the Options of Different Life 750 kcmil only			
	Cable Replacement	CableCure [redacted]	Cable Injection [redacted]
Expected Life, years	40	20	40**
NPV	$1,238,000	$1,041,702	$823,314
Replacement Chain Method * (i = 8%)	$1,238,000	$1,265,197	$823,314

* Method: Determine the lowest common denominator of all the "project lives". Calculate the Net Present Value for the project repeated "n" times. Compare the projects; choose that project with highest NPV or less negative in our case.
** [redacted]

Risks associated with cable injection:

a. A variety of first generation polyethylene insulation cable will remain in service.
b. After removing of the old terminations and splices some of the cables may be too short for a quality splice.
c. Some of the cable sections may not be injectable due to physical (loss of pressure) or electrical parameters and therefore will have to be replaced.
d. Need to trace another parameter of the injected cable section and having to manage the cable injection records for warranty purposes.
e. The cable injection warranty will only cover the cost of injection for the affected section. The cost of associated NSPI labour and cost of restoration will not be covered.
f. Introduction of non-standard hardware to the system. All of the new terminations have features for cable injection (e.g. reticular flash preventer)
g. Working with contractor will require additional coordination effort.
h. Unforeseeable cost plus items

[redacted]

The cost of cable injection per basic length of three phase section (typ. Switch-to-switch) today is:
$823,314 / 57 (Table 7.2) = $14,444

When one of the three cables of the injected section fails in 20 years, NSPI will be reimbursed with:
$570,000 / (57x3) = $3,333

The present value of the future warranty payment is:
PV=3,333(P/F,8%,20)= $715

8.0 BUDGETARY TIMELINES

Year 1, 2 and 3 – replace radial sections of the feeders 1H-403, 405, 419 and 431
Year 4 and 5 – replace loops and ties of the feeders 1H-403, 405 and 419

2010: a) 1H-403 – radial section between 1H and 28H-416 Scotia Square (1,400m)
b) 1H-405 – radial section between 1H and 28H-417 Scotia Square (1,440m)
c) PILC cable removal between 1H and MH46 on Granville St (1,000m)

2011: a) 1H-419 – radial section between 1H and L431-401 Proctor Street (2,140m)
b) 1H-419 – half of the radial section between L431-404 and L431-211 Art Gallery Vault (645m)

2012: a) 1H-431 – radial section between 1H and Art Gallery Vault (2,230m)
b) 1H-419 – second half of the radial section between L431-404 and L431-211 Art Gallery Vault (645m)

2013: a) 1H-403 – North Loop from 28H-410 to L431-229 Metro Center (2,240m)
b) 1H-403 – Metro Center Loop from L431-230 to L431-232 (1,700m)

2014: a) 1H-403 – Scotia Square 28H-415 to Grand Parade Vault (380m)
b) 1H-403 – Scotia Square 28H-411 to Metro Center L431-230 (410m)
c) 1H-405 – 23kV loop (1,900m)
d) 1H-419 – Tie to Scotia Square (240m)

Budgetary Item for 2010

The underground work units and cost of materials are described in Section 5.4.1 of the Report. The RT labour is calculated as: [redacted]

1. Cable NSPI# 6548-0400
   (1400 + 1440) x 1.1 x $25 x 3 = **$234,300**
2. Accessories
   Separable cable connectors as per Appendix E: 28 x $1,432 = **$40,095**
   Support arms – 28 x $50 = **$1,400**
3. Labour
   Cable installation (28 basic runs) 28 x 9 = [redacted] **$161,532**
   PILC cable removal [redacted] **$9,615**
4. Contracting
   Traffic control [redacted] day: 28 x 500 x 1.2442 = **$17,419**
5. Salvage
   3 x 3 x 1 km of copper PILC 500 kcmil cable = 10,000 kg of salvageable copper
   Assume salvage value is $5.00/kg, the total value is **$50,000**
   3 x 2.84 km of 750 kcmil al cable = 8,740 kg of salvageable aluminum
   Assume the salvage value is $1.5/kg the total value is **$13,000**

Total: $401,419

APPENDIX A – Cable Lengths and Available Ducts

(A) 1H-403 – Main Radial 1H to 28H-416 – 1400 m of 750 kcmil		
From	To	Available Ducts
1H Substation	MH2	9A (A- available), Remove: 243, 246, 247
MH2	MH4	1A* Removals: 243, 246, 247
MH4	MH5	
MH5	MH6	
MH6	MH9	
MH9	MH10	2A* Removals: 243, 246, 247
MH10	MH48	
MH48	MH46	
MH46	MH26	0A, 1 cemented over,
MH26	MH28	0A
MH28	MH32	3A
MH32	28H-416 Scotia Square	2A*

(B) 1H-403 – North Loop from 28H-410 to L431-229 Metro Center			
From	To	Cable	Available Ducts
28H-410	MH32	500, 180 m	2A
MH32	MH39		5A
MH39	MH41	350, 530 m	4A*
MH41	MH42		4A*
MH42	MH43		5A
MH43	MH126		2A
	MH102	350, 400 m	3A*
MH102	MH103		0A
MH103	Police Station Vault		0A
Police Station Vault	Citadel Inn Vault	350, 70 m	0A
Citadel Inn Vault	MH103	350, 550 m	0A
MH103	MH102		0A
MH102	MH43		3A*
MH43	MH42		5A
MH42	MH41		4A*
MH41	MH39		4A*
MH39	MH38	750, 160 m	3A*
MH38	MH40		5A
MH40	MH38	750, 150 m	5A
MH38	MH116		5A
MH116	MH38	750, 230 m	5A
MH38	MH37		9A
MH37	MH36		9A
MH36	L431-229 MetroCtr		8A

(C) 1H-403 –Metro Center Loop from L431-230 to L431-232			
From	To	Cable	Available Ducts
Metro Venter Vault	MH36	750, 210 m	11A
MH36	MH110		4A
MH110	MH114		
MH114	Prince George Vault		
Prince George Vault	MH114	750, 220 m	
MH114	MH124		
MH124	Cambridge Vault		
Cambridge Vault	MH124	750, 160 m	
MH124	MH87		
MH87	MH131		
MH131	MH132	750, 220 m	
MH132	MH117	750, 140 m	
MH117	MH115	750, 80 m	
MH115	MH109	750, 280 m	
MH109	Grand Parade Vault		
Grand Parade Vault	MH33	750, 120 m	
MH33	MH34		
MH34	MH35	750, 120 m	
MH35	MH123		
MH123	MH35	750, 150 m	
MH35	MH36		
MH36	L431-232 Metro Ctr		

(D) 1H-403 – 28H-415 to Grand Parade Vault			
From	To	Cable	Available Ducts
28H-415	MH30	750, 190 m	2A
MH30	MH31		2A
MH31	L431-187 Barrington Place		0A
L431-186	MH31	750, 190 m	0A
MH31	MH30		2A
MH30	MH33		12A
MH33	L431-227 Grand Parade Vault		9A

(E) 1H-403 – 28H-411 to L431-230 Metro Center – Tie with 1H-405			
From	To	Cable	Available Ducts
28H-411	MH32	500, 180 m	A2, Upgrade?
MH32	MH39		A5, Upgrade?
MH39	MH38	750, 230 m	A3*
MH38	MH37		A9
MH37	MH36		A9

MH36	L431-230 Metro Center		A11

(F) 1H-405 – Main Radial 1H to 28H-417			
From	To	Cable	Available Ducts
1H-405	MH2	750, 1050 m	9A
MH2	MH4		1A
MH4	MH5		1A
MH5	NH6		1A
MH6	MH9		1A
MH9	MH10		2A
MH10	MH48		2A
MH48	MH46		2A
MH46	MH47		3A
MH47	MH133		13A
MH133	MH47	750, 390 m	13A
MH47	MH46		3A
MH46	MH26		0A
MH26	MH28		1A
MH28	MH32		3A
MH32	28H-417		2A, may be used for 1H-403 upgrades

(G) 1H-405 – 23 kV Loop			
From	To	Cable	Available Ducts
28H-408	MH32	350, 390 m	2A
MH32	MH39		5A
MH39	MH41		4A
28H-409	MH32	350, 390 m	2A
MH32	MH39		5A
MH39	MH41		4A
28H-408	28H-424 Center Pad	350, 110 m	
28H-409	28H-423 Center Pad	350, 110 m	
MH41	28H-419 Scotia Tower	350, 20 m	
MH41	28H-418 Scotia Tower	350, 20 m	
MH41	MH42	350, 120 m	4A
MH41	MH42	350, 120 m	4A
MH42	28H-427 North Pad	4/0, 90 m	1A
MH42	28H-428 North Pad	4/0, 90 m	1A
MH42	28H-433 MacKeen Tower	350, 50 m	0A
MH42	28H-432 MacKeen Tower	350, 50 m	0A

28H-433	MH43	#1, 170 m	
MH43	28H-442		
28H-432	MH43	#1, 170 m	
MH43	28H-441		

(H) 1H-419 – to L431-401 Proctor Street			
From	To	Cable	Available Ducts
1H-405	MH2	750, 1140 m	9A
MH2	MH4		1A
MH4	MH5		1A
MH5	MH6		1A
MH6	MH9		1A
MH9	MH10		2A
MH10	MH48		2A
MH48	MH46		2A
MH46	MH47		3A
MH47	MH125		3A
MH125	MH26	750, 1000 m	1A
MH26	MH28		1A
MH28	MH32		3A
MH32	28H		2A*
28H	MH30		2A
MH30	MH23		6A
MH23	MH22		7A
MH22	MH21		9A
MH21	MH90		0A
MH90	MH91		0A
MH91	MH92		
MH92	6H-401 Proctor St		

(I) 1H-419 – L431-404 Proctor Street to L431-211 Art Gallery Vault			
From	To	Cable	Available Ducts
L431-404	MH92	750, 560 m	
MH92	MH91		
MH91	MH90		0A
MH90	MH21		0A
MH21	MH20		5A
MH20	MH19		7A
MH19	L431-257 Xerox Building		4A
L431-256	MH19	750, 110 m	4A
MH19	L431-259 Sheraton Vault		5A
L431-258 Sheraton Vault	MH19	750, 190 m	5A

MH19	MH18		15A
MH18	MH22		9A
MH22	MH18	750, 240 m	9A
MH18	MH16		14A
MH16	MH14		14A
MH14	1801 Hollis St		4A
1801 Hollis St	MH14	750, 190 m	4A
MH14	MH13		14A
MJH13	MH56		12A
MH56	L431-211 Art Gallery Vault		0A

(J) 1H-419 Loop from L431-211 to L431-209 Art Gallery Vault			
From	To	Cable	Available Ducts
L431-211 Art Gallery Vault	MH56	3/0, 140 m	0A
MH56	MH55		13A
NH55	MH25		1A
MH25	L431-236 Royal Bank Vault		4A
L431-237 Royal Bank Vault	MH25	3/0, 210 m	4A
MH25	MH24		4A
MH24	MH15		
MH15	MH17		2A
MH17	L431-238 Historic Properties Vault		0A
L431-239 Historic Properties Vault	MH7	4/0, 160 m	
MH7	MH15		
MH15	L431-240 Law Courts Vault		
Law Courts Vault	MH111	3/0, 50 m, NB radial	
MH111	Ferry Term. Vault		
Ferry Term. Vault	MH13		
MH13	Riser Pole		
L431-241 Law Courts Vault	MH15	4/0, 140 m	
MH15	MH24		4A
MH24	L431-242 Hist. Prop. Prom. Vault		
L431-243 Hist. Prop. Prom. Vault	MH24	4/0, 190 m	
MH24	MH25		4A
MH25	Royal Bank Vault		4A

Royal Bank Vault	MH25		4A
MH25	L431-244 Bank of Montreal		2A
L431-245 Bank of Montreal	MH25	3/0, 70 m	2A
MH25	MH105		0A
MH105	MH25	3/0, 170 m	0A
MH25	MH55		1A
MH55	MH56		12A
MH56	L431-209 Art Gallery Vault		0A

(K) 1H-419 MH22 to 28H-413			
From	To	Cable	Available Ducts
L431-176 MH22	MH23	750, 240 m	
MH23	MH30		6A
MH30	28H-413 Scotia Square		2A

(L) 1H-431 to Art Gallery Vault			
From	To	Cable	Available Ducts
1H-431	MH2	750, 380 m	12A
MH2	MH3		2A
MH3	MH60		2A
MH60	Riser D431-001		0A
Riser D431-354	MH59	750, 150 m	0A
MH59	MH58		9A
MH58	MH57	750, 90 m	9A
MH57	MH148		
MH148	Ralston Vault	750, 100 m	
Ralston Vault	MH57	750, 160 m	
MH57	MH7		8A
MH7	Keith's Brewery Vault		1A
Keith's Brewery	MH7	750, 170 m	1A
MH7	Harbour Walk Vault		5A
Harbour Walk Vault	MH7	750, 180 m	5A
MH7	MH8		15A
MH8	Summit Place Vault		
Summit Place Vault	MH89	750, 190 m	
MH89	MH49		5A
MH49	MH51		9A
MH51	Founder's Square Vault		0A
Founder's Square	MH51	750, 110 m	0A

Vault			
MH51	MH52		5A
MH52	Bedford Row Vault		
Bedford Row Vault	MH52	750, 100 m	3A
MH52	MH53		12A
MH53	Public Works Vault		
Public Works Vault	MH53	750, 180 m	
MH53	MH12		
MH12	MH88		
MH88	Maritime Museum Vault		
Maritime Museum Vault	MH88	750, 320 m	
MH88	MH12		
MH12	MH13		
MH13	MH56		
MH56	Art Gallery Vault		

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APPENDIX B – Primary Service Cables

Note: Due to short cable length, the primary services located in the same with the switch vault or manhole may not be shown in the list.

1 of 4

1H-403 Primary Service Cables		
CS Number	Cable Size [AWG], [kcmil]	Cable Length [m]
CS431-139	3/0	70
CS431-170-T2	#1	160
CS431-150	750	10
CS431-221	3/0	10
CS431-227	3/0	40
CS431-265	350	60
CS431-426	350	40
CS431-046	3/0	50
CS431-182	3/0	150
CS431-270	750	80
CS431-001	3/0	50
CS431-211	3/0	80
CS431-162	3/0	100
CS431-154	3/0	40
CS431-402	3/0	50
CS431-430	3/0	150
CS431- 531	#1	100
CS431-036	3/0	50
CS231-012	1/0	200
CS231-038	1/0	270
CS431-428	3/0	10
CS431-197	3/0	130
CS431-137	3/0	100
CS431-185	3/0	20
CS431-184	3/0	10

2 of 4

1H-405 Primary Service Cables		
CS Number	Cable Size [AWG], [kcmil]	Cable Length [m]
CS431-007	3/0	50
CS431-012	3/0	70
CS431-005	3/0	50
CS431-504	-	-
CS431-505	-	-
CS431-506	-	-
CS431-507	-	-
CS431-508	-	-

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1H-419 Primary Service Cables		
CS Number	Cable Size [AWG], [kcmil]	Cable Length [m]
CS431-351	3/0	10
CS431-138	3/0	70
CS431-196-T2	750	30
CS431-268	#1	50
CS431-279	3/0	10

1H-431 Primary Service Cables		
CS Number	Cable Size [AWG], [kcmil]	Cable Length [m]
CS431-205	#1	55
CS431-002	3/0	50
CS431-345	#1	50
CS431-247	#1	30
CS431-049	#1	10
CS431-217	3/0	10
CS431-220	3/0	220
CS431-271	3/0	50
CS431-450	350	270

APPENDIX C – Splices and Terminations

The allocation of the cable accessories below is assumed based on single line diagrams and may not be an exact representation of the actual type or quantity. For accessory legend see 5.2.

Splices and Terminations									
MH# /Vault	Equip. in MH	1H-403		1H-405		1H-419		1H-431	
		Feeder	Service	Feeder	Service	Feeder	Service	Feeder	Service
001									
002									
003								s	
004		s		s		s			
005									
006		s		s		s			
007									
008									
009									
010		s		s		s			
011									
012								s	
013									
014									
015									
016									
017									
018									
019									
020						s			
021									
022	TX+SW					3T	2T+2L		
023						s			
024									
025									
026				s					
027									
028		s							
029									
030									
031									
032						s			
033									
034	SW	2T	T+L						
035									
036		T							
037									
038									
039		2s							
040	SW	2T	T+L						
041				2s					
042		s		2s					
043		s							

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044									
045									
046		s				s			
047				s					
048									
049									
050									
051									
052	TX+SW								
053									
054									
055									
056									
057									
058								T	
059									
060									
061									
062									
063									
064									
065									
066									
067									
068									
069									
070									
071									
072									
073									
074									
075									
076									
077									
078									
079									
080									
081									
082									
083									
084									
085									
086									
087									
088									
089									
090						2s			
091A									
091B									
092									
093									
094									
095									

096									
097									
098									
099									
100									
101									
102		s							
103									
104									
105	TX+SW					2T	T+L		
106									
107									
108	TX		L						
109									
110									
111									
112									
113									
114									
115	TX+SW	2T	4T+4L						
116		2T	2T+2L						
117	TX+SW	2T	T+L						
118									
119									
120	SW								
121									
122	TX								
123	TX+SW	2T	2T+2L						
124	TX								
125	TX+SW					2T	2T+2L		
126	Adj Sw	2LF	2LF+2 L						
127									
128									
129									
130									
131	TX+SW	5T	5T+5L						
132	TX+SW	2T	2T+L						
133	TX+SW			4T	4T+4L				
134									
135									
136									
137									
138									
139									
140									
141									
142									
143									
144									
145									
146									
147									
148	TX+SW							2T	2T+2L

149									
150									
151									
152									
153									
154	SW								
155									
156									
157									
158									
159	TX	2T	2T+2L						
160									
161									
162									
163									
164									
165									
166									
167									
168									
169									
170									
171									
200									
B01	TX+SW								
B02	TX+SW								
D01									
D02	TX								
D03	SW								
D04									
D05									
D06									
D07									
D08									
D09									
D10	SW								
D11	SW								
D12									
D13	TX+SW								
D14	TX+SW								
D15									
D16	TX+SW								
D17									
D18	TX+SW								
D19									
D2	TX								
D20	TX								
D21	TX+SW								
D22									
D23	TX+SW								
D24									
D25									
D26									

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D27									
D28									
D29									
D30									
D31									
D32									
D33									
D34									
D35									
D36A									
D36B									
D37									
D38									
D39									
D40									
D41									
D42									
D43									
D44A									
D44B									
D44C									
D44D									
D44E									
D44F									
D44G									
D44H									
D44I									
D44J									
D6									
Police Station		4LF	LF						
Citadel Hotel		4LF	LF						
Plaza 1881									
Blue Cross									
Metro Center		11LF	3LF						
Prince George		2T	T+L						
Cambrid ge Suites		2T	2T+2L						
Canada Trust									
City Hall									
Grand Parade		3T	3T+3L						
Proctor Street									
Xerox Bldg						2T	2T+2L		
Sherato						2T	T+L		

n									
Hollis 1801						2T	T+L		
Art Gallery						3T	T+L	T	
Royal Bank						2LF	LF		
Historic Prop. Warerfront						2LF	LF		
Ferry Terminal						2LF			
Law Courts						2T	2T+3LF		
Hist Prop. Promenade						2T	T+L		
Bank of Montreal						2LF	LF		
Ralston Building								2T	T+L
Summit Place								2T	T+L
Founder's Square								3T	T+L
Bedford Row								2T	2T+2L
Public Works Canada								2T	2T+2L
Barrington Place		2T	T+L						
Market St 1770			4L						
6H Proctor Street						6LF			
O/H section								2LF	4LF
Keith's Brewery								2T	2T+2L
Harbour Walk								2T	T+L
Maritime Museum								2T	2T+2L
28H South Pad Vault		10LF		36LF+2T		LF			
Center Pad Vault				4T	T+L				

