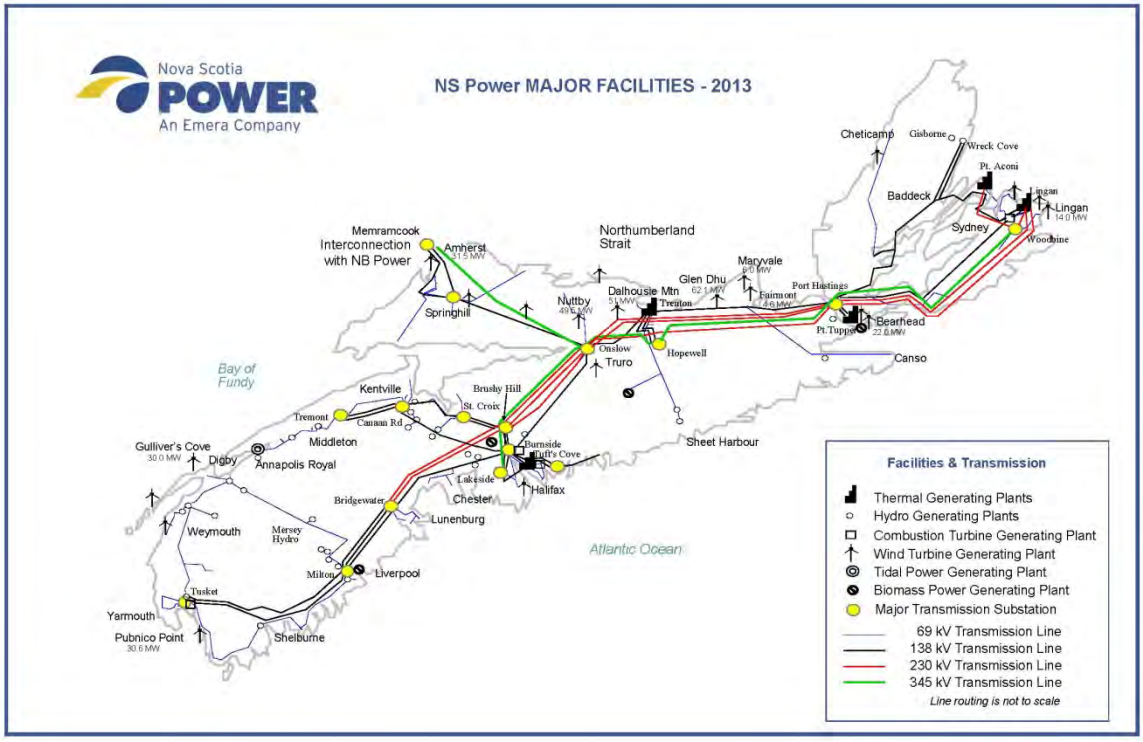
Nova Scotia Power
2014 Annual Capital Expenditure Plan



November 2013

Refiled: December 13, 2013

Table of Contents

Executive Summary 4

1 Introduction 7
1.1 Asset Management and Capital Investments 7
1.2 Economic Analysis Model and Stakeholder Engagement 12

2 2013 ACE Plan Follow-up 14
2.1 2013 Capital Items Pending Submission 14
2.2 2013 ACE Capital Items Deferred / Cancelled 16

3 Capital Spending History and Forecast Overview 23
3.1 Historical, Budget and Forecast 23
3.2 Total Annual Capital Expenditures by Function 24
3.3 5-Year Annual Capital Expenditure 24

4 2014 Annual Capital Expenditure Plan 26
4.1 Summary of Expenditures 26
4.2 2014 ACE Plan Capital Items Submitted for Approval 27
4.3 2014 ACE Plan Capital Items Forecast for Subsequent Approval 30
4.4 2014 ACE Plan Capital Items with Estimated Total Project Cost of Less Than $250,000 . 34
4.5 2014 ACE Plan Capital Items – Point Aconi Generating Station 37

5 Generation 39
5.1 Generation – Highlights 40
5.2 Generation – Carry-over Capital Spending Summary 41
5.3 Generation – New 2014 Capital Items for ACE Plan Approval 43

6 Transmission 44
6.1 Transmission – Highlights 45
6.2 Transmission – Carry-over Capital Spending Summary 46
6.3 Transmission – New 2014 Capital items for ACE Plan Approval 47

7 Distribution 48
7.1 Distribution – Highlights 49
7.2 Distribution – Carry-over Capital Spending Summary 50
7.3 Distribution – New 2014 Capital Items for ACE Plan Approval 51

8 General Plant 52
8.1 General Plant – Highlights 53

8.2 General Plant – Carry-over Capital Spending Summary 54
8.3 General Plant – New 2014 Capital Items for ACE Plan Approval 55

9 Routine Capital Program 56
9.1 Routine Capital Spending by Function Yr/Yr 56
9.2 Routine Capital Spending Project Breakdown Yr/Yr 57
9.3 2014 Routine Capital Spending Project Details 60

10 Appendix 77
10.1 UARB ACE Plan Directives 77
10.1.1 2011 ACE Plan Directive 7 – Approximate Impact of 2014 ACE Plan on Revenue Requirement 77
10.1.2 2011 ACE Plan Directive 9 – Summary of 2014 ACE Plan Capital Items Related to NERC and/or NPCC Standards 80
10.1.3 Directive 11 – Annual Ranking/ Prioritization of Capital Projects 80
10.1.4 2011 ACE Plan Directive 12 - 2014 to 2016 Forecasted ACE Plan Expenditures by Functional Class and Spending Program 89
10.1.5 2013 ACE Plan Directive 2 – Routine Expenditures 91
10.1.6 2013 ACE Plan Directive 13 – Discretionary Expenditures 92
10.1.7 2013 ACE Plan Directive 14 – Impact of Reliability Projects 93
10.1.8 2013 ACE Plan Directive 15 – Interruptible Customers 100
10.2 2014 Capital Spending by Justification Criteria 103
10.3 2014 Capital Spending by Justification Sub-Criteria 104
10.4 Capital Categories 105
10.5 Capital Functions 106
10.6 Quick Reference Sheet 107
10.7 2014 Depreciation Rates 108
10.8 Summary of Economically Justified Projects 113
10.9 Glossary of Terms 114

Executive Summary

Throughout recent regulatory proceedings, including prior General Rate Application (GRA) and Annual Capital Expenditure (ACE) Plan proceedings, and in direct conversations with customers, there has been a consistent message that Nova Scotia Power (NS Power, the Company) must make every effort to ensure our operations are conducted as efficiently as possible and we pursue all reasonable avenues to reduce upward pressure on future electricity rates.

The 2014 ACE Plan is an important part of NS Power's business communications with the Nova Scotia Utility and Review Board (Board, UARB), stakeholders and NS Power's customers: it is focused on affordability, while maintaining a safe and reliable power system.

We have made measurable progress in recent years with our generation portfolio transformation and improved customer reliability. NS Power is on the path to meet its 2015 Renewable Electricity Standard (RES) requirements and has achieved marked improvement in its key reliability measures.

NS Power is preparing capital expenditures for 2014 consistent with NS Power's revised 2013 ACE Plan.[1] The overall 2014 capital budget is $228 million, of which NS Power seeks approval of 43 capital work orders plus the capital routine program. Proposed capital expenditures for 2014 are compared to prior years in the table below.

[1] NS Power 2013 ACE Plan Reply Evidence, NSUARB-P-128.13, February 13, 2013.

Year	2009 Actual	2010 Actual	2011 Actual	2012 Actual	Approved revised 2013 ACE Plan[2]	ACE Plan 2014
Generation	$133.3	$129.0	$85.4	$88.7	$66.4	$58.8
New Renewables	31.7	256.0	66.2	53.2	34.8	30.9
Transmission	22.7	45.1	58.4	45.4	41.6	51.8
Distribution	52.3	59.6	62.4	68.7	66.7	59.0
General Plant	39.6	54.0	42.5	28.5	36.4	27.5
Total	**$279.7**	**$543.7**	**$315.0**	**$284.5**	**$246.0**	**$228.0**

NS Power's 2014 capital expenditure program balances spending with the investment necessary to sustain our capital assets and provide reliable service. The majority of capital work orders submitted for approval are less than $1 million each: 26 projects are forecast between $250,000 and $500,000; 13 are forecast between $500,000 and $1 million, and 4 exceed $1 million. Most of these work orders reflect sustaining capital work on our system. Representative projects include rebuilding or refurbishing aging and deteriorated plant and equipment as can be seen in the examples provided below.