Scotia Tower Vault				4T	T+L				
North Pad Vault				4T	T+L				
MacKeen Pad Vault				4T	T+L				
Trade Mart Vault				2T	T+L				

APPENDIX D – Art Gallery Tie (Details)

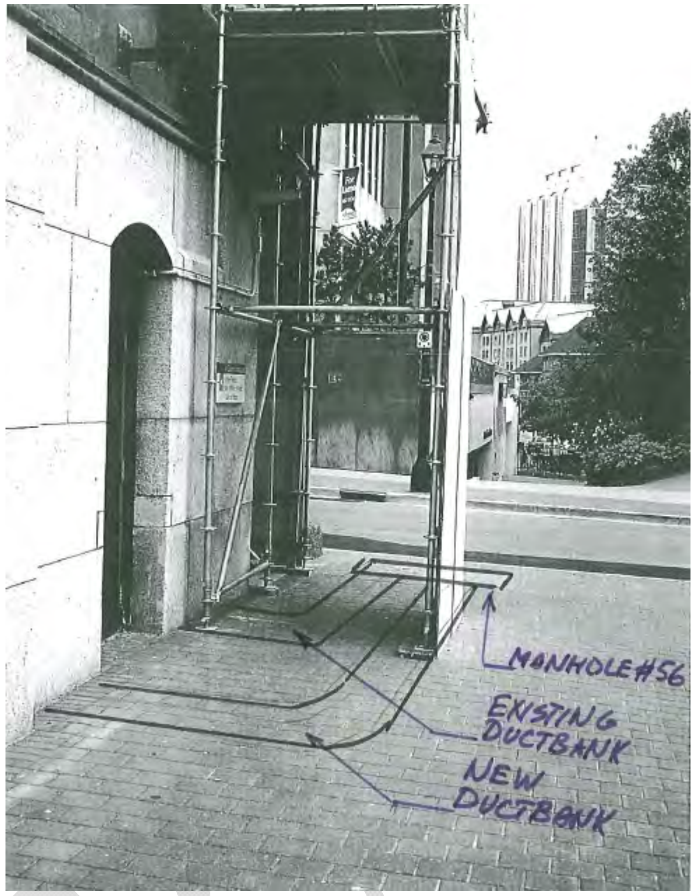


Fig. 4.3 Art Gallery Ductbank Extension

The inlaid brick manhole cover should be replaced with a different type of cover that can be quickly removed and reinstalled as required.


Fig. 4.4 Manhole MH56

The electrical connections in the vault will have to be modified to allow for a new switch. One of the options would be to install a new two-way 200 A VacPac switch and relocate the CS431-272 primary service from the existing four-way VacPac switch to the new switch. The source side of the new switch will be piggybacked at L431-209. See Fig. 4.5 and 4.6 for details. This will free up one of the 600 A switches on the existing VacPac which will be used to tie-in the feeder 1H-424.

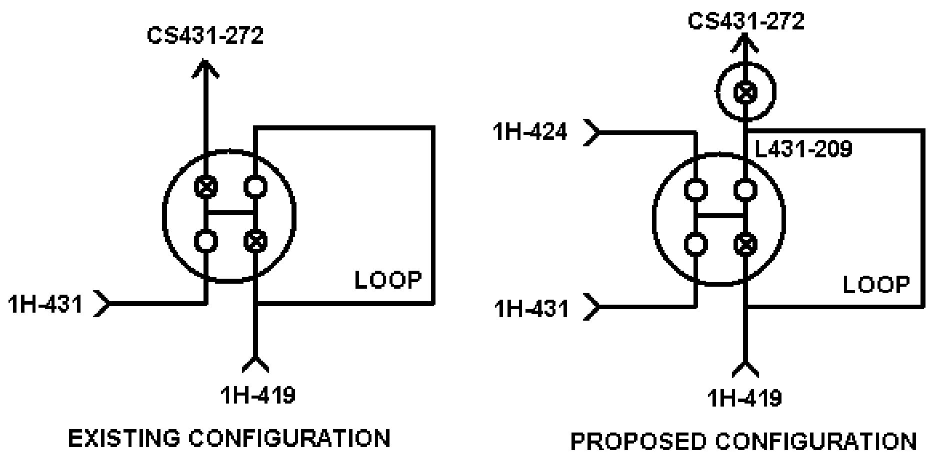


Fig. 4.5 Electrical Connections Before and After

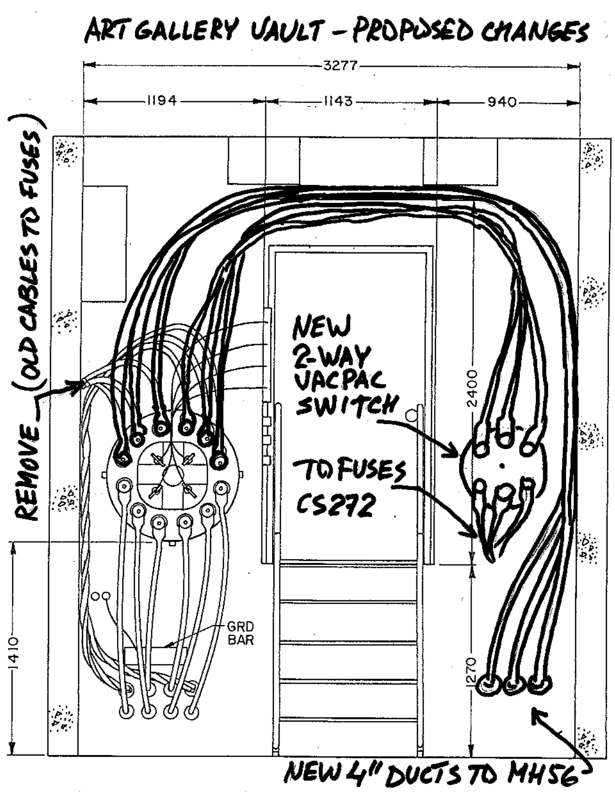


Fig. 4.6 New Two-Way Switch in the Vault

The following is the list of basic jobs for the project:

1. Install nine 100 mm ducts (3 spare) between the Art Gallery vault and MH56 (approx. 8 m).
2. Repair or replace manhole cover MH56
3. Install six 750 kcmil Al cables from MH13 through MH56 to Art Gallery vault (60 – 70 m)
4. Install new 2-way 200 A VacPac switch in the vault. Cooper model # 21VP125-22. The SMD-20 fuse mounts in the vault may need to be slightly moved to allow for proper clearance.
5. Transfer cs431-272 from four-way to two-way VacPac switch. The source side of the new switch connects to L431-209.
6. Terminate and connect the new cables to L431-212 -the freed-up switch.
7. Splice-in the other end of the cable to the feeder 1H-424 in MH13 using 600A deadbreak terminations.
8. Consider installing barriers in front of the fuses in the vault.

APPENDIX E – Deadfront Splice Specifications for 750 kcmil Cable

One three phase separable deadfront splice on the full size feeder cable will require the following materials:

#	Description	NSPI Code	QTY	Price
1	Basic Shielded Elbow 25 kV	5465-2370	6	$76.87/ea
2	Cable Adapter #750, Compact	5465-0189	6	$15.84/ea
3	Connecting Plug 25 kV	5465-7400	3	$79.26/ea
4	Basic Insulating Plug	5465-7350	6	$46.29/ea
5	Conductor Contact, #750 Compact	5465-1320	6	$33.17/ea
6	Constant Force Spring	5465-0655	6	$13.56/ea
7	Braid Flexible Tinned	5465-0650	3 m	$7.98 per ft

DRA

CI Number: 43255

Title: **2013 Distribution Cutout Replacements**

Start Date: 2013/01
Final Cost Date: 2013/12
Function: Distribution
Forecast Amount: $618,065

DESCRIPTION:

This project provides for the replacement of porcelain cutouts on selected feeders. Feeder sections targeted for 2013 include:

3N-303, 92H-334, 1V-443G, 40H-304, 87H-311, 87H-312, 104H-422, 104H-433G, 4N-311, 4N-313, 15N-404G, 1N-402G, 62N-411, 22W-313, 73W-411GC, 93V-313G, 22V-312, 55V-322, 83V-303, 63V-312 and 50W-411G.

Summary of Related CIs +/- 2 yrs:
2011 CI 39270 2011 Distribution Cutout Replacements $2,916,035
2012 CI 41392 2012 Distribution Cutout Replacements $2,596,796

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Equipment Replacement

Why do this project?

This work is being done as part of the overall customer reliability improvement investment. The program entails cutout replacements on a prioritized feeder basis, as required, to improve customer reliability. Porcelain cutout insulators develop hairline cracks with age. Moisture present further expands the cracks during the freeze/thaw cycle, eventually causing device failures. Cut-out failures are one of the leading causes of device failure outages, accounting for an average of 50,000 customer interruptions and 100,000 customer hours of interruption annually.

Why do this project now?

Cut-out replacements performed to date have resulted in improved reliability and reduced failure rates, which can be further reduced by continued replacements. An additional 9,700 customer hours of interruption are expected to be saved on an annual basis from the feeders targeted in 2013.

Why do this project this way?

It has been determined that the best approach to reduce outages, caused by cutout failures, is to prioritize feeders as opposed to targeting specific cutout replacements across a number of feeders.

The labour portion for this project is being sourced trough NS Power's existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 43255 - 2013 Distribution Cutout Replacements

Project Number

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin.

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		14,909	0	14,909
094		094 - Interest Capitalized		7,209	0	7,209
095		095-COPS Contracts AO		107,612	0	107,612
095		095-COPS Regular Labour AO		26,415	0	26,415
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	22,850	0	22,850
002	040	002 - T&D Overtime Labour	040 - DP - O/H Cond.Devices	0	0	0
012	040	012 - Materials	040 - DP - O/H Cond.Devices	97,611	0	97,611
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	326,196	0	326,196
001	085	001 - Regular Labour (No AO)	085 Design	1,952	0	1,952
001	085	001 - T&D Regular Labour	085 Design	13,310	0	13,310
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
			Total Cost:	618,065	0	618,065
			Original Cost:	175,531		

Location: Distribution
CI# / FP#: 43255
Title: 2013 Distribution Cutout Replacements
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	PLT Labour	Person Day	[redacted]		$ 22,850.38		
1.2	Engineering (P.Eng): Design	Lot	1	11319.00	$ 11,319.00		
1.3	Project Support Labour (No AO)	Lot	1	1952.21	$ 1,952.21		
1.4	Planner	Lot	1	1991.29	$ 1,991.29		
				Sub-Total	$ 38,112.88		
2	**012 Materials**						
2.1	Cutouts	[redacted]			$ 97,610.63		
				Sub-Total	$ 97,610.63		
3	**013 T&D Contracts**						
3.1	EUS	[redacted]			$ 326,196.00		
				Sub-Total	$ 326,196.00		
4	**094 Interest Capitalized**						
4.1	Interest		1	7,208.90	$ 7,208.90		
4.2							
4.3							
				Sub-Total	$ 7,208.90		
5	**095 Administrative Overhead**						
5.1	Contracts AO		1	107,612.16	$ 107,612.16		
5.2	Labour AO		1	26,415.36	$ 26,415.36		
5.3	Vehicle AO		1	14,909.04	$ 14,909.04		
				Sub-Total	$ 148,936.56		
Cost Estimate				**Total**	$ 618,064.97		
6	**Original Cost**				$ 175,530.52		
6.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43234

Title: **104S-313 Baddeck Re-build**

Start Date: 2013/05
Final Cost Date: 2013/11
Function: Distribution
Forecast Amount: $593,045

DESCRIPTION:

This project is to rebuild the first portion of feeder 104S-313 which currently is of backlot construction, along the Trans Canada Highway. The portions of the line that runs through backlots would remain but become branch lines of the feeder. Isolating switches will be installed which will allow the backlot branch line to be fed from either direction and will allow for issues on the branch line to be isolated when there are outages on it.

Summary of Related CIs +/- 2 years:
No projects for 2011, 2012, 2013, 2014 & 2015

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Deteriorated Conductor

Why do this project?

The beginning of feeder 104S-313 is deteriorated and contains many splices, and runs through back yards and woods between Highway 205 and the Trans Canada Highway. Whenever there is an issue in this area, it takes out the entire line all the way to Englishtown. By re-building the first portion of this line along the Trans Canada Highway, the line going through the backlots would become a branch line and the reliability to the rest of the feeder would greatly improve.

Why do this project now?

This project will provide improved reliability through avoided customer interruptions.

Why do this project this way?

Re-building the beginning of 104S-313 along the Trans Canada Highway and installing isolating switches will improve reliability for all customers served by this feeder.

This work will be completed by NS Power.

CI Number : 43234 - 104S-313 Baddeck Re-build

Project Number

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin.

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		37,788	0	37,788
094		094 - Interest Capitalized		11,286	0	11,286
095		095-COPS Contracts AO		50,409	0	50,409
095		095-COPS Regular Labour AO		66,951	0	66,951
013	002	013 - COPS Contracts	002 - DP - Land Rights	[redacted]	0	[redacted]
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	55,522	0	55,522
002	035	002 - T&D Overtime Labour	035 - DP - Wood Poles	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	107,314	0	107,314
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
066	035	066 - Other Goods & Services	035 - DP - Wood Poles	10,000	0	10,000
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	25,966	0	25,966
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	60,818	0	60,818
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	482	0	482
002	040	002 - T&D Overtime Labour	040 - TP - O/H Cond.Devices	0	0	0
012	040	012 - Materials	040 - TP - O/H Cond.Devices	654	0	654
001	085	001 - Regular Labour (No AO)	085 Design	3,376	0	3,376
001	085	001 - T&D Regular Labour	085 Design	1,431	0	1,431
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	8,250	0	8,250
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	593,045	0	593,045
			Original Cost:			

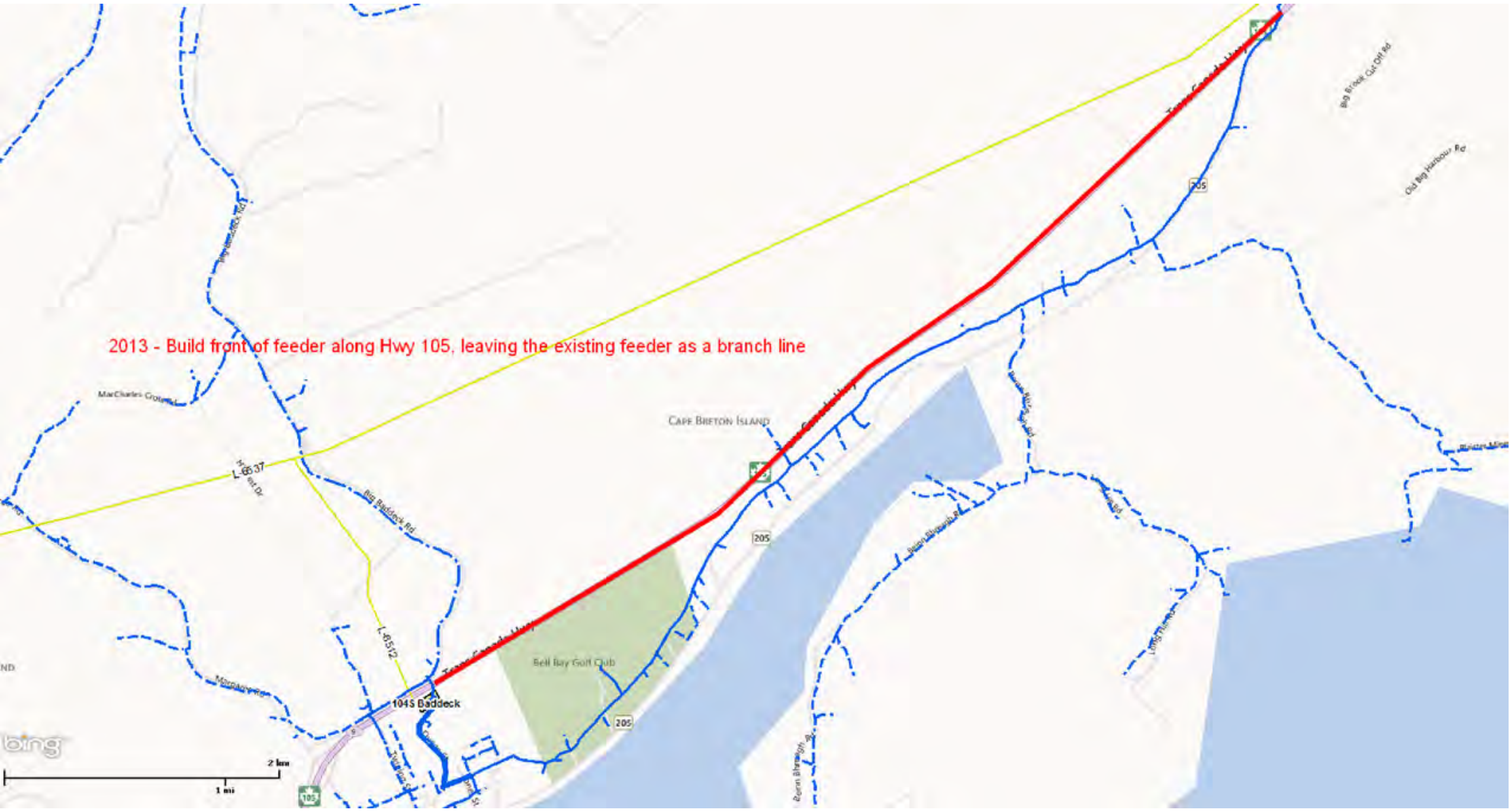
Location: Distribution
CI# / FP#: 43234
Title: 104S-313 Baddeck Re-Build
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1					$ -		
1.2	Regular Labour (No AO)	Lot	1	$ 3,375.72	$ 3,375.72		
1.3	T&D Regular Labour	Lot	1	$ 1,430.92	$ 1,430.92		
1.4	T&D Regular Labour	Lot	1	$ 8,250.02	$ 8,250.02		
1.5	T&D Regular Labour	Person Day	[redacted]		$ 81,969.83		
1.6							
1.7							
1.8							
1.9							
1.1							
				Sub-Total	$ 95,026.49		
2	**012 Materials**						
2.1					$ -		
2.2	Standard material Cutouts, and Insulators	Lot	1	168,785.78	$ 168,785.78		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 168,785.78		
3	**013 T&D Contracts**						
3.1	Tree Trimming	Lot	1	[redacted]			
3.2	Flagging & Backhoe	Lot	1				
3.3					$ -		
				Sub-Total	$ 152,800.00		
4	**066 Other Goods & Services**						
4.1	Permits & Easements	Lot	1	10000	$ 10,000.00	Nav Waters Permit	
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 10,000.00		
5	**094 Interest Capitalized**						
5.1	Interest	Lot	1	11285.7	$ 11,285.70		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 11,285.70		
6	**095 Administrative Overhead**						
6.1	COPS Contracts AO	Lot	1	$ 50,408.75	$ 50,408.75		
6.2	COPS Regular Labour AO	Lot	1	$ 66,950.90	$ 66,950.90		
6.3	Vehicle T&D Reg. Labour AO	Lot	1	$ 37,787.62	$ 37,787.62		
				Sub-Total	$ 155,147.27		
Cost Estimate				**Total**	$ 593,045.24		
7	**Original Cost**						
7.1					$ -		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Map from a NSPI GIS