Generation	Transmission
44351 Lingan Mill Refurbishment This project is to replace mill components that have reached the end of their useful life.	45033 – L7001 Replacements This project is required to replace 10 deteriorated structures on transmission line 7001 between Onslow and Brushy Hill that have reached the end of the service life.
44732 Trenton 5 Boiler Refurbishment This project is for select replacement of boiler tubes and components based on inspection results.	43672 – 82V-T71 Transformer Rewind This project is in Elmsdale. It is to proactively rewind 82V-T1 to prevent a forced outage resulting from mechanical failure of internal coil blocking.
44968 Hydro Wreck Cove Unit 2 Excitation Replacement is required to ensure reliable performance of this essential component of the generating unit.	44977 – 3W Breaker, Switch & Cable Replacements The existing breaker, switches, pole structure and control cables at the Big Falls substation have all reached the end of their life and are becoming deteriorated.

[2] Forecasted 2013 YE spend, as of Q3, estimated at $206.5M.

Throughout the course of 2013, NS Power engaged with Board staff and consultants for the Small Business Advocate and Consumer Advocate on the process to revise NS Power's Capital Expenditure Justification Criteria (CEJC). Many enhancements to the CEJC, including revisions to NS Power's Economic Analysis Model, were adopted with support from those parties. The UARB approved the new Summary CEJC and accepted the new Detailed CEJC on September 18, 2013.

The 2014 ACE Plan is an important part of lessening upward pressure on rates without compromise to reliability or unreasonable risk of large future investment. NS Power places balancing reliability and affordability among our top priorities.

NS Power respectfully requests Board approval of the following:

- 43 Capital Items with 2014 budget spending of $21,853,840 and total project spending of $24,851,650. (Please refer to Section 4.2.)

- Capital routine programs with 2014 budget spending of $72,275,566. (Please refer to Section 9.1.)

1 Introduction

1.1 Asset Management and Capital Investments

The 2014 ACE Plan has been developed to meet our customers' expectations as explained below. It is a sustaining capital program representing cost-effective investments to ensure safe, reliable electrical service for our customers. There is an emphasis on making the best use of our existing assets and ensuring they are well-maintained. In this way, NS Power is addressing the affordability of investments and reducing upward pressure on rates.

We understand that our customers' concerns go beyond economics and rate impacts. Our customers expect a well-maintained system, reliable service, and less reliance on fossil fuel generation. The following sections discuss each of these customer desires.

Asset Management

Firm peak power demand requirements have not abated. As can be seen below, firm peak over the last several years has remained relatively steady, despite reductions at major industrial customers.

Year	Firm Peak (MW)
2013 Year-to-Date	1897
2012	1735*
2011	1903
2010	1820
2009	1824
2008	1840

* Comparatively low 2012 Firm Peak due to unusually warm weather in Jan – Mar period of that year.

As such, NS Power continues to rely on its full generation fleet to meet firm peak, and therefore must pursue continued investment in these assets to ensure a reliable source of power.

NS Power's strategy for reducing capital expenditures is consistent with our Generation Asset Management Strategy. This strategy employs a risk profiling method based on the evaluation of an asset's criticality and condition. Risk profiles are utilized to determine the appropriate risk mitigation strategies. Based on this approach, one of three outcomes for associated capital work orders is possible:

1) the project is necessary,
2) the project is eligible for delay, or
3) the project can be cancelled (risk mitigated by some other means).

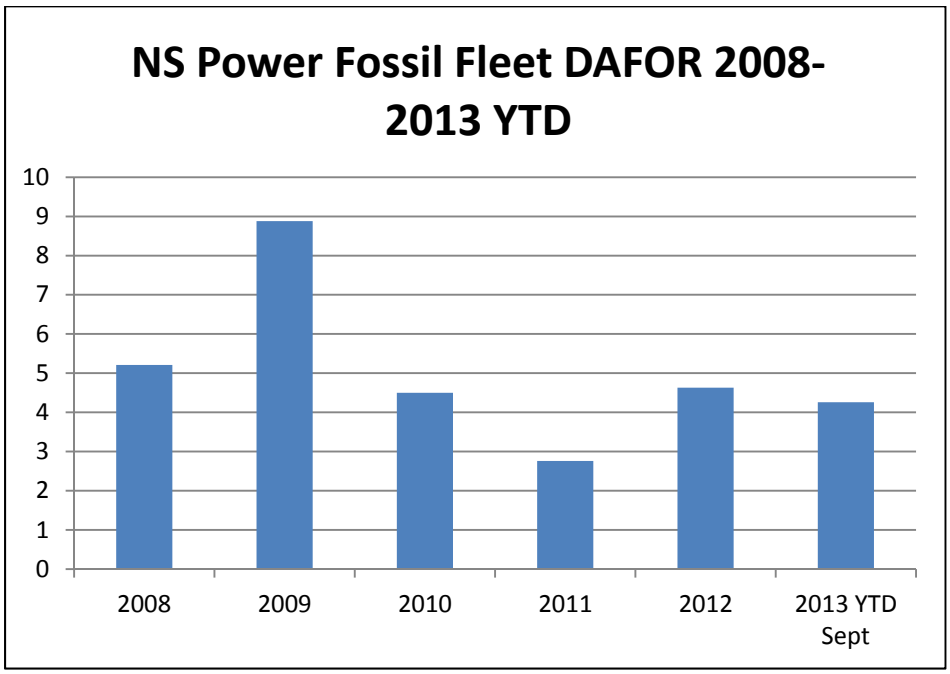
This approach considers forecasted unit utilization (e.g., anticipated retirements, lay-up, and two-shifting[3]) when determining investment and other mitigating measures. In this way, NS Power is better able to deploy capital expenditures where they're needed, when they're needed.

In addition to investment planning, this Asset Management approach provides a mechanism for making timely decisions in response to a changing operational environment and other challenges. For example, this approach informed the decision to defer the major turbine outage for Lingan Unit 3 from 2013 to 2014, and again to 2015. Based on NS Power's evaluation and understanding of turbine and generator health and risk, Lingan Unit 2 will operate as a base-loaded unit in 2014 in lieu of seasonal operation as previously planned.

The Generation Asset Management processes have been applied to turbines, generators and combustion turbine asset classes. Other asset classes in development include boilers, motors, compressors, pumps and fans. Increasingly, NS Power will be presenting investment plans in the form of asset class based programs that better reflects this approach to asset management.

To date in 2013, the management of our generation assets has contributed to a favourable Derated Adjusted Forced Outage Rate (DAFOR) as shown in the chart below.

[3] Two-shifting: capability of a generating unit to be removed from service and returned to service within a short period of time (approx. 8 hours). A common two-shift scenario is to remove a unit from service late in a day and return the unit to service within 8 hours (following morning).

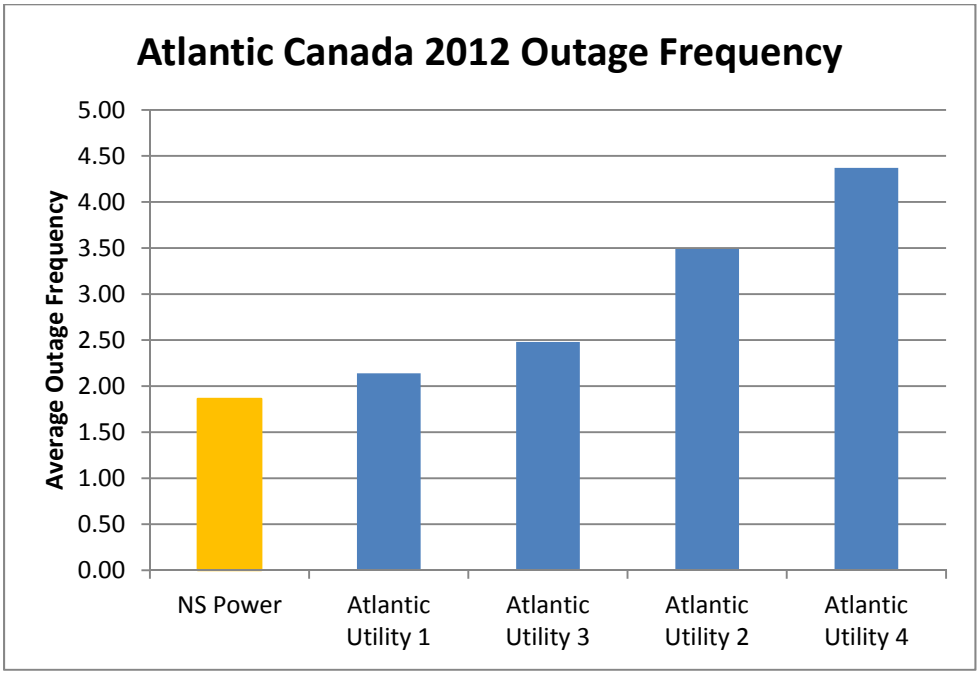