2013 104S-313 Baddeck Rebuild



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Customer Interruptions

	2005	2006	2007	2008	2009	2010	2011
104S-313:BAD	1104	1403	3030	3590	4487	3418	3366
104S-313G:BAD	394	520	798	1199	1506	1451	1292
Grand Total	**1498**	**1923**	**3828**	**4789**	**5993**	**4869**	**4658**

Customer-Hours

	2005	2006	2007	2008	2009	2010	2011
104S-313:BAD	1,454	3,012	22,037	7,345	6,797	15,233	11,144
104S-313G:BAD	438	900	7,061	1,612	2,451	6,672	5,213
Grand Total	**1,893**	**3,911**	**29,098**	**8,957**	**9,248**	**21,905**	**16,357**

Event Count

	2005	2006	2007	2008	2009	2010	2011
104S-313:BAD	18	24	43	18	26	48	59
104S-313G:BAD	6	5	6	6	6	7	11
Grand Total	**24**	**29**	**49**	**24**	**32**	**55**	**70**

Customer Count

	2005	2006	2007	2008	2009	2010	2011
104S-313:BAD	355	388	392	392	395	397	386
104S-313G:BAD	130	129	131	131	136	139	132
Grand Total	**485**	**517**	**523**	**523**	**531**	**536**	**518**

Customer Count

	2005	2006	2007	2008	2009	2010	2011
NSP All-in	454165	459373	466831	471998	478257	481775	486916

SAIFI

	2005	2006	2007	2008	2009	2010	2011
104S-313:BAD	3.11	3.62	7.73	9.16	11.36	8.61	8.72
104S-313G:BAD	3.03	4.03	6.09	9.15	11.07	10.44	9.79
Grand Total	**3.09**	**3.72**	**7.32**	**9.16**	**11.29**	**9.08**	**8.99**

SAIFI

	2005	2006	2007	2008	2009	2010	2011
NSP All-in	3.54	2.91	3.97	4.15	2.86	4.36	3.73

SAIDI

	2005	2006	2007	2008	2009	2010	2011
104S-313:BAD	4.10	7.76	56.22	18.74	17.21	38.37	28.87
104S-313G:BAD	3.37	6.97	53.90	12.31	18.02	48.00	39.49
Grand Total	**3.90**	**7.56**	**55.64**	**17.13**	**17.42**	**40.87**	**31.58**

SAIDI

	2005	2006	2007	2008	2009	2010	2011
NSP All-in	10.34	5.00	14.18	11.29	5.80	17.67	7.90

CI Number: 43217

Title: **24C-442G Hwy 16 Rebuild Phase 1**

Start Date: 2013/03
Final Cost Date: 2013/08
Function: Distribution
Forecast Amount: $548,147

DESCRIPTION:

This project is to rebuild approximately 6.7 km of the 24C-442G feeder from Highway 316 to Fox Island Road to the side of the road and upgrading the size of the conductor on this stretch from #2 ASCR to 336 ASC.
This is the first phase of a three phase project to rebuild approximately 13 km of feeder 24C-442G along Highway 16 to Canso.

Summary of Related CIs +/- 2 years:
2014 CI TBD 22C-442G Hwy 16 Rebuild Phase 2 $TBD
2015 CI TBD 22C-442G Hwy 16 Rebuild Phase 3 $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Deteriorated Conductor

Why do this project?

The existing #2 ACSR conductor on this section of the 24C-442G feeder is deteriorated. It has a history of breaking and cannot be worked on under live conditions. Additionally, the poles along this section of line are also deteriorated and have numerous woodpecker holes throughout.

Why do this project now?

Rebuilding this section of deteriorated line with new poles and conductor will improve the reliability in this area and to the town of Canso. The possibility of conductor breakage will be reduced and crews will have the ability to work on this section of line under live conditions with improved access from the road.

Why do this project this way?

Rebuilding the line next to the road with new poles and conductor will improve access to the distribution plant, reduces the risk of prolonged outages due to handling the aging conductor, and reduces the restoration time during outage events.

This work will be completed by NS Power personnel.

CI Number : 43217 - 24C-442G Hwy 16 Reconductor Phase 1 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		55,812	0	55,812
094		094 - Interest Capitalized		9,992	0	9,992
095		095-COPS Contracts AO		26,161	0	26,161
095		095-COPS Regular Labour AO		98,887	0	98,887
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	57,340	0	57,340
002	035	002 - T&D Overtime Labour	035 - DP - Wood Poles	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	82,896	0	82,896
013	035	013 - COPS Contracts	035 - DP - Wood Poles	79,300	0	79,300
001	038	001 - T&D Regular Labour	038 - DP - Insulators	241	0	241
002	038	002 - T&D Overtime Labour	038 - DP - Insulators	0	0	0
012	038	012 - Materials	038 - DP - Insulators	79	0	79
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	58,841	0	58,841
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	47,719	0	47,719
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	2,492	0	2,492
002	040	002 - T&D Overtime Labour	040 - DP - O/H Cond.Devices	0	0	0
012	040	012 - Materials	040 - DP - O/H Cond.Devices	2,131	0	2,131
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	1,340	0	1,340
002	041	002 - T&D Overtime Labour	041 - DP - O/H Line Transf.	0	0	0
012	041	012 - Materials	041 - DP - O/H Line Transf.	6,859	0	6,859
001	050	001 - T&D Regular Labour	050 - DP - Street Lights	241	0	241
002	050	002 - T&D Overtime Labour	050 - DP - Street Lights	0	0	0
001	052	001 - T&D Regular Labour	052 - DP - Services	595	0	595
002	052	002 - T&D Overtime Labour	052 - DP - Services	0	0	0
012	052	012 - Materials	052 - DP - Services	146	0	146
001	085	001 - Regular Labour (No AO)	085 Design	2,797	0	2,797
001	085	001 - T&D Regular Labour	085 Design	2,110	0	2,110
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	12,168	0	12,168
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	548,147	0	548,147
			Original Cost:	121,767		

Location: Distribution
CI# / FP#: 43217
Title: 24C-442G Highway 16 to Canso Reconductor
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1							
1.2	Project Support Labour (No AO)	Lot	1	$ 2,796.61	$ 2,796.61		
1.3	NSP T&D Regular Labour	Lot	1	$ 2,110.47	$ 2,110.47		
1.4	T&D Regular Labour - Supervision	Lot	1	$ 12,167.95	$ 12,167.95		
1.5	NSP T&D Regular Labour	PD	[redacted]		$ 121,089.85		
1.6							
1.7							
				Sub-Total	$ 138,164.87		
2	**012 Materials**						
2.1					$ -		
2.2	Standard material Cutouts,	Lot	1	139,830.41	$ 139,830.41	Work Order Generated	
2.3	and Insulators				$ -		
2.4					$ -		
				Sub-Total	$ 139,830.41		
3	**013 T&D Contracts**						
3.1	Rock Breaking	Lot	1	[redacted]			
3.2	Flagging	Lot	1				
3.3	Backhoe	Lot	1				
				Sub-Total	$ 79,300.00		
4	**094 Interest Capitalized**						
4.1					$ 9,992.23		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 9,992.23		
5	**095 Administrative Overhead**						
5.1	COPS Contracts AO				$ 26,161.08		
5.2	COPS Regular Labour AO				$ 98,886.55		
5.3	Vehicle T&D Reg. Labour AO				$ 55,812.34		
				Sub-Total	$ 180,859.97		
Cost Estimate				**Total**	$ 548,147.48		
6	**Original Cost**						
6.1					$ 121,767.36		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Map from a NSPI GIS

Overview of 24C-442GB Rebuild

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Parameters:

Feedersec	24C-442G
Cause	Deteriorated Equipment and Tree Contacts
Customers	655

Year	Annual CI	Annual CHI	SAIFI	SAIDI
2008	596	13,562	0.91	20.70
2009	195	5,207	0.30	7.95
2010	2,542	14,259	3.88	21.77
2011	3,749	9,464	5.72	14.45
2012 (June)	893	2,145	1.36	3.28
Grand Total	7,975	44,637		

The table above shows outage statistics that can be attributed to the deteriorated state of the distributrion plant and exposure to tree contacts on 24C-442G. In the last 4.5 years, from 2008 to June of 2012, deteriorate plant and tree contacts outages occuring the targeted section of line has resulted in over 7,900 customer interruptions and over 44,600 customer hours of interruption.

CI Number: 41350

Title: **16W-301 Hebron Rebuild Phase 2**

Start Date: 2013/04
Final Cost Date: 2013/12
Function: Distribution
Forecast Amount: $501,720

DESCRIPTION:

This project provides for the costs associated with rebuilding a 4km section of the 16W-301 feeder. The size of the conductor will be upgraded from #4 to 336 ASCR. This is phase two of a three phase project to upgrade conductor on the 16W-301 feeder out of the Hebron Substation. The first phase of the project was included as part of the 2011 ACE Plan and involved the reconductoring of a portion of the feeder from #4 to 336 ASCR. Detailed design indicates that rebuilding the line this way will avoid customer outages. This work will be completed by NS Power.

Summary of Related CIs +/- 2 years:
2011 CI 40338 16W-301 Hebron Reconductor (Phase 1) $350,000
2014 CI TBD 16W-301 Hebron Rebuild Phase 3TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Deteriorated Conductor

Why do this project?

The current conductor at the front end of the 16W-301 feeder is undersized. Load growth requires that the conductor be upgraded to maintain voltage levels at the back-end of the feeder. The current conductor is roughly 40 years old, is deteriorated and sections of this conductor have several breaks in it.

Why do this project now?

A regulator bank is installed on this line. However, upgrading the size of the conductor at the front end of the feeder is required to maintain voltage levels on the back end of the feeder. Due to the age and condition of the current conductor, replacing this conductor will improve the reliability in the area through a reduction in outages caused by conductor failure.

Why do this project this way?

Approximately 2kms of the feeder will be built on the opposite side of the road thereby reducing the risk of prolonged outages due to handling the aging conductor.

CI Number : 41350 - 16W-301 Hebron Rebuild Phase 2 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		43,751	0	43,751
094		094 - Interest Capitalized		7,557	0	7,557
095		095-COPS Contracts AO		32,083	0	32,083
095		095-COPS Regular Labour AO		77,517	0	77,517
013	002	013 - COPS Contracts	002 - DP - Land Rights	[redacted]	0	[redacted]
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	12,001	0	12,001
001	004	001 - T&D Regular Labour	004 - DP - Misc.Equipment	54	0	54
002	004	002 - T&D Overtime Labour	004 - DP - Misc.Equipment	0	0	0
012	004	012 - Materials	004 - DP - Misc.Equipment	0	0	0
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	34,977	0	34,977
002	035	002 - T&D Overtime Labour	035 - DP - Wood Poles	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	54,105	0	54,105
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	42,772	0	42,772
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	40,478	0	40,478
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	4,810	0	4,810
002	040	002 - T&D Overtime Labour	040 - DP - O/H Cond.Devices	0	0	0
012	040	012 - Materials	040 - DP - O/H Cond.Devices	4,952	0	4,952
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	5,145	0	5,145
002	041	002 - T&D Overtime Labour	041 - DP - O/H Line Transf.	0	0	0
012	041	012 - Materials	041 - DP - O/H Line Transf.	18,478	0	18,478
001	050	001 - T&D Regular Labour	050 - DP - Street Lights	375	0	375
001	052	001 - T&D Regular Labour	052 - DP - Services	5,718	0	5,718
002	052	002 - T&D Overtime Labour	052 - DP - Services	0	0	0
012	052	012 - Materials	052 - DP - Services	2,617	0	2,617
001	085	001 - Regular Labour (No AO)	085 Design	2,068	0	2,068
001	085	001 - T&D Regular Labour	085 Design	1,654	0	1,654
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	9,538	0	9,538
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
001	090	001 - T&D Regular Labour	090 - DP - LED Street Lights	1,072	0	1,072
002	090	002 - T&D Overtime Labour	090 - DP - LED Street Lights	0	0	0

CI Number : 41350 - 16W-301 Hebron Rebuild Phase 2 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

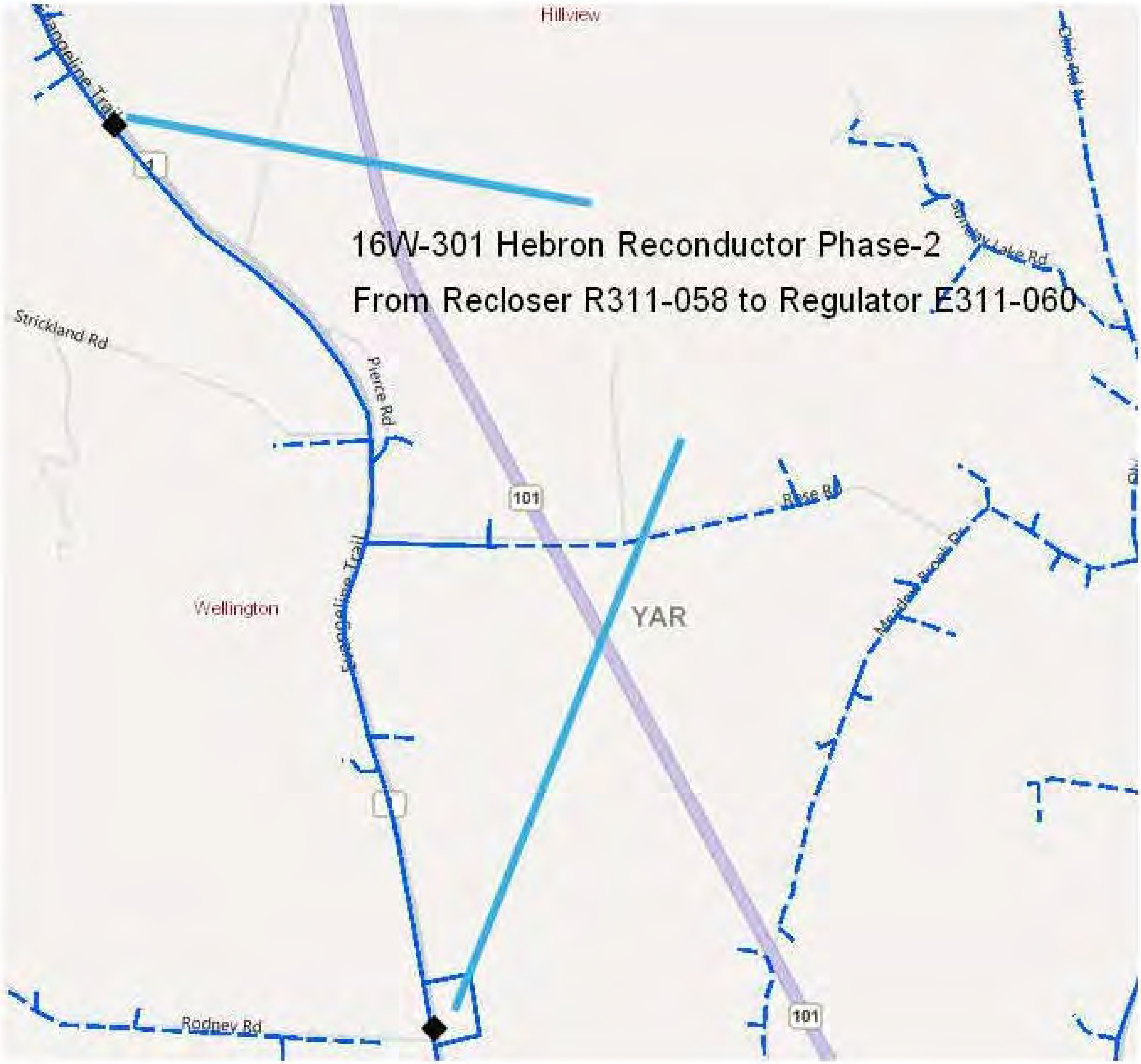
Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
012	090	012 - Materials	090 - DP - LED Street Lights	2,746	0	2,746
			Total Cost:	501,720	0	501,720
			Original Cost:	113,131		

Location: Distribution
CI# / FP#: 41350
Title: 16W-301 - Hebron Rebuild Ph 2
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1							
1.2	Regular Labour (No AO)	Lot	1	$ 2,067.53	$ 2,067.53		
1.3	NSPI T&D Regular Labour	Person Days	[redacted]		$ 94,922.19		
1.3	Site Supervision	Lot	1	$ 9,538.44	$ 9,538.44	~10% of Total Labour	
1.3	Planner	Lot	1	$ 1,654.39	$ 1,654.39	~2% of T&D Labour	
1.1							
				Sub-Total	$ 108,182.55		
2	**012 Materials**						
2.1							
2.2	Standard material Cutouts, LA, Poles, Anchors, Conductor, Transformers, and Insulators	Lot	1	$ 103,376.26	$ 103,376.26	Work Order Generated	
2.3	Sacrificial Life Aliant Poles	Lot	1	$ 20,000.00	$ 20,000.00		
2.4							
				Sub-Total	$ 123,376.26		
3	**013 Contracts**						
3.1	Tree Trimming	Lot	1	[redacted]		Planning Estimate for Contractor	
3.2	Flagging and Backhoe	Lot	1			Planning Estimate for Contractor	
3.3							
				Sub-Total	$ 97,251.75		
4	**020 Easements**						
4.1	Easements	Lot	1	$ 12,001.00	$ 12,001.00		
4.2							
4.3					$ -		
				Sub-Total	$ 12,001.00		
5	**094 Interest Capitalized**						
5.1	Interest Capitalized	Lot	1	$ 7,556.88	$ 7,556.88		
5.2							
5.3							
				Sub-Total	$ 7,556.88		
6	**095 Administrative Overhead**						
6.1	Contract AO	Lot	1	$ 32,083.34	$ 32,083.34		
6.2	Regular Labour AO	Lot	1	$ 77,517.02	$ 77,517.02		
6.3	T&D Vehicle AO	Lot	1	$ 43,751.22	$ 43,751.22		
				Sub-Total	$ 153,351.58		
Cost Estimate				**Total**	$ 501,720.02		
7	**Original Cost**						
7.1					$ 113,131.28		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project


Hillview
16W-301 Hebron Reconductor Phase-2
From Recloser R311-058 to Regulator E311-060
Strickland Rd
Pierce Rd
101
Wellington
YAR
Rodney Rd
101

Parameters:
Source: 16W-301:YAR
Customers: 1,849

	Annual CI			Annual CHI				
Year	**Corrosion**	**Electrical Failure**	**Mechanical Failure**	**Corrosion**	**Electrical Failure**	**Mechanical Failure**	**Total CI**	**Total CHI**
2003	0	7	369	0	19	597	376	616
2004	4	1,725	54	5	4,543	160	1,783	4,709
2005	14	2	1,910	17	2	2,761	1,926	2,780
2006	6	18	288	23	78	533	312	634
2007	7	100	749	11	131	1,742	856	1,884
2008	0	4	324	0	10	388	328	399
2009	38	6	461	158	24	918	505	1,100
2010	162	10	156	210	19	459	328	688
2011	2	1,838	256	1	3,170	305	2,096	3,477
2012	1	38	943	2	67	1,250	982	1,320
Grand Total	**234**	**3,748**	**5,510**	**427**	**8,065**	**9,114**	**9,492**	**17,606**

The table above shows outage statistics that can be attributed to the deteriorated state of the distributrion plant on 16W-301. In the last 3.5 years, from 2009 to June of 2012, deteriorated plant has resulted in over 3,900 customer interruptions and over 6,500 customer hours of interruption.

CI Number: 43551

Title: **56N-401 Pictou Rebuild and Conversion**

Start Date: 2013/04
Final Cost Date: 2013/11
Function: Distribution
Forecast Amount: $444,595

DESCRIPTION:

This project provides for the costs associated with rebuilding 56N-401, a 25kV line along Beeches Road in Pictou. Also included within this project are the costs associated with converting some of the 4kV load along Beeches Road.

Summary of Related CIs +/- 2 years:
No projects in 2011, 2012, 2013, 2014 and 2015

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Capacity

Why do this project?

56N-401 currently runs on the water side of the Pictou Golf Course, making accessibility very difficult during outages. The line is also in its later stages of deterioration. Additionally, the 4kV load in the area is overloaded. Converting some of this load now, and moving the 25kV to the road, will address the overload condition.

Why do this project now?

This plant is deteriorated and is reaching the end of its life. Further, NS Power’s ability to respond to outage events will be improved.

Why do this project this way?

By rebuilding this line along the road, reliability will improve and it will also help with the future conversion of the remaining 4kV.

CI Number : 43551 - 56N-401 Pictou Rebuild and Conversion **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		416	0	416
095		095-COPS Regular Labour AO		736	0	736
095		095 - T&CS Regular Labour AO		1,816	0	1,816
095		095-COPS Contracts AO		90,130	0	90,130
013	002	013 - COPS Contracts	002 - DP - Land Rights	20,000	0	20,000
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	2,000	0	2,000
012	035	012 - Materials	035 - DP - Wood Poles	15,750	0	15,750
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
012	038	012 - Materials	038 - DP - Insulators	53	0	53
013	038	013 - COPS Contracts	038 - DP - Insulators	[redacted]	0	[redacted]
012	039	012 - Materials	039 - DP - O/H Cond.	16,601	0	16,601
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	[redacted]	0	[redacted]
012	040	012 - Materials	040 - DP - O/H Cond.Devices	4,418	0	4,418
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	[redacted]	0	[redacted]
012	041	012 - Materials	041 - DP - O/H Line Transf.	30,533	0	30,533
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	[redacted]	0	[redacted]
013	050	013 - COPS Contracts	050 - DP - Street Lights	[redacted]	0	[redacted]
012	052	012 - Materials	052 - DP - Services	756	0	756
013	052	013 - COPS Contracts	052 - DP - Services	[redacted]	0	[redacted]
001	085	001 - T&CS Regular Labour	085 Design	5,812	0	5,812
001	085	001 - Regular Labour (No AO)	085 Design	1,362	0	1,362
001	085	001 - T&D Regular Labour	085 Design	1,008	0	1,008
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
			Total Cost:	444,595	0	444,595
			Original Cost:	45,849		

Location: Distribution
CI# / FP#: 43551
Title: 56N-401 Pictou Rebuild & Conversion
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (No AO)	Lot	1	$ 1,362.22	$ 1,362.22		
1.2	Design Labour	Lot	1	$ 6,820.11	$ 6,820.11		
1.3					$ -		
1.4					$ -		
				Sub-Total	$ 8,182.33		
2	**012 Materials**						
2.1	Standard material Cutouts, and Insulators	Lot	1	68111.23	$ 68,111.23	Work Order Generated	
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 68,111.23		
3	**013 T&D Contracts**						
3.1	EUS	manhour	[redacted]		$ 253,203.76	Contract Rate 2013	
3.2	Tree Trimming	Lot	1	20000	$ 20,000.00		
3.3					$ -		
				Sub-Total	$ 273,203.76		
4	**020 Royalties, Easements**						
4.1	Permits & Easements	Lot	[redacted]		$ 2,000.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 2,000.00		
5	**094 Interest Capitalized**						
5.1	Interest				$ -		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ -		
6	**095 Administrative Overhead**						
6.1	Contract AO		1	90129.92	$ 90,129.92		
6.2	Labour AO		1	2552.08	$ 2,552.08		
6.3	Vehicle AO		1	415.6	$ 415.60		
				Sub-Total	$ 93,097.60		
Cost Estimate				**Total**	$ 444,594.92		
7	**Original Cost**				$ 45,848.52		
7.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

2013 56N-401 Pictou Rebuild

In this project the 25kV line will be extended along Denoon Street through to where it ends on Three Brooks Rd, via Beeches Road.

There will be two sections where new construction will occur for approximately 250m.

There is also roughly 900 m of three phase rebuild (where required) along with 430m of construction from 1 to 3 phases on Beeches / Three Brooks Rd.

Union Street will remain at 4kV.

Extend 1 phase from Harbour Drive down Harbour Crescent to feed the customers at the end of street.

Rebuild line that feeds smelters Lane roadside.

Install Inlines after 3phase load beyond current recloser location.

Install inlines where the 25kV line comes to the cemetery

Scope potential new location for Recloser R451-021, prior to intersection of Highway 256 (Three Brooks Rd) and Bayview Rd

Remove single phase along Three Brooks Road, near intersection of Bayview Road.

CI Number: 41358

Title: **624V-311 Scotch Village Phase 3**

Start Date: 2013/04
Final Cost Date: 2013/10
Function: Distribution
Forecast Amount: $422,926

DESCRIPTION:

This project is the final phase of a three year program to replace deteriorated plant along Highway 236 from Scotch Village to Clarksville. This will involve the replacement of deteriorated poles, conductors, and devices as required to improve the reliability of the line. The scope of this project includes rebuilding a 4 km section of the 624V-311 feeder using the current roadside alignment. Work will begin east of Atwood Road, and finish at the intersection of Highway 236 and Highway 202 at Clarksville. NS Power will be completing this work.

Summary of Related CIs +/- 2 years:
2011 CI 40379 Scotch Village Phase 2 $458,177

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Requirement to Serve

Why do this project?

The plant along this line dates back into the 1960s and is deteriorated. A new line will be constructed to reduce customer outages due to failure of this aging line.

Why do this project now?

Due to the age and condition of the current section of line, rebuilding this section of line will improve the reliability in the area through a reduction in outages caused by failure.

Why do this project this way?

Rebuilding the line within the existing alignment will allow use of an already established ROW, and allow re-use of some existing plant.

CI Number : 41358 - 624V-311 Scotch Village Ph 3 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		36,200	0	36,200
094		094 - Interest Capitalized		3,046	0	3,046
095		095-COPS Regular Labour AO		64,138	0	64,138
095		095-COPS Contracts AO		32,278	0	32,278
013	002	013 - COPS Contracts	002 - DP - Land Rights	[redacted]	0	[redacted]
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	[redacted]	0	[redacted]
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	27,400	0	27,400
002	035	002 - T&D Overtime Labour	035 - DP - Wood Poles	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	62,627	0	62,627
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
001	038	001 - T&D Regular Labour	038 - DP - Insulators	121	0	121
002	038	002 - T&D Overtime Labour	038 - DP - Insulators	0	0	0
012	038	012 - Materials	038 - DP - Insulators	40	0	40
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	44,919	0	44,919
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	22,546	0	22,546
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	2,184	0	2,184
002	040	002 - T&D Overtime Labour	040 - DP - O/H Cond.Devices	0	0	0
012	040	012 - Materials	040 - DP - O/H Cond.Devices	543	0	543
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	1,983	0	1,983
002	041	002 - T&D Overtime Labour	041 - DP - O/H Line Transf.	0	0	0
012	041	012 - Materials	041 - DP - O/H Line Transf.	9,525	0	9,525
001	052	001 - T&D Regular Labour	052 - DP - Services	1,827	0	1,827
002	052	002 - T&D Overtime Labour	052 - DP - Services	0	0	0
012	052	012 - Materials	052 - DP - Services	400	0	400
001	085	001 - T&D Regular Labour	085 Design	1,369	0	1,369
001	085	001 - Regular Labour (No AO)	085 Design	971	0	971
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	7,891	0	7,891
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
001	090	001 - T&D Regular Labour	090 - DP - LED Street Lights	107	0	107

CI Number : 41358 - 624V-311 Scotch Village Ph 3 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
002	090	002 - T&D Overtime Labour	090 - DP - LED Street Lights	0	0	0
			Total Cost:	422,957	0	422,957
			Original Cost:	133,070		

Location: Distribution
CI# / FP#: 41358
Title: 624V-311 Scotch Village Phase 3
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour No AO	Lot	1	$ 970.94	$ 970.94		
1.2	Planner	Lot	1	$ 1,368.62	$ 1,368.62	~ 2% of T&D Labour	
1.3	Field Supervision	Lot	1	$ 7,890.81	$ 7,890.81	~ 10% of Total Labour	
1.4	NSPI T&D Regular Labour	Person Day	[redacted]	[redacted]	$ 78,540.13	Work Order Generated	
1.5					$ -		
1.6					$ -		
1.7					$ -		
				Sub-Total	$ 88,770.50		
2	**012 Materials**						
2.1	Standard material Cutouts, Poles, Conductor, Transformers, Insulators, Anchors and Guys	Lot	1	$ 48,546.82	$ 48,546.82	Work Order Generated	
2.2	Aliant Pole Costs	Lot	1	$ 47,134.00	$ 47,134.00	Estimate based on the Aliant Joint Use Agreement	
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 95,680.82		
3	**013 Other Contracts**						
3.1	Tree Trimming	Lot	1	[redacted]	[redacted]	Planner Estimate	
3.2	Flagging	Lot	1	[redacted]	[redacted]	Planner Estimate	
3.3	Backhoe	Lot	1	[redacted]	[redacted]	Planner Estimate	
				Sub-Total	$ 97,843.00		
4	**020 Land Rights**						
4.1	Easement	Lot	1	[redacted]	[redacted]		
4.2					$ -		
4.3					$ -		
				Sub-Total	[redacted]		
5	**094 Interest Capitalized**						
5.1	Interest	Lot	1	$ 3,046.38	$ 3,046.38		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 3,046.38		
6	**095 Administrative Overhead**						
6.1	Contract AO	Lot	1	$ 32,278.40	$ 32,278.40		
6.2	Labour AO	Lot	1	$ 64,137.56	$ 64,137.56		
6.3	Vehicle AO	Lot	1	$ 36,199.76	$ 36,199.76		
				Sub-Total	$ 132,615.72		
Cost Estimate				**Total**	$ 422,957.42		
7	**Original Cost**						
7.1					$ 133,069.73		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

624V-311 Scotchvillage Reconductor

Phase -3

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Parameters:
Feeder Section: 624V-311
Customers: 291

	Annual CI			Annual CHI				
Year	**Corrosion**	**Electrical Failure**	**Mechanical Failure**	**Corrosion**	**Electrical Failure**	**Mechanical Failure**	**Total CI**	**Total CHI**
2003	0	2	5	0	11	10	7	21
2004	0	0	540	0	0	1,098	540	1,098
2005	0	0	236	0	0	242	236	242
2006	0	0	306	0	0	786	306	786
2007	1	275	2	1	78	4	278	82
2008	0	0	3	0	0	37	3	37
2009	0	1	4	0	1	9	5	10
2010	0	297	697	0	752	1,622	994	2,375
Prior to Re-Build	1	575	1,793	1	842	3,808	2,369	4,652
2011	1	0	4	4	0	12	5	16
2012 (June)	0	0	1	0	0	5	1	5
Grand Total	**2**	**575**	**1,798**	**4**	**842**	**3,826**	**2,375**	**4,672**

The table above shows outage statistics that can be attributed to the deteriorated state of the distributrion plant on 624V-3131. Prior to the start of the three-year re-build project, deteriorated plant had resulted in over 2,300 customer interruptions and over 4,600 customer hours of interruption. Outage statistics following the start of the re-build project indicate that the project is successfully improving reliability due to deteriorated plant.

CI Number: 43219

Title: **93V-311 Saulnierville Reconductor Phase 2**

Start Date: 2013/03
Final Cost Date: 2013/06
Function: Distribution
Forecast Amount: $418,888

DESCRIPTION:

This project provides for the replacement of 3.8 km of deteriorated conductor and 14 deteriorated poles on feeder 93V-311 along Highway 1 from Comeauville toward Little Brook in Digby County. The feeder will be reconductored with 336ASC for contingency and storm hardening.

This is phase two of a three year project to upgrade conductor on the 93V-311 feeder out of the Saulnierville Substation.

Summary of Related CIs +/- 2 years:
2011 CI 41203 93V-311 Saulnierville Recondcutor Phase 1 $199,877 (Part of D055)
2014 CI TBD 93V-311 Saulnierville Reconductor Phase 3 $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Deteriorated Conductor

Why do this project?

The current conductor is 1/0, and the steel core is in a deteriorated state. This project will replace the deteriorated conductor with 336ASC, a larger conductor that will enable the feeder to provide reliable daily operation and offer contingency loading for the area.

Why do this project now?

The conductor requires replacement as it is deteriorated. Replacement of the conductor will improve the reliability of the feeder and the local system.

Why do this project this way?

Replacing the deteriorated conductor with a larger conductor is the most effective method for increasing reliability and providing contingency during periods of increased load. A portion of the labour associated with this project is being sourced through NS Power’s existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power’s workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 43219 - 93V-311 Saulnierville Reconductor Phase 2 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

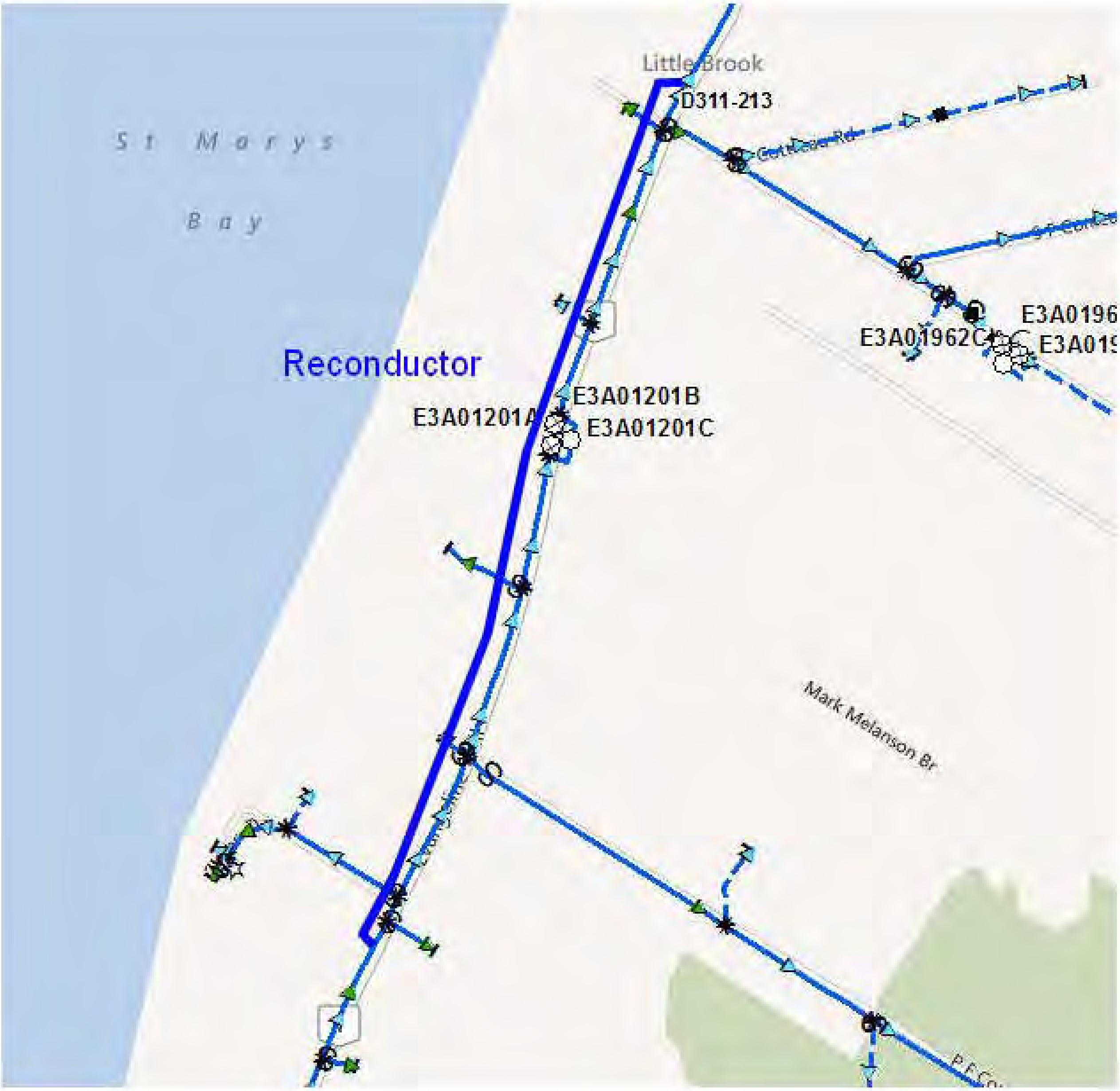
Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		2,912	0	2,912
094		094 - Interest Capitalized		5,941	0	5,941
095		095-COPS Regular Labour AO		5,160	0	5,160
095		095-COPS Contracts AO		86,516	0	86,516
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	1,500	0	1,500
012	035	012 - Materials	035 - DP - Wood Poles	10,904	0	10,904
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
012	038	012 - Materials	038 - DP - Insulators	40	0	40
013	038	013 - COPS Contracts	038 - DP - Insulators	[redacted]	0	[redacted]
012	039	012 - Materials	039 - DP - O/H Cond.	22,493	0	22,493
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	[redacted]	0	[redacted]
012	040	012 - Materials	040 - DP - O/H Cond.Devices	1,240	0	1,240
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	[redacted]	0	[redacted]
012	041	012 - Materials	041 - DP - O/H Line Transf.	11,561	0	11,561
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	[redacted]	0	[redacted]
012	052	012 - Materials	052 - DP - Services	375	0	375
013	052	013 - COPS Contracts	052 - DP - Services	[redacted]	0	[redacted]
001	085	001 - Regular Labour (No AO)	085 Design	932	0	932
001	085	001 - T&D Regular Labour	085 Design	1,044	0	1,044
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	6,020	0	6,020
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
013	090	013 - COPS Contracts	090 - DP - LED Street Lights	[redacted]	0	[redacted]
			Total Cost:	418,888	0	418,888
			Original Cost:	70,130		

Location: Central Territory
CI# / FP#: 43219
Title: 93V-311 Saulnierville Reconductor Phase 2
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1					$ -		
1.2	Project Support Labour (No AO)	Lot	1	$ 932.26	$ 932.26		
1.3	Design Labour	Lot	1	$ 1,044.08	$ 1,044.08		
1.4	Field Supervision	Lot	1	$ 6,019.66	$ 6,019.66		
1.5					$ -		
				Sub-Total	$ 7,996.00		
2	**012 Materials**						
2.1					$ -		
2.2	Standard material Cutouts, LA, Transformers and Insulators	Lot	1	46612.84	$ 46,612.84	Work Order Generated	
2.3					$ -		
				Sub-Total	$ 46,612.84		
3	**013 T&D Contracts**						
3.1	EUS	Hr	[redacted]		$ 262,249.28		
3.2							
3.3					$ -		
				Sub-Total	$ 262,249.28		
4	**013 Other Contracts**						
4.1					$ -		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ -		
5	**020 Royalties, Easements, Approvals**						
5.1	Easement	Each	[redacted]		$ 1,500.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 1,500.00		
6	**094 Interest Capitalized**						
6.1	Interest		1	5941.01	$ 5,941.01		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 5,941.01		
7	**095 Administrative Overhead**						
7.1	Contract AO		1	86516.04	$ 86,516.04		
7.2	Labour AO		1	5160.06	$ 5,160.06		
7.3	Vehicle AO		1	2912.38	$ 2,912.38		
				Sub-Total	$ 94,588.48		
Cost Estimate				**Total**	$ 418,887.60		
8	**Original Cost**						
8.1					$ 70,130.13		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project



Little Brook
D311-213
St Marys
Bay
Reconductor
E3A0196
E3A01962C
E3A019
E3A01201B
E3A01201A
E3A01201C
Mark Melanson Br

CI Number: 43282

Title: **2013 Distribution Feeder Ties**

Start Date: 2013/03
Final Cost Date: 2013/12
Function: Distribution
Forecast Amount: $389,878

DESCRIPTION:

This project provides for the costs associated with building spans of line, re-conductoring and installing transfer switches in order to tie distribution lines together to allow for load transfer between circuits. The scope of this project will focus on three different feeder ties in 2013:

1. 11S-304 to 11S-306 – Murphy Rd – Re-conductor 2 km of line
2. 515S-311 to 104S-313 – Cabot Trail Rd – Extend 2.5 km of single phase line
3. 82V-402 to 127H-413 – Old Post Rd – Construct 5 spans of 3 phase and upgrade 5 spans of 1 phase to 3 phase

Summary of Related Projects +/- 2 years:
2011 CI 39272 2011 Distribution Feeder Ties $500,000 2012 CI 41339 2012 Distribution Feeder Ties $492,873
2014 Distribution Feeder Ties - $ TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Outage Performance

Why do this project?

This work is being undertaken as part of the overall customer reliability improvement investment. This is year four of a five year (2010-2014) plan to improve reliability to NS Power's customers. This project is required in order to improve reliability by enabling the transfer of customers between feeders during outages.

Why do this project now?

This project will improve system reliability by providing alternate supply during outage situations.

Why do this project this way?

This is the most cost effective and efficient way to create a feeder interconnection between the circuits.

The labour for this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 43282 - 2013 Distribution Feeder Ties

Project Number

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin.

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		9,506	0	9,506
094		094 - Interest Capitalized		9,665	0	9,665
095		095-COPS Contracts AO		66,161	0	66,161
095		095-COPS Regular Labour AO		16,842	0	16,842
013	002	013 - COPS Contracts	002 - DP - Land Rights	40,000	0	40,000
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	7,500	0	7,500
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	2,504	0	2,504
002	035	002 - T&D Overtime Labour	035 - DP - Wood Poles	0	0	0
002	035	002 - Overtime Labour (No AO)	035 - DP - Wood Poles	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	8,800	0	8,800
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	10,143	0	10,143
002	039	002 - Overtime Labour (No AO)	039 - DP - O/H Cond.	0	0	0
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	35,200	0	35,200
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	[redacted]	0	[redacted]
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	3,130	0	3,130
002	040	002 - T&D Overtime Labour	040 - DP - O/H Cond.Devices	0	0	0
002	040	002 - Overtime Labour (No AO)	040 - DP - O/H Cond.Devices	0	0	0
012	040	012 - Materials	040 - DP - O/H Cond.Devices	11,000	0	11,000
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	[redacted]	0	[redacted]
001	085	001 - Regular Labour (No AO)	085 Design	1,100	0	1,100
001	085	001 - T&D Regular Labour	085 Design	1,076	0	1,076
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	6,204	0	6,204
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
011	087	011 - Travel Expense	087 Field Super.& Ops.	250	0	250
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	250	0	250
			Total Cost:	389,878	0	389,878
			Original Cost:	50,563		

Location: **Distribution**
CI# / FP#: 43282
Title: 2013 Distribution Feeder Ties
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour (No AO)	Lot	1	$ 1,100.00	$ 1,100.00		
1.2	PLT Labour	mday	[redacted]		$ 15,776.62		
1.3	T&D Site Supervision	Lot	1	$ 6,203.52	$ 6,203.52		
1.4	T&D Design Labour	Lot	1	$ 1,075.97	$ 1,075.97		
1.5					$ -		
				Sub-Total	$ 24,156.11		
2	**012 Materials**						
2.1	O/H Conductor	Lot	1	35200	$ 35,200.00		
2.2	Poles	Lot	1	8800	$ 8,800.00		
2.3	O/H Devices	Lot	1	11000	$ 11,000.00		
2.4					$ -		
				Sub-Total	$ 55,000.00		
3	**013 T&D Contracts**						
3.1	EUS	Hour	[redacted]		$ 160,548.00		
3.2	Tree Trimming - 11S (light)	km	[redacted]		$ 10,000.00		
3.3	Tree Trimming - 515S/104S (heavy)	km	[redacted]		$ 25,000.00		
3.4	Tree Trimming - 82V/127H (heavy)	km	[redacted]		$ 5,000.00		
				Sub-Total	$ 200,548.00		
4	**020 Royalties, Easements**						
4.1	Easements - 515S/104S	ea	[redacted]		$ 5,000.00		
4.2	Easements - 82V/127H	span	[redacted]		$ 2,500.00		
4.3					$ -		
				Sub-Total	$ 7,500.00		
5	**011 Travel Expenses**						
5.1	Travel	Lot	1	250	$ 250.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 250.00		
6	**041 Meals and Entertainment**						
6.1	Meals	Lot	1	250	$ 250.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 250.00		
7	**094 Interest Capitalized**						
7.1	Interest		1	9665.11	$ 9,665.11		
7.2							
7.3							
				Sub-Total	$ 9,665.11		
8	**095 Administrative Overhead**						
8.1	Contracts AO		1	66160.77	$ 66,160.77		
8.2	Labour AO		1	16842.45	$ 16,842.45		
8.3	Vehicle AO		1	9506.05	$ 9,506.05		
				Sub-Total	$ 92,509.27		
Cost Estimate				**Total**	$ 389,878.49		
9	**Original Cost**				$ 50,563.00		
9.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43189

Title: **2013 Downline Recloser Additions**

Start Date: 2013/01
Final Cost Date: 2013/11
Function: Distribution
Forecast Amount: $380,204

DESCRIPTION:

This project provides for the costs associated with the installation of additional downline reclosers on selected distribution feeders. In 2013, it is planned to add midpoint reclosers to 8 distribution circuits. Feeder selection is based on Customer Interruptions (CI) x Customer Hours (CH) weighting for full feeder outages that were not caused by loss of transmission. The eight feeders that are part of this project are: 129H-413, 104H-421, 137H-413, 20H-304, 16N-301, 13V-303, 36V-302 and 102W-312.

Summary of Related CIs +/- 2 years:
2011 CI 39269 2011 Downline Recloser Additions $444,765
2012 CI 41353 2012 Downline Recloser Additions $543,284
2014 CI TBD 2014 Downline Recloser Additions $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Outage Performance

Why do this project?

This project is required to improve distribution system reliability. An estimated 9,100 customer-interruptions and 33,500 customer-hours per year will be avoided through this improved feeder sectionalizing. These numbers are based on the eight new additional downline reclosers proposed for 2013.

Why do this project now?

Ongoing reliability analysis has indicated that the feeders being targeted in this project would benefit from the addition of a midpoint recloser. The target is to have no more than 2,000 customers on an urban/suburban feeder section and no more than 1,000 customers on rural feeder sections.

Why do this project this way?

The installation of a midpoint recloser is a utility standard approach to improving distribution reliability. Appropriate sectionalizing of a feeder will improve outage statistics. For instance, installing a recloser at 50% of the length of a feeder with 50% of the customer count before and after the recloser will result in a 25% (on average) improvement in both the System Average Interruption Frequency Index (SAIFI) and the System Average Interruption Duration Index (SAIDI) statistics. The reduction in customer outages will improve customer service. Given the predicted improvement in CI and CH, the $/ACHI (Avoided Customer Hours of Interruption) is evaluated to be $11.35/ACHI.

NS Power personnel will complete the work for this project.

CI Number : 43189 - 2013 Downline Recloser Additions **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		20,282	0	20,282
094		094 - Interest Capitalized		7,076	0	7,076
095		095-COPS Contracts AO		6,730	0	6,730
095		095-COPS Regular Labour AO		35,936	0	35,936
095		095 - T&CS Regular Labour AO		3,639	0	3,639
012	004	012 - Materials	004 - DP - Misc.Equipment	0	0	0
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	0	0	0
002	035	002 - T&D Overtime Labour	035 - DP - Wood Poles	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	2,000	0	2,000
013	035	013 - COPS Contracts	035 - DP - Wood Poles	1,200	0	1,200
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	0	0	0
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	1,600	0	1,600
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	49,193	0	49,193
002	040	002 - T&D Overtime Labour	040 - DP - O/H Cond.Devices	0	0	0
012	040	012 - Materials	040 - DP - O/H Cond.Devices	221,400	0	221,400
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	19,200	0	19,200
001	085	001 - T&CS Regular Labour	085 Design	11,648	0	11,648
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
011	085	011 - Travel Expense	085 Design	200	0	200
041	085	041 - Meals & Entertainment	085 Design	100	0	100
			Total Cost:	380,204	0	380,204
			Original Cost:	9,405		

Location: Distribution
CI# / FP#: 43189
Title: 2013 Downline Recloser Additions
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	001 Regular Labour						
1.1	Electrician	Person Day	[redacted]		$ 10,780.48		
1.2	Power Line Technician	Person Day	[redacted]		$ 38,412.64		
1.3	Engineering (P.Eng)	hr	[redacted]		$ 7,280.00		
1.4	Technologists	hr	[redacted]		$ 4,367.85		
1.5					$ -		
				Sub-Total	$ 60,840.97		
2	012 Materials						
2.1	Recloser	ea	[redacted]		$ 126,000.00	Attachment 1 Page 4 of 5	
2.2	IntelliRupter	ea	[redacted]		$ 72,000.00	Attachment 2 Page 9 of 9	
2.3	Recloser materials	lot	[redacted]		$ 18,000.00		
2.4	IntelliRupter materials	lot	[redacted]		$ 5,000.00		
2.5	pole and framing	lot	[redacted]		$ 4,000.00		
2.6					$ -		
				Sub-Total	$ 225,000.00		
3	013 Contracts						
3.1	Traffic control	hr	[redacted]		$ 19,200.00		
3.2	Backhoe	lot	[redacted]		$ 1,200.00		
3.3					$ -		
				Sub-Total	$ 20,400.00		
4	011 Travel Expenses						
4.1	Travel	lot	1	200	$ 200.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 200.00		
5	041 Meals and Entertainment						
5.1	Meals	lot	1	100	$ 100.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 100.00		
6	094 Interest Capitalized						
6.1	Interest	lot	1	7076.43	$ 7,076.43		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 7,076.43		
7	095 Administrative Overhead						
7.1	Labour AO		1	39,574.42	$ 39,574.42		
7.2	Vehicle AO		1	20,282.33	$ 20,282.33		
7.3	Contract AO		1	6,729.96	$ 6,729.96		
				Sub-Total	$ 66,586.71		
Cost Estimate				**Total**	$ 380,204.11		
8	**Original Cost**				$ 9,404.90		
8.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachments 1 & 2

Removed due to confidentiality

2013 Recloser Additions

	Feeder	Cust Count	CI/y	CH/y	Location	ACI	ACHI	Units	$/ACHI	Cost
	129H-413	4028	3867.2	6588.2	Midpoint recloser on Bedfor hwy, north of Larry Uteck	759.5	1293.9	1	41.98	$ 54,315
	104H-421	2872	6298.7	19395.6	Midpoint recloser on Duffus east of Gottingen	1402.3	4318.0	1	13.84	$ 59,775
	137H-413	2678	3807.8	8217.6	Midpoint recloser near D4A06345	1688.0	3643.0	1	11.94	$ 43,490
	20H-304	2593	2583.8	8592.2	Midpoint recloser near Herring Cove Rd and MacIntosh St.	827.4	2751.4	1	17.76	$ 48,855
	16N-301	4028	6564.1	70689.0	Midpoint recloser at L353-092	2315.3	14207.7	1	3.06	$ 43,442
	13V-303	1564	4577.2	13789.7	Midpoint recloser near D315-356	1041.9	3139.0	1	13.84	$ 43,442
	36V-302	1581	2529.2	10676.4	Midpoint recloser near P316-006	601.9	2540.8	1	17.10	$ 43,442
	102W-312	1509	1811.2	5885.3	Midpoint recloser just past tap for D321-008	495.8	1611.0	1	26.97	$ 43,442
Total	**8**	**20853**	**32039.1**	**143834.1**		**9132.0**	**33504.6**	**8**		**$ 380,204**
								Avg $/ACHI	**$ 11.35**	

CI Number: 43276

Title: **2013 Distribution Reliability Technologies**

Start Date: 2013/04
Final Cost Date: 2013/10
Function: Distribution
Forecast Amount: $328,540

DESCRIPTION:

This project provides for the installation of various covered conductor technologies. 121 potential spans have been identified on the following targeted feeders: 101H-411, 101H-412, 101H-421, 101H-423, 104H-411, 104H-412, 104H-413, 104H-432, 104H-442, 10H-231, 113H-433, 1H-427, 20H-305, 92H-331 and 9H-224.

Related Projects:
CI 40545 2011 Distribution Reliability Tech $110,769
CI 41534 2012 Distribution Reliability Tech$2,496,069
CI TBD 2014 Distribution Reliability Tech $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Outage Performance

Why do this project?

Covered conductor technologies can be strategically used in areas with high risk of galloping and foreign object interference from animals and tree contacts, to improve reliability by reducing the amount of customer interruptions.

Why do this project now?

This work is being done as part of the overall customer reliability improvement investment. Various covered conductor technologies were successfully trialed in 2011 and 2012.

Why do this project this way?

Suitable locations for covered conductor technologies were identified on feeder sections with high customer exposure and high customer hours of interruption from outage types that covered conductor technologies can reduce.

A portion of the labour associated with this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 43276 - 2013 Distribution Reliability Technologies **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		44,824	0	44,824
094		094 - Interest Capitalized		6,286	0	6,286
095		095-COPS Contracts AO		8,076	0	8,076
095		095-COPS Regular Labour AO		79,418	0	79,418
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	61,049	0	61,049
002	040	002 - T&D Overtime Labour	040 - DP - O/H Cond.Devices	0	0	0
012	040	012 - Materials	040 - DP - O/H Cond.Devices	54,450	0	54,450
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	24,480	0	24,480
001	085	001 - T&D Regular Labour	085 Design	47,668	0	47,668
001	085	001 - Regular Labour (No AO)	085 Design	1,089	0	1,089
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
011	085	011 - Travel Expense	085 Design	600	0	600
041	085	041 - Meals & Entertainment	085 Design	600	0	600
			Total Cost:	328,540	0	328,540
			Original Cost:			

Location: Distribution
CI# / FP#: 43276
Title: 2013 Distribution Reliability Technologies
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support Labour	Lot	1	$ 1,089.00	$ 1,089.00		
1.2	Power Line Technician	manday	[redacted]		$ 61,048.66		
1.3	Engineering Design Labour	Lot	1	$ 47,668.25	$ 47,668.25		
1.4							
1.5					$ -		
				Sub-Total	$ 109,805.91		
2	**012 Materials**						
2.1	Medium Voltage Line Cover and misc hardware	metres	[redacted]		$ 45,738.00		
2.2	Miscellaneous Hardware	Lot	1	8712	$ 8,712.00		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 54,450.00		
3	**013 T&D Contracts**						
3.1	EUS	hour	[redacted]		$ 24,480.00		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 24,480.00		
4	**011 Travel Expenses**						
4.1	Travel	Lot	1	600	$ 600.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 600.00		
5	**041 Meals and Entertainment**						
5.1	Meals	Lot	1	600	$ 600.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 600.00		
6	**094 Interest Capitalized**						
6.1	Interest		1	6286.36	$ 6,286.36		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 6,286.36		
7	**095 Administrative Overhead**						
7.1	Labour AO		1	79,417.71	$ 79,417.71		
7.2	Vehicle AO		1	44,823.99	$ 44,823.99		
7.3	Contract AO		1	8,075.97	$ 8,075.97		
				Sub-Total	$ 132,317.67		
Cost Estimate				**Total**	$ 328,539.94		
8	**Original Cost**						
8.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43194

Title: **3S-303 North Sydney Targeted Replacements**

Start Date: 2013/01
Final Cost Date: 2013/07
Function: Distribution
Forecast Amount: $308,730

DESCRIPTION:

This project is part of a program to improve customer service and reliability, as measured by System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI) performance and deteriorated plant incidents on selected feeders throughout the Province. Specifically, deteriorated poles and conductor, porcelain arrestors, cutouts, rusty transformers and guys will be replaced.

Summary of Related CIs +/- 2 years:

No projects in 2011, 2012, 2013, 2014 and 2015.

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Outage Performance

Why do this project?

This work is being done as part of the overall customer reliability improvement investment. This is year four of a five year (2010-2014) plan to improve reliability to NS Power's customers. Distribution equipment (e.g. poles, conductor, cutouts and transformers) failures are a primary driver of customer outages. This project will address distribution equipment issues on feeder section 3S-303, out of the North Sydney Substation. This feeder section, which is approximately 10.3 km in length, was selected due to past performance, customer density and feeder length.

Why do this project now?

This feeder has been included in the 2013 Reliability Investment Plan based on performance, customer density and feeder length. It is expected that targeted replacements on 3S-303 will result in annual savings of around 1225 customer hours of interruption.

Why do this project this way?

This project will address the distribution equipment weakness on this feeder.

The labour for this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 43194-D469 - 3S-303 North Sydney Targeted Replacements **Project Number** D469

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		355	0	355
094		094 - Interest Capitalized		821	0	821
095		095-COPS Contracts AO		71,270	0	71,270
095		095-COPS Regular Labour AO		628	0	628
012	035	012 - Materials	035 - DP - Wood Poles	4,259	0	4,259
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
012	038	012 - Materials	038 - DP - Insulators	1,695	0	1,695
013	038	013 - COPS Contracts	038 - DP - Insulators	[redacted]	0	[redacted]
012	039	012 - Materials	039 - DP - O/H Cond.	470	0	470
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	[redacted]	0	[redacted]
012	040	012 - Materials	040 - DP - O/H Cond.Devices	11,116	0	11,116
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	[redacted]	0	[redacted]
012	041	012 - Materials	041 - DP - O/H Line Transf.	851	0	851
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	[redacted]	0	[redacted]
013	052	013 - COPS Contracts	052 - DP - Services	[redacted]	0	[redacted]
001	085	001 - T&D Regular Labour	085 Design	860	0	860
001	085	001 - Regular Labour (No AO)	085 Design	368	0	368
013	090	013 - COPS Contracts	090 - DP - LED Street Lights	[redacted]	0	[redacted]
			Total Cost:	308,730	0	308,730
			Original Cost:	73,386		

Location: Distribution
CI# / FP#: 43194
Title: 3S-303 North Sydney Targeted Replacements
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 & 002 Labour**						
1.1	Design Labour	Lot	1	$ 860.21	$ 860.21		
1.2	Project Support Labour (No AO)	Lot	1	$ 367.84	$ 367.84		
1.3							
1.4					$ -		
				Sub-Total	$ 1,228.05		
2	**012 Materials**						
2.1	Poles and O/H Devices	Lot	1	18392	$ 18,392.00		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 18,392.00		
3	**013 T&D Contracts**						
3.1	Line Work	Lot	[redacted]		$ 216,036.00		
3.2							
3.3					$ -		
				Sub-Total	$ 216,036.00		
4	**020 Easements**						
4.1					$ -		
4.2					$ -		
4.3					$ -		
4.4							
				Sub-Total	$ -		
5	**094 Interest Capitalized**						
5.1	Interest	Lot	1	821.1	$ 821.10		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 821.10		
6	**094 & 095 Administrative Overhead**						
6.1	Labour Overhead	Lot	1	628.39	$ 628.39		
6.2	Vehicle Overhead	Lot	1	354.66	$ 354.66		
6.3	Contracts Overhead	Lot	1	71270.28	$ 71,270.28		
				Sub-Total	$ 72,253.33		
Cost Estimate				**Total**	$ 308,730.48		
7	**Original Cost**				$ 73,386.00		
7.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Customer Hours of Interruption from Targeted Device Failures

Feeder	Customers	2007	2008	2009	2010	2011	Average CHI
3S-303	733	957	45	1,042	3,522	562	1,225

CI Number: 43177

Title: **103W-311 Gold River Reconductor Phase 3**

Start Date: 2013/03
Final Cost Date: 2013/09
Function: Distribution
Forecast Amount: $306,410

DESCRIPTION:

This project entails reconductoring a 4.2 km section of the 103W-311 feeder on Highway 3 South from Pine Drive, heading east. A small section of the off road section of this line will be relocated to roadside on Highway 3 to increase accessibility. This is phase three of a four year project to upgrade 12 km of conductor on the 103W-311 feeder out of the Gold River Substation. The work will be executed by NS Power personnel.

The first year of the project, which was included as part of the 2011 ACE Plan, involved the reconductoring of approximately 7 km of feeder (~175 spans) from Delbury Road along Highway 3 South. The second phase completed in 2012 involved the reconductoring of approximately 7 km of feeder (~ 210 spans) along Highway 3 to the Pine Drive.

Summary of Related CIs +/- 2 years:
2011 CI 40203 103W-311 Gold River Phase 1 - $434,415
2012 CI 41327 103W-311 Gold River Phase 2 - $310,296
2014 CI TBD 103W-311 Gold River Phase 4 $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Requirement to Serve

Why do this project?

The existing conductor on this portion of the feeder is a combination of #6 and #4 AL which is undersized for the load it carries. By reconductoring with 336ASCR, a larger conductor with more capacity, the conductor will be of the appropriate size for increased load conditions, and the ability to transfer load to this feeder from others will be enabled.

Why do this project now?

Reconductoring this portion of the feeder with a larger wire will improve reliability to the area by providing load transferring capabilities and provide contingency for all times of the year .

Why do this project this way?

This is the most effective method for increasing contingency loading in the area. Reconductoring the small wire closest to the existing source provides the required capacity for load transfers.

CI Number : 43177 - 103W-311 Gold River Reconductor Phase 3 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		35,088	0	35,088
094		094 - Interest Capitalized		3,138	0	3,138
095		095-COPS Contracts AO		13,815	0	13,815
095		095-COPS Regular Labour AO		62,167	0	62,167
013	002	013 - COPS Contracts	002 - DP - Land Rights	[redacted]	0	[redacted]
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	[redacted]	0	[redacted]
012	004	012 - Materials	004 - DP - Misc.Equipment	0	0	0
066	007	066 - Other Goods & Services	007 - DP - Environmental	7,500	0	7,500
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	13,384	0	13,384
002	035	002 - T&D Overtime Labour	035 - DP - Wood Poles	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	10,040	0	10,040
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
001	038	001 - T&D Regular Labour	038 - DP - Insulators	161	0	161
002	038	002 - T&D Overtime Labour	038 - DP - Insulators	0	0	0
012	038	012 - Materials	038 - DP - Insulators	64	0	64
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	53,249	0	53,249
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	38,100	0	38,100
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	2,840	0	2,840
002	040	002 - T&D Overtime Labour	040 - DP - O/H Cond.Devices	0	0	0
012	040	012 - Materials	040 - DP - O/H Cond.Devices	2,188	0	2,188
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	2,117	0	2,117
002	041	002 - T&D Overtime Labour	041 - DP - O/H Line Transf.	0	0	0
012	041	012 - Materials	041 - DP - O/H Line Transf.	2,891	0	2,891
001	050	001 - T&D Regular Labour	050 - DP - Street Lights	375	0	375
002	050	002 - T&D Overtime Labour	050 - DP - Street Lights	0	0	0
001	052	001 - T&D Regular Labour	052 - DP - Services	4,014	0	4,014
002	052	002 - T&D Overtime Labour	052 - DP - Services	0	0	0
012	052	012 - Materials	052 - DP - Services	369	0	369
001	085	001 - Regular Labour (No AO)	085 Design	1,073	0	1,073
001	085	001 - T&D Regular Labour	085 Design	1,325	0	1,325
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	7,638	0	7,638

CI Number : 43177 - 103W-311 Gold River Reconductor Phase 3 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	306,410	0	306,410
			Original Cost:	31,045		

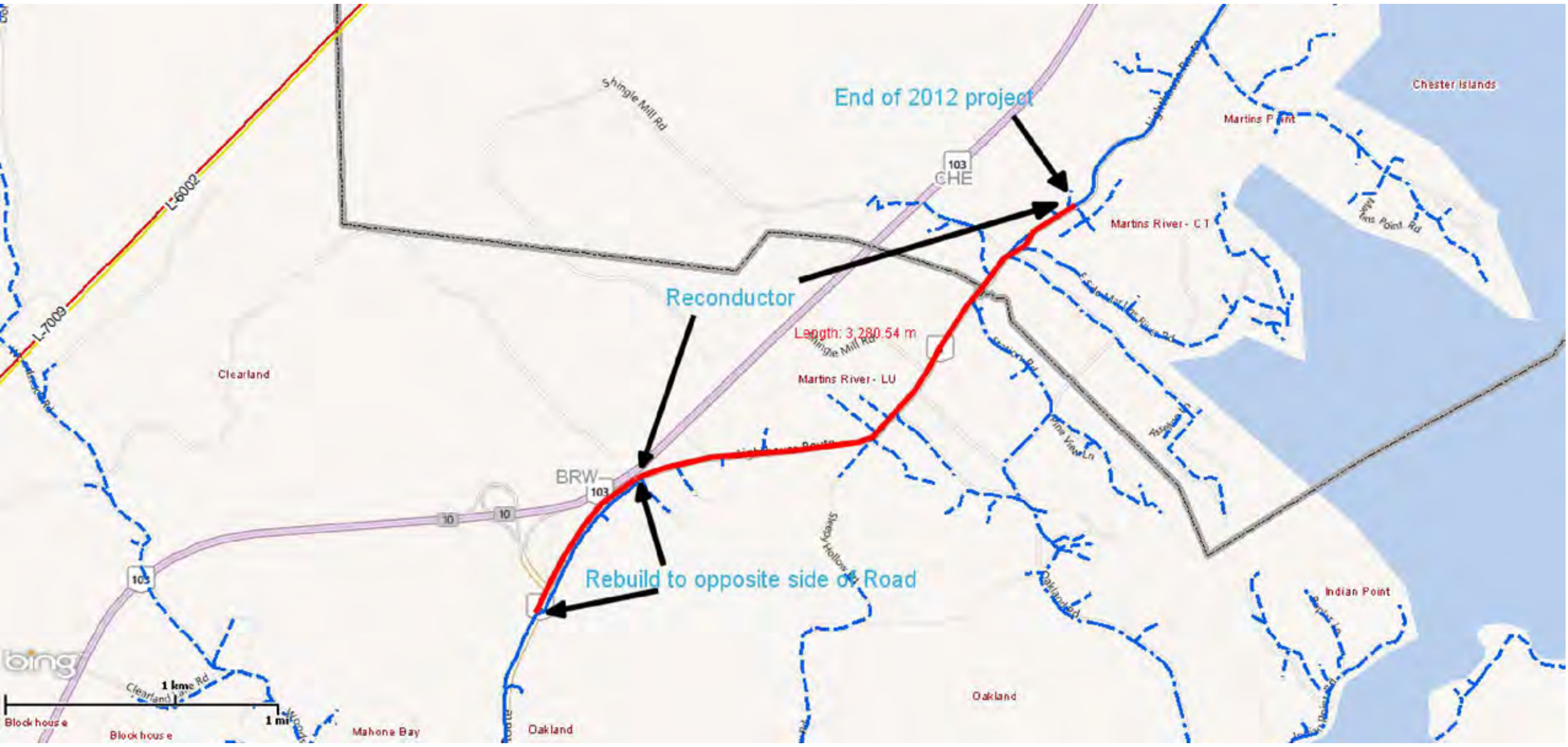
Location: Central Territory
CI# / FP#: 43177
Title: 103W-311 Gold River Reconductor 3
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	NSPI T &D Regular Labour	Person Day	[redacted]		$ 76,139.34		
1.2	Project Support Labour (No AO)	Lot	1	$ 1,073.03	$ 1,073.03		
1.3	Planner	Lot	1	$ 1,324.79	$ 1,324.79	~ 2% of T & D Labour	
1.4	T&D Regular Labour	Lot	1	$ 7,638.09	$ 7,638.09	~10% of Total Labour	
1.5							
1.6							
				Sub-Total	$ 86,175.25		
2	**012 Materials**						
2.1	Standard material Cutouts, Conductor, Poles, Transformers and Insulators	Lot	1	$ 53,651.62	$ 53,651.62	Work Order Generated	
2.2					$ -		
				Sub-Total	$ 53,651.62		
4	**013 Contracts**						
4.1	Tree Trimming	Spand	10	[redacted]			
4.2	Flagging	Lot	1				
4.3	Backhoe	Lot	1				
				Sub-Total	$ 41,875.00		
5	**020 Land Rights**						
5.1	Easement	Lot	1	[redacted]			
5.2					$ -		
5.3					$ -		
				Sub-Total	[redacted]		
6	**066 Other Goods & Services**						
6.1	River Crossing Permit	Lot	1	$ 7,500.00	$ 7,500.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 7,500.00		
7	**094 Interest Capitalized**						
7.1	Interest	Lot	1	$ 3,138.33	$ 3,138.33		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 3,138.33		
8	**095 Administrative Overhead**						
8.1	Contract AO	Lot	1	$ 13,814.58	$ 13,814.58		
8.2	Labour AO	Lot	1	$ 62,167.16	$ 62,167.16		
8.3	Vehicle AO	Lot	1	$ 35,087.64	$ 35,087.64		
				Sub-Total	$ 111,069.38		
Cost Estimate				**Total**	$ 306,409.58		
10	**Original Cost**						
10.1					$ 31,044.63		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Gold River Recondcutor

Phase 3



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CI Number: 43218

Title: **88W-323HA – Tusket Islands Phase 3**
Start Date: 2013/06
Final Cost Date: 2013/09
Function: Distribution
Forecast Amount: $287,196

DESCRIPTION:

This project is to replace deteriorated poles and framing on the portion of feeder 88W-323HA which runs on Calf Island, part of the Tusket Islands. This is year three of a multi-year plan to replace deteriorated poles and framing on the Tusket Islands which are served by 88W-323HA.

Summary of Related CIs +/- 2 years:
2010 CI 39642 Part of D055 Routine Tusket Islands Phase 1 $86,733
2011CI 40386 Tusket Islands Phase 2 $220,000
2014 CI TBD Tusket Islands Phase 4 $TBD

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Requirement to Serve

Why do this project?

NS Power has a requirement to serve all customers, and as such must maintain a supply of permanent power to the Tusket Islands. The distribution poles on Calf Island are deteriorated and must be replaced to ensure the reliable supply of power to this island.

Why do this project now?

Replacing the deteriorated equipment is required to avoid a lengthy and unplanned outage on Calf Island.

Why do this project this way?

Replacement of the deteriorated plant in-kind is the most cost effective manner to maintain service to Calf Island. This project will be completed by NS Power.

CI Number : 43218 - 88W-323HA Tusket Islands Phase 3 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		11,170	0	11,170
094		094 - Interest Capitalized		2,331	0	2,331
095		095-COPS Contracts AO		51,464	0	51,464
095		095-COPS Regular Labour AO		19,791	0	19,791
013	002	013 - COPS Contracts	002 - DP - Land Rights	[redacted]	0	[redacted]
002	007	002 - T&D Overtime Labour	007 - DP - Environmental	0	0	0
066	007	066 - Other Goods & Services	007 - DP - Environmental	1,000	0	1,000
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	18,298	0	18,298
012	035	012 - Materials	035 - DP - Wood Poles	17,672	0	17,672
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	8,186	0	8,186
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	118	0	118
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	54	0	54
002	040	002 - T&D Overtime Labour	040 - DP - O/H Cond.Devices	0	0	0
001	046	001 - T&D Regular Labour	046 - DP - U/G Conductor	134	0	134
012	046	012 - Materials	046 - DP - U/G Conductor	196	0	196
001	085	001 - Regular Labour (No AO)	085 Design	360	0	360
001	085	001 - T&D Regular Labour	085 Design	422	0	422
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
			Total Cost:	287,196	0	287,196
			Original Cost:	30,129		

Location: Distribution
CI# / FP#: 43218
Title: 88W-323HA - Tusket Islands 3
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1					$ -		
1.2	Regular Labour (No AO)	Lot	1	$ 359.72	$ 359.72		
1.3	PLT Labour	PD	[redacted]		$ 26,671.00		
1.4	Design Labour	Lot	1	$ 422.05	$ 422.05		
1.5					$ -		
				Sub-Total	$ 27,452.78		
2	**012 Materials**						
2.1					$ -		
2.2	Standard material: Poles, and Insulators	Lot	1	17985.85	$ 17,985.85	Work Order Generated	
2.3					$ -		
				Sub-Total	$ 17,985.85		
3	**013 T&D Contracts**						
3.1	Tree Trimming	Lot	1	[redacted]			
3.2	Backhoe	Lot	1				
3.3	Boat Rental	Lot	1			Tusket Phases 1&2	40386
				Sub-Total	$ 156,000.00		
4	**066 Other**						
4.1	Environmental Permits	Lot	1	1000	$ 1,000.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 1,000.00		
5	**094 Interest Capitalized**						
5.1	Interest		1	2331.13	$ 2,331.13		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 2,331.13		
6	**095 Administrative Overhead**						
6.1	Contract AO		1	51,464.40	$ 51,464.40		
6.2	Labour AO		1	19,791.49	$ 19,791.49		
6.3	Vehicle AO		1	11,170.48	$ 11,170.48		
				Sub-Total	$ 82,426.37		
Cost Estimate				**Total**	$ 287,196.13		
7	**Original Cost**						
7.1					$ 30,129.28		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 41346

Title: **82S-304 Whitney Pier Targeted Feeder Replacements**

Start Date: 2013/01
Final Cost Date: 2013/07
Function: Distribution
Forecast Amount: $276,358

DESCRIPTION:

This project is part of a program to improve customer service and reliability, as measured by System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI) performance and deteriorated plant incidents on selected feeders throughout the Province. Specifically, deteriorated poles and conductors, porcelain arrestors, cutouts, rusty transformers and guys will be replaced.

Summary of Related CIs +/- 2 years:
No projects in 2010, 2011, 2013, and 2014

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Outage Performance

Why do this project?

This work is being done as part of the overall customer reliability improvement investment. This is year four of a five year (2010-2014) plan to improve reliability for NS Power's customers.

Distribution equipment (e.g. poles, conductor, cutouts and transformers) failures are a primary driver of customer outages. This project will address distribution equipment issues on feeder 82S-304, out of the Whitney Pier Substation. This feeder, which is 35.9 km in length, was selected due to past performance.

Why do this project now?

This feeder has been added to the 2013 Reliability Investment Plan based on performance, customer density and feeder length. It is expected that targeted replacements on 82S-304 will result in annual savings of around 1512 customer hours of interruption.

Why do this project this way?

This project will address the distribution equipment weakness on this feeder.

The labour for this project will be sourced through NS Power's existing Power Line Technician (PLT) Service Agreement with EUS. This is aligned with NS Power's workforce planning model which is designed to optimize the allocation and execution of PLT resources among work requirements.

CI Number : 41346-D464 - 82S-304 Whitney Pier Targeted Feeder Replacements **Project Number** D464

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		318	0	318
094		094 - Interest Capitalized		727	0	727
095		095-COPS Regular Labour AO		563	0	563
095		095-COPS Contracts AO		63,935	0	63,935
013	004	013 - COPS Contracts	004 - DP - Misc.Equipment	[redacted]	0	[redacted]
012	035	012 - Materials	035 - DP - Wood Poles	8,176	0	8,176
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
012	038	012 - Materials	038 - DP - Insulators	1,061	0	1,061
013	038	013 - COPS Contracts	038 - DP - Insulators	[redacted]	0	[redacted]
012	039	012 - Materials	039 - DP - O/H Cond.	686	0	686
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	[redacted]	0	[redacted]
012	040	012 - Materials	040 - DP - O/H Cond.Devices	6,003	0	6,003
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	[redacted]	0	[redacted]
013	052	013 - COPS Contracts	052 - DP - Services	[redacted]	0	[redacted]
001	085	001 - T&D Regular Labour	085 Design	771	0	771
001	085	001 - Regular Labour (No AO)	085 Design	319	0	319
013	090	013 - COPS Contracts	090 - DP - LED Street Lights	[redacted]	0	[redacted]
			Total Cost:	276,358	0	276,358
			Original Cost:	31,912		

Location: Distribution
CI# / FP#: 41346
Title: 82S-304 Whitney Pier Targeted Feeder Replacements
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 & 002 Labour**						
1.1	Design Labour	Lot	1	$ 771.34	$ 771.34		
1.2	Project Support Labout (No AO)	Lot	1	$ 318.51	$ 318.51		
1.3					$ -		
1.4					$ -		
				Sub-Total	$ 1,089.85		
2	**012 Materials**						
2.1	Poles, O/H Conductor Devices	Lot	1	15925.28	$ 15,925.28		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 15,925.28		
3	**013 T&D Contracts**						
3.1	Line Work	Lot	[redacted]		$ 193,800.00		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 193,800.00		
4	**020 Easements**						
4.1					$ -		
4.2					$ -		
4.3					$ -		
4.4							
				Sub-Total	$ -		
5	**094 Interest Capitalized**						
5.1	Interest	Lot	1	727.03	$ 727.03		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 727.03		
6	**094 & 095 Administrative Overhead**						
6.1	Labour Overhead	Lot	1	563.46	$ 563.46		
6.2	Vehicle Overhead	Lot	1	318.02	$ 318.02		
6.3	Contracts Overhead	Lot	1	63934.62	$ 63,934.62		
				Sub-Total	$ 64,816.10		
Cost Estimate				**Total**	$ 276,358.26		
7	**Original Cost**				$ 31,911.98		
7.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Customer Hours of Interruption from Targeted Device Failures

Feeder	Customers	2007	2008	2009	2010	2011	Average CHI
82S-304	1,189	49	37	3,759	43	3,673	1,512

CI Number: 43188

Title: **2013 Distribution Automation**

Start Date: 2013/01
Final Cost Date: 2013/12
Function: Distribution
Forecast Amount: $274,349

DESCRIPTION:

This project provides for costs associated with the installation of five additional recloser devices on three feeders to provide sectionalizing points and automated restoration ties. The feeders that will have reclosing devices installed are: 11S-302 (2 reclosers), 84S-302 (2 reclosers) and 11S-411 (1 recloser). Feeder selection is based on Customer Interruptions (CI) x Customer Hours (CH) weighting for full feeder outages that were not caused by loss of transmission.

Summary of Related Projects +/- 2 years:
2011 CI 39269 Recloser Additions - $444,765
2012 CI 41351 2012 Distribution Automation $553,965

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Outage Performance

Why do this project?

This project is designed to improve distribution feeder reliability. By installing loop sectionalizing automated restoration schemes, NS Power will be able to significantly reduce the number of customer interruptions and customer-hours of interruption each year through improved feeder sectionalizing and the automatic restoration of unfaulted feeder segments. An estimated 1313 customer-interruptions and 4084 customer-hours per year will be avoided by completing this project.

Why do this project now?

Reliability analyses have indicated that the feeders being targeted in this project would benefit from the addition of an automated restoration scheme.

Why do this project this way?

This project targets NS Power's poor performing feeders for the purpose of improving reliability. Appropriate sectionalizing of a feeder will improve outage statistics. For instance, installing a recloser at 50 % of the length of a feeder with 50 % of the customer count before and after the recloser will result in a 25 % (on average) improvement in both the System Average Interruption Frequency Index (SAIFI) and the System Average Interruption Duration Index (SAIDI) statistics. Further, when the new downline feeder section can be transferred automatically to an alternate feeder using a tie recloser after the source feeder has tripped, the improvement in predicted reliability doubles to 50%. Given the predicted improvement in CI and CH, the $/ACHI (Avoided Customer Hours of Interruption) for this project is evaluated to be $67.18/ACHI.

CI Number : 43188 - 2013 Distribution Automation **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		12,676	0	12,676
094		094 - Interest Capitalized		5,646	0	5,646
095		095-COPS Contracts AO		4,355	0	4,355
095		095 - T&CS Regular Labour AO		2,396	0	2,396
095		095-COPS Regular Labour AO		22,460	0	22,460
012	004	012 - Materials	004 - DP - Misc.Equipment	0	0	0
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	0	0	0
002	035	002 - T&D Overtime Labour	035 - DP - Wood Poles	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	4,000	0	4,000
013	035	013 - COPS Contracts	035 - DP - Wood Poles	[redacted]	0	[redacted]
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	0	0	0
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	1,000	0	1,000
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	30,746	0	30,746
002	040	002 - T&D Overtime Labour	040 - DP - O/H Cond.Devices	0	0	0
012	040	012 - Materials	040 - DP - O/H Cond.Devices	169,500	0	169,500
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	[redacted]	0	[redacted]
001	085	001 - T&CS Regular Labour	085 Design	7,670	0	7,670
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
011	085	011 - Travel Expense	085 Design	500	0	500
041	085	041 - Meals & Entertainment	085 Design	200	0	200
			Total Cost:	274,349	0	274,349
			Original Cost:	12,857		

Location: Distribution
CI# / FP#: 43188
Title: 2013 Recloser Additions
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	manday	[redacted]		$ 6,737.80		
1.2	Power Line Technician	manday	[redacted]		$ 24,007.90		
1.3	Engineering (P.Eng)	hr	[redacted]		$ 4,550.00		
1.4	Technologists	hr	[redacted]		$ 3,120.00		
1.5					$ -		
1.6					$ -		
				Sub-Total	$ 38,415.70		
2	**012 Materials**						
2.1	Recloser	ea	2	$ 21,000.00	$ 42,000.00		43189
2.2	IntelliRupter	ea	3	$ 36,000.00	$ 108,000.00		43189
2.3	Recloser materials	lot	2	$ 3,000.00	$ 6,000.00		
2.4	IntelliRupter materials	lot	3	$ 2,500.00	$ 7,500.00		
2.5	pole and framing	lot	2	$ 2,000.00	$ 4,000.00		
2.6	Repeater	ea	1	$ 4,000.00	$ 4,000.00		
2.7	IntelliNode	ea	1	$ 3,000.00	$ 3,000.00		
2.8					$ -		
2.9					$ -		
				Sub-Total	$ 174,500.00		
3	**013 Contracts**						
3.1	Traffic control	hr	[redacted]				
3.2	Backhoe	lot	[redacted]				
3.3					$ -		
				Sub-Total	$ 13,200.00		
4	**011 Travel Expenses**						
4.1	Travel	lot	1	$ 500.00	$ 500.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 500.00		
5	**041 Meals and Entertainment**						
5.1	Meals	lot	1	$ 200.00	$ 200.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 200.00		
6							
6.1					$ -		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ -		
7							
7.1					$ -		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ -		
8	**094 Interest Capitalized**						
8.1	Interest	lot	1	$ 5,646.35	$ 5,646.35		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 5,646.35		
9	**095 Administrative Overhead**						
9.1	COPS Regular Labour AO	lot	1	$ 22,459.74	$ 22,459.74		
9.2	Vehicle T&D Reg. Labour AO	lot	1	$ 12,676.45	$ 12,676.45		
9.3	COPS Contracts AO	lot	1	$ 4,354.68	$ 4,354.68		
9.4	T&CS Regular Labour AO	lot	1	$ 2,396.11	$ 2,396.11		
				Sub-Total	$ 41,886.98		
Cost Estimate				**Total**	$ 274,349.03		
10	**Original Cost**						
10.1					$ 12,857.30		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

2013 Distribution Automation

	Feeder	Cust Count	CI/y	CH/y	Location	ACI	ACHI	Units	$/ACHI	Cost
	11S-302	1474	1867.6	3324.8	Midpoint recloser near D3A21596, tie at G3A01201	668.2	1189.6	2	90.45	$ 101,415
	84S-302	249	446.1	2324.9	Midpoint recloser at Gardiner Rd, tie at G371-308	231.5	1206.5	2	89.19	$ 101,415
	11S-411	2852	1140.4	4661.2	Tie recloser at L4A01501	412.9	1687.6	1	44.96	$ 71,519
Total	3	4575.0	3454.1	10310.9		1312.6	4083.6	5		$ 274,349
								Avg $/ACHI	67.18	

General Plant

CI Number: **43346**

Title: **IT - Service Hub Upgrade**

Start Date: 2013/03
Final Cost Date: 2014/01
Function: General Plant
Forecast Amount: $614,532

DESCRIPTION:

ServiceHub is the software application that enables the mechanized workload scheduling and dispatching for wiring inspections, meter related work and distribution field planning related work. This application also provides functionality used by the Customer Care Centre to confirm appointments in real-time with customers for the same related service orders. The ServiceHub application is integrated to NS Power's Customer Information System, Transmission and Distribution (T&D) work management system, Outage Management System and distribution design system providing NS Power with unique functionality. NS Power optimizes many types of work across a broad workforce optimizing the geographic location of the individual worker and the skills available, unlike most other utilities where the workforce is segmented by the type of work completed.

Summary of Related CIs +/- 2 years:
No other projects 2011, 2012, 2013, 2014 or 2015

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Sub Criteria: Computer

Why do this project?

NS Power's current ServiceHub application version V8.9.3 went into production in March 2009 and is now three major releases behind the current in-production supported release from the vendor. The most current version, version 11, is a major application change that all new development and enhancements must be built on. This new version also renames the product from ServiceHub to G4. The new version allows ServiceHub to be compatible with NS Power's Geographic Information System (GIS). This will enable NS Power to utilize internal geographic information for better scheduling. It also includes functionality for backlog management. This enables future resource and work optimization. If this upgrade is not incorporated, any required fixes to production problems will be charged to NS Power instead of being part of the part of the new solution with the upgrade.

Why do this project now?

As a software application that provides NS Power innovative functionality it is important NS Power remains as current as possible within the window of vendor support. The business processes which ServiceHub supports are dynamic and constantly being fined tuned to meet changing customer expectations, and enhance workforce utilization. As such, the functionality offered in newer releases of the application respond to requested improvements from industry as these business processes mature.

Why do this project this way?

NS Power's software license with the ServiceHub vendor, ViryaNet, provides for free access to software upgrades including all patches and fixes implemented by the vendor. This upgrade involves both internal NS Power labour and consulting costs to complete the upgrade. The required hardware upgrades are completed in accordance with NS Power's hardware refresh program included in capital routine P031. This application enables the scheduling and dispatching of work for almost 200 employees and booking appointments with customers for another 100 employees.

CI Number : 43346 - IT - Service Hub Upgrade **Project Number**

Parent CI Number : -

Cost Centre : 027 - 027-Administration **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		13,335	0	13,335
095		095-IT Regular Labour AO		51,211	0	51,211
095		095-COPS Regular Labour AO		74,146	0	74,146
001	078	001 - IT Regular Labour	078 - GP - Comp. Appl. Software	102,340	0	102,340
001	078	001 - T&D Regular Labour	078 - GP - Comp. Appl. Software	101,500	0	101,500
011	078	011 - Travel Expense	078 - GP - Comp. Appl. Software	23,200	0	23,200
028	078	028 - Consulting	078 - GP - Comp. Appl. Software	[redacted]	0	[redacted]
034	078	034 - Appl. Software	078 - GP - Comp. Appl. Software	0	0	0
066	078	066 - Other Goods & Services	078 - GP - Comp. Appl. Software	[redacted]	0	[redacted]
			Total Cost:	614,532	0	614,532
			Original Cost:			

Location: Head office
CI#: 43346
Title: IT - Service Hub Upgrade

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	IT Labour (340 days)	hr	[redacted]	[redacted]	$ 102,340.00	[redacted]	
1.2	T&D Labour (350 days)	days	[redacted]	[redacted]	$ 101,500.00	[redacted]	
1.3					$ -		
				Sub-Total	$ 203,840.00		
2	**028 Consulting**						
2.1	Vendor Consulting / Software Development	lot	1	[redacted]	[redacted]	Cost Support 1	
2.2							
2.3							
				Sub-Total	[redacted]		
3	**011 Travel Expenses**						
3.1	Vendor Travel	lot	1	$ 23,200.00	$ 23,200.00		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 23,200.00		
4	**066 Other Goods & Services**						
4.1	Contingency	1	lot	[redacted]	[redacted]		
4.2					$ -		
4.3					$ -		
				Sub-Total	[redacted]		
5	**094 Interest Capitalized**						
5.1	Interest Capitalized	lot	1	$ 13,335.00	$ 13,335.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 13,335.00		
6	**095 Administrative Overhead**						
6.1	IT Labour AO	lot	1	$ 51,210.94	$ 51,210.94		
6.2	T&D Labour AO	lot	1	$ 74,145.75	$ 74,145.75		
				Sub-Total	$ 125,356.69		
Cost Estimate				**Total**	$ 614,531.69		
7	**Original Cost**						
7.1					N/A		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Attachment 1

Removed due to confidentiality

CI Number: 43272

Title: **SCADA-EMS Hardware Replacement**

Start Date: 2013/01
Final Cost Date: 2013/09
Function: General Plant
Forecast Amount: $497,250

DESCRIPTION:

This project is to replace 9 SCADA-EMS servers, 3 PI servers and 25 work stations. Included in the project are the costs associated with a software upgrade to Brick 37 to accommodate the new Windows 7 work stations.

Summary of Related CIs +/- 2 years:
2010 CI 38182 2010 Backup Control Centre $3,222,066

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Sub Criteria: Computers

Why do this project?

The SCADA-EMS Open Systems International Inc. system was first deployed in 2008 and requires replacement to align with the standard NS Power IT life cycle for hardware of 6 years. Recent desktop failures support the replacement of the hardware with new desktops, which will have Windows 7 installed, further aligning with corporate IT strategy.

Why do this project now?

The risk of failure based on the age of the hardware necessitates the need for replacement. Not moving ahead with this project will continue to expose us to equipment failures and will have the potential of impacting our observation and control on the bulk power system.

Why do this project this way?

The hardware solution must be redundant to support NS Power's contingency and bulk power NERC requirements and therefore it is recommended that both the servers and work-stations be replaced.

The SCADA-EMS vendor will be engaged to help deploy and stage the hardware replacement as there is a need to have an implementation plan with next to zero downtime.

CI Number : 43272 - SCADA-EMS Hardware Replacement

Project Number

Parent CI Number : -

Cost Centre : 620 - 620-Control Centre Operations

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		16,492	0	16,492
094		094 - Interest Capitalized		15,838	0	15,838
095		095-COPS Regular Labour AO		29,220	0	29,220
001	064	001 - T&D Regular Labour	064 - GP - Sup. Control and DA	40,000	0	40,000
002	064	002 - T&D Overtime Labour	064 - GP - Sup. Control and DA	0	0	0
011	064	011 - Travel Expense	064 - GP - Sup. Control and DA	10,000	0	10,000
012	064	012 - Materials	064 - GP - Sup. Control and DA	10,000	0	10,000
028	064	028 - Consulting	064 - GP - Sup. Control and DA	[redacted]	0	[redacted]
034	064	034 - Appl. Software	064 - GP - Sup. Control and DA	[redacted]	0	[redacted]
035	064	035 - Comp.Hrdwr & Op.Sftwr	064 - GP - Sup. Control and DA	[redacted]	0	[redacted]
041	064	041 - Meals & Entertainment	064 - GP - Sup. Control and DA	2,500	0	2,500
			Total Cost:	497,250	0	497,250
			Original Cost:	441,793		

Location: General Property
CI# / FP#: 43272
Title: SCADA EMS Hardware Replacement
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Technologists	Person Days	[redacted]		$ 40,000.00		
1.2							
				Sub-Total	$ 40,000.00		
2	**012 Materials**						
2.1	Materials	Lot	1	10000	$ 10,000.00		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 10,000.00		
3	**028 Consulting**						
3.1	Consulting	Lot	1	[redacted]			
3.2					$ -		
3.3					$ -		
				Sub-Total	[redacted]		
4	**011 Travel Expenses**						
4.1	Travel	Lot	1	10000	$ 10,000.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 10,000.00		
5	**041 Meals and Entertainment**						
5.1	Meals	Lot	1	2500	$ 2,500.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 2,500.00		
6	**034 Appl. Software**						
6.1	Software	Lot	1	[redacted]			
6.2					$ -		
6.3					$ -		
				Sub-Total	[redacted]		
7	**035 Comp. Hardware**						
7.1	Workstations, Servers & Monitors	Lot	1	[redacted]			
7.2					$ -		
7.3					$ -		
				Sub-Total	[redacted]		
8	**094 Interest Capitalized**						
8.1	Interest	lot	1	15838.3	$ 15,838.30		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 15,838.30		
9	**095 Administrative Overhead**						
9.1	Labour AO				$ 29,220.00		
9.2	Vehicle AO				$ 16,492.00		
9.3							
				Sub-Total	$ 45,712.00		
Cost Estimate				**Total**	$ 497,250.30		
10	**Original Cost**				$ 441,793.00		
10.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

CI Number: 43227

Title: **2013 Remote Terminal Unit Replacements**

Start Date: 2013/06
Final Cost Date: 2014/06
Function: General Plant
Forecast Amount: $682,211

DESCRIPTION:

The 2013 Remote Terminal Unit (RTU) capital replacement program will replace select RTUs, enabling NS Power to redeploy spare parts for other RTUs. In 2013 this project provides for the replacement of the following RTUs: 22W Barrington 10W Tusket, 2S Victoria Junction, 22N Church Street.

Summary of Related CIs +/- 2 years:
2011CI 40245 2011 RTU Replacement Program $459,517
2012 CI 41428 2012 RTU Capital Replacement $314,026
This is a multi-year project that will continue beyond 2013. Future CIs TBD

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Sub Criteria: Equipment Replacement

Why do this project?

Due to evolving industry standards, technology and product lifespans, approximately 90 of the RTUs that are currently in service have been deemed as obsolete by the original equipment manufacturers. The commercial availability of spare parts is becoming increasingly difficult to manage effectively.

Replacement of part of the operating inventory creates spares for use as necessary.

Why do this project now?

The inventory of the RTU spare parts has become sparse. Most of the existing RTUs have reached the end of their useful life. RTU installations require extensive time and effort to complete and having an effective RTU management plan is critical for the orderly replacement of units that are experiencing reliability issues and to gradually modernize the fleet.

Why do this project this way?

Most of NS Power’s RTUs have reached the end of their useful life and through a measured replacement plan it is possible to supplement the spares in inventory.

CI Number : 43227 - 2013 RTU Replacements

Project Number

Parent CI Number : -

Cost Centre : 620 - 620-Control Centre Operations

Budget Version 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		37,503	0	37,503
094		094 - Interest Capitalized		24,610	0	24,610
095		095 - T&CS Regular Labour AO		9,167	0	9,167
095		095-COPS Regular Labour AO		66,446	0	66,446
001	064	001 - T&D Regular Labour	064 - GP - Sup. Control and DA	90,960	0	90,960
002	064	002 - T&D Overtime Labour	064 - GP - Sup. Control and DA	0	0	0
011	064	011 - Travel Expense	064 - GP - Sup. Control and DA	22,031	0	22,031
012	064	012 - Materials	064 - GP - Sup. Control and DA	382,724	0	382,724
041	064	041 - Meals & Entertainment	064 - GP - Sup. Control and DA	8,491	0	8,491
066	064	066 - Other Goods & Services	064 - GP - Sup. Control and DA	10,933	0	10,933
001	085	001 - T&CS Regular Labour	085 Design	29,345	0	29,345
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
			Total Cost:	682,211	0	682,211
			Original Cost:	301,696		

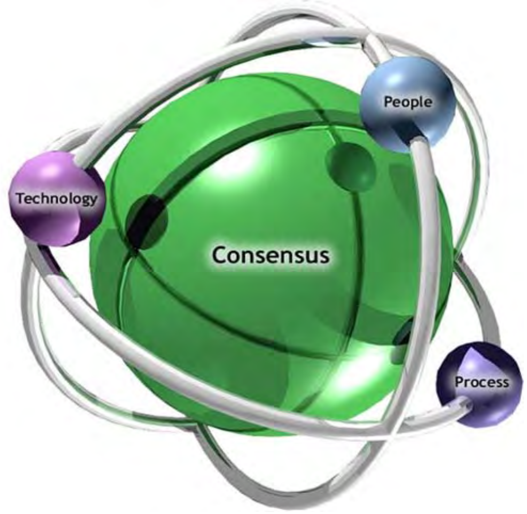
Location: General Property
CI# / FP#: 43227
Title: 2013 RTU Replacements
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician Labour	Person Day	[redacted]		$ 90,960.30		
1.2	Design Labour	Person Day			$ 29,345.12		
1.3							
1.4							
1.5							
				Sub-Total	$ 120,305.42		
2	**012 Materials**						
2.1	Materials	Lot	1	382724	$ 382,724.00		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 382,724.00		
3	**011 Travel Expenses**						
3.1	Travel	Lot	1	22031	$ 22,031.00		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 22,031.00		
4	**041 Meals and Entertainment**						
4.1	Meals	Lot	1	8491	$ 8,491.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 8,491.00		
5	**066 Other Goods & Services**						
5.1	Project Contingency	Lot	1	10933	$ 10,933.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 10,933.00		
6	**094 Interest Capitalized**						
6.1	Interest	lot	1	24609.68	$ 24,609.68		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 24,609.68		
7	**095 Administrative Overhead**						
7.1	Labour AO		1	75613.84	$ 75,613.84		
7.2	Vehicle AO		1	37502.94	$ 37,502.94		
7.3							
				Sub-Total	$ 113,116.78		
Cost Estimate				**Total**	$ 682,210.88		
8	**Original Cost**				$ 301,696.00		
8.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Nova Scotia Power

CCO – Projects and Systems Support



Five Year Investment Plan

Remote Terminal Units – RTU - (2010 – 2015)

Executive Summary

Remote Terminal Units – RTU - (2010 – 2015)

Work Plan Assessment

Executive Summary:

This document is a detailed review of our current and potential remote control and visibility to and from SCADA-EMS from a people, process and technology view.

Emphasis will include the state of the existing (asset) RTU fleet as it pertains to our Reliability plan, SCADAPACKS and future expansion to sites where visibility and control are not available. It will also review the processes that are in place to ensure sustainability and the people that are in place to support this effort. This exercise is an extension of the “Control Centre Operations Systems Support Asset Review Plan” completed in 2008.

From an asset point of view, Nova Scotia Power currently has 128 RTUs (Remote Terminal Units) covering more 65% of our customer base. We also have 110 sub-stations without RTUs. This RTU infrastructure is also used to support more than 30 plus SCADAPACKS, installed mainly for hydro.

The average ages of our RTUs are about 13 years old of which 61 are more than 15 years old. Our fleet of RTU’s are from 6 different vendors and our current vendor of choice is QEI. We currently have 36 of the 110 sub-stations without RTU’s that have feeders with more than 1000 customers attached.

These are located at sites across the province and provide critical real-time data and control for our day-to-day operations. We use RTUs from many different manufacturers that come in all sizes to accommodate the diverse configurations required at each site.

From a people view point, we have two EIT’s that are well trained that support the maintenance, capital and day-to-day operations.

In regards to process we have a service request system that is used to manage requests that translate into a work plan or immediate fixes.

With a clear development effort for people in place and a well-defined process for the management of RTU’s this review will focus more on the asset.

Replacing all obsolete RTUs is not practical nor is it economical because of time and cost. Instead our strategy is to phase out the old, broken or non-salvageable RTUs over the span of five years.

To determine which RTUs to replace we gathered field data on each RTU and used it to build a selection matrix. This matrix took factors related to the reliability of the RTUs into account (age, replacements available, salvageable parts, etc...) and assigned rankings to help isolate the best candidates for replacement.

To determine which substation to provide a new RTU we utilized an “$/achi” formula which uses the cost of installing a new RTU over the estimated number of reduced customer hours per year. We also utilized other factors or anomalies such as the load, downstream distribution feeders off the transmission and the length of line from the sub-station.

Using the above factors we created a 5 year investment plan that can be seen in the table within the “Technology – Our Assets” section.

CI Number: 43221

Title: **2013 New Remote Terminal Units Deployment**

Start Date: 2013/06
Final Cost Date: 2014/06
Function: General Plant
Forecast Amount: $687,806

DESCRIPTION:

This project provides for the installation of Remote Terminal Units (RTUs) at three substations to provide remote monitoring and control of selected substations and provides for the upgrade of some existing RTUs to further enhance their communication capabilities. The sites planned for installation in 2013 are as follows:

88W Pleasant Street 55V Waterville
126H Porters Lake

Summary of Related CIs +/- 2 years:
2011 CI 40274 New RTU Deployment $509,706
2012 CI 41433 2012 New RTU Deployment $1,062,700
2014 CI TBD 2014 New RTU Deployment $TBD

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Sub Criteria: Equipment Replacement

Why do this project?

Completion of these new RTU installations and communication upgrades will provide remote monitoring and control capacity to System Operators at the Energy Control Centre which will improve outage prediction, and improve reliability through reduction of power outage duration. A total of more than 14,578 customers are served by these three stations.

Why do this project now?

Increasing operational visibility of distribution substation by the addition of RTUs and enhancing the operator's ability to perform remote switching will provide a subsequent reduction in customer interruption hours.

Why do this project this way?

The technology that will be used in this project aligns with the communication methods employed in the over 120 other RTUs across the province.

CI Number : 43221 - 2013 New RTU Deployment **Project Number**

Parent CI Number : -

Cost Centre : 620 - 620-Control Centre Operations **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		34,427	0	34,427
094		094 - Interest Capitalized		24,759	0	24,759
095		095 - T&CS Regular Labour AO		8,122	0	8,122
095		095-COPS Regular Labour AO		60,997	0	60,997
001	064	001 - T&D Regular Labour	064 - GP - Sup. Control and DA	83,500	0	83,500
002	064	002 - T&D Overtime Labour	064 - GP - Sup. Control and DA	0	0	0
011	064	011 - Travel Expense	064 - GP - Sup. Control and DA	25,000	0	25,000
012	064	012 - Materials	064 - GP - Sup. Control and DA	410,001	0	410,001
041	064	041 - Meals & Entertainment	064 - GP - Sup. Control and DA	7,500	0	7,500
066	064	066 - Other Goods & Services	064 - GP - Sup. Control and DA	7,500	0	7,500
001	085	001 - T&CS Regular Labour	085 Design	26,000	0	26,000
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
			Total Cost:	687,806	0	687,806
			Original Cost:			

Capital Project Detailed Estimate

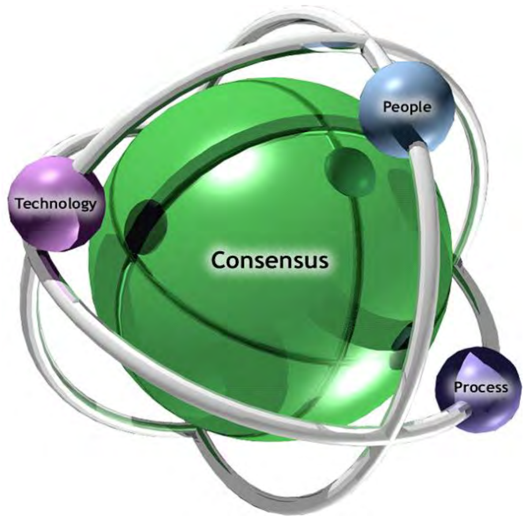
Location: General Property
CI# / FP#: 43221
Title: 2013 New RTU Deployment
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician/Tech Labour	Lot	1.00	83,500.00	$ 83,500.00	The labour costs associated with this project are for engineering design, as well as for the installation of the RTUs	41433
1.6	Engineering (P.Eng)	Lot	1.00	$ 26,000.00	$ 26,000.00		.
1.7							
1.8							
				Sub-Total	$ 109,500.00		
2	**012 Materials**						
2.1	Materials	Lot	1	410,001.00	$ 410,001.00	The material costs associated with this item are for the purchase of RTUs and associated accessories and are based on similar units purchased in 2011 and 2012.	41433
2.2					$ -		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 410,001.00		
3	**013 T&D Contracts**						
3.1					$ -		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ -		
4	**011 Travel Expenses**						
4.1	Travel	Lot	1	25000	$ 25,000.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 25,000.00		
5	**041 Meals and Entertainment**						
5.1	Meals & Entertainment	Lot	1	7500	$ 7,500.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 7,500.00		
6	**066 Other Goods & Services**						
6.1	Other Goods & Services	Lot	1	7500	$ 7,500.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 7,500.00		
7							
7.1					$ -		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ -		
8	**094 Interest Capitalized**						
8.1	Interest				$ 24,759.18		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 24,759.18		
9	**095 Administrative Overhead**						
9.1	T&CS Labour AO				$ 8,122.40		
9.2	COPS Labour AO				$ 60,996.75		
9.3	Vehicle AO				$ 34,427.05		
				Sub-Total	$ 103,546.20		
Cost Estimate				**Total**	$ 687,806.38		
10	**Original Cost**						
10.1					$ -		

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project

Nova Scotia Power

CCO – Projects and Systems Support



Five Year Investment Plan

Remote Terminal Units – RTU - (2010 – 2015)

Executive Summary

Remote Terminal Units – RTU - (2010 – 2015)

Work Plan Assessment

Executive Summary:

This document is a detailed review of our current and potential remote control and visibility to and from SCADA-EMS from a people, process and technology view.

Emphasis will include the state of the existing (asset) RTU fleet as it pertains to our Reliability plan, SCADAPACKS and future expansion to sites where visibility and control are not available. It will also review the processes that are in place to ensure sustainability and the people that are in place to support this effort. This exercise is an extension of the “Control Centre Operations Systems Support Asset Review Plan” completed in 2008.

From an asset point of view, Nova Scotia Power currently has 128 RTUs (Remote Terminal Units) covering more 65% of our customer base. We also have 110 sub-stations without RTUs. This RTU infrastructure is also used to support more than 30 plus SCADAPACKS, installed mainly for hydro.

The average ages of our RTUs are about 13 years old of which 61 are more than 15 years old. Our fleet of RTU’s are from 6 different vendors and our current vendor of choice is QEI. We currently have 36 of the 110 sub-stations without RTU’s that have feeders with more than 1000 customers attached.

These are located at sites across the province and provide critical real-time data and control for our day-to-day operations. We use RTUs from many different manufacturers that come in all sizes to accommodate the diverse configurations required at each site.

From a people view point, we have two EIT’s that are well trained that support the maintenance, capital and day-to-day operations.

In regards to process we have a service request system that is used to manage requests that translate into a work plan or immediate fixes.

With a clear development effort for people in place and a well-defined process for the management of RTU’s this review will focus more on the asset.

Replacing all obsolete RTUs is not practical nor is it economical because of time and cost. Instead our strategy is to phase out the old, broken or non-salvageable RTUs over the span of five years.

To determine which RTUs to replace we gathered field data on each RTU and used it to build a selection matrix. This matrix took factors related to the reliability of the RTUs into account (age, replacements available, salvageable parts, etc...) and assigned rankings to help isolate the best candidates for replacement.

To determine which substation to provide a new RTU we utilized an "$/achi" formula which uses the cost of installing a new RTU over the estimated number of reduced customer hours per year. We also utilized other factors or anomalies such as the load, downstream distribution feeders off the transmission and the length of line from the sub-station.

Using the above factors we created a 5 year investment plan that can be seen in the table within the "Technology – Our Assets" section.

CI Number: 43190

Title: **Replace Microwave Radio System 2013**

Start Date: 2013/02
Final Cost Date: 2013/12
Function: General Plant
Forecast Amount: $351,087

DESCRIPTION:

This project provides for the replacement of existing low capacity microwave radio equipment on two radio hops in the South Shore: Shelburne to French Lake and French Lake to Tusket. This equipment and systems allow for transport of critical Supervisory Control and Data Acquisition (SCADA), teleprotection, voice and data traffic on NS Power telecommunication network infrastructure.

Summary of Related CIs +/- 2 years:
2011 40252 Replace Microwave Radio Systems $351,658
2011 40249 New Chester Microwave Radio Link $407,925
2011 40247 Radio Tower Upgrades $324,686
2012 41419 2012 Replace Microwave Radio Systems $601,339
2014 CI TBD Replace Microwave Radio System 2014 $TBD

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Sub Criteria: Telecommunication

Why do this project?

Replacement of the equipment for two radio hops is required to ensure reliability and provide the required system capacity of the telecom network infrastructure. Due to the low capacity of the existing radios, if the existing ring breaks, the Company will be unable to re-route all its data and voice traffic due to capacity restrictions. This project removes this bottleneck and allows for flexibility, better reliability and future expansions.

The installation of the two new radios at the sites listed above completes the microwave radio ring around the South Shore and the Valley which provides for a redundant system and improves reliability and flexibility.

Why do this project now?

The project will help to improve the reliability of the radio links. The existing radios on these links have poor reliability that do not meet NS Power's standards for critical voice and data traffic for SCADA, teleprotection and other communication. It is necessary that these links meet NS Power's reliability standards. It is necessary to upgrade these radio links now due to the need for redundancy and disaster scenario planning recovery. This project allows for circuits to be re-routed to the new Back Up Control Centre at Tufts Cove in the event of a disaster. With the recent additions of new generation and the associated transmission system expansion, it is necessary to upgrade these communication links to be able to handle the additional telecom circuit requirements.

Why do this project this way?

This is part of an ongoing project to upgrade NS Power's major radio link using Alcatel's MDR8000 microwave radios. This allows for the sharing of spares, maintenance practices, training and expertise. Microwave links with Alcatel MDR8000 radios are frequency diverse radios which allow for hops to be maintained without taking outages.

NS Power personnel will be completing this work.

CI Number : 43190 - Replace Microwave Radio System 2013 **Project Number**

Parent CI Number : -

Cost Centre : 625 - 625-Control Centre Operations - Tel **Budget Version** 2013 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		1,636	0	1,636
092		092-Vehicle T&D Reg. Labour AO		4,407	0	4,407
094		094 - Interest Capitalized		15,317	0	15,317
095		095-COPS Overtime Labour AO		2,899	0	2,899
095		095-COPS Regular Labour AO		7,808	0	7,808
095		095-COPS Contracts AO		6,598	0	6,598
012	054	012 - Materials	054 - GP - Remote Monitoring	8,000	0	8,000
001	060	001 - T&D Regular Labour	060 - GP - Broadband Radio	3,968	0	3,968
002	060	002 - T&D Overtime Labour	060 - GP - Broadband Radio	7,936	0	7,936
011	060	011 - Travel Expense	060 - GP - Broadband Radio	3,100	0	3,100
012	060	012 - Materials	060 - GP - Broadband Radio	239,800	0	239,800
013	060	013 - COPS Contracts	060 - GP - Broadband Radio	20,000	0	20,000
028	060	028 - Consulting	060 - GP - Broadband Radio	20,000	0	20,000
001	085	001 - T&D Regular Labour	085 Design	6,720	0	6,720
041	085	041 - Meals & Entertainment	085 Design	2,900	0	2,900
			Total Cost:	351,087	0	351,087
			Original Cost:	73,619		

Location:
CI# / FP#: 43190
Title: Replace Microwave Radio System
Execution Year: 2013

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Telecom Technician	hr	[redacted]		$ 1,984.00		
1.2	System Maintenance Technician	hr	[redacted]		$ 1,984.00		
1.3	Engineering (P.Eng)	hr	[redacted]		$ 6,720.00		
				Sub-Total	$ 10,688.00		
2	**002 Overtime Labour**						
2.1	Telecom Technician Overtime	hr	[redacted]		$ 3,968.00		
2.2	System Maintenance Technician Overtime	hr	[redacted]		$ 3,968.00		
				Sub-Total	$ 7,936.00		
3	**012 Materials**						
3.1	Alcatel MDR 8000 Radios	ea	[redacted]		$ 152,000.00		
3.2	7GHz RFS 6ft Antenna and Waveguide & Ac	ea	[redacted]		$ 48,000.00		
3.3	Weatherproof antenna connector cover for a	ea	[redacted]		$ 2,000.00		
3.4	Misc. connectors, adaptors, cable, BIX etc.	ea	[redacted]		$ 4,000.00		
3.5	T1 Patch Panels (DSX-DR56)	ea	[redacted]		$ 2,400.00		
3.6	DPS NetGuardian Alarm Monitoring	ea	[redacted]		$ 8,000.00		
3.7	Network Equipment	ea	[redacted]		$ 1,000.00		
3.8	Radio Tower Modifications	ea	[redacted]		$ 30,000.00		
3.9	Radio Licence Issuance Fees	ea	[redacted]		$ 400.00		
				Sub-Total	$ 247,800.00		
4	**013 T&D Contracts**						
4.1	Tower Modifications & Antenna Installation Contract	Lot	1	20000	$ 20,000.00		
4.2							
4.3					$ -		
				Sub-Total	$ 20,000.00		
5	**011 Travel Expenses**						
5.1	Travel Expenses	Lot	1	3100	$ 3,100.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 3,100.00		
6	**041 Meals and Entertainment**						
6.1	Meals	Lot	1	2900	$ 2,900.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 2,900.00		
7	**028 Consulting**						
7.1	Engineering Tower Consultant	Lot	1	20000	$ 20,000.00		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 20,000.00		
8	**094 Interest Capitalized**						
8.1	Interest Capitalized	Lot	1	15316.63	$ 15,316.63		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 15,316.63		
9	**095 Administrative Overhead**						
9.1	Contract AO		1	6598	$ 6,598.00		
9.2	Labour AO		1	10706.19	$ 10,706.19		
9.3	Vehicle AO		1	6042.66	$ 6,042.66		
				Sub-Total	$ 23,346.85		
Cost Estimate				**Total**	$ 351,087.48		
10	**Original Cost**				$ 73,619.00		
10.1							

Note 1: Reference to "Completed similar projects (FP#'s)" is to be provided when the item estimate is based on work of similar scope for a recently completed project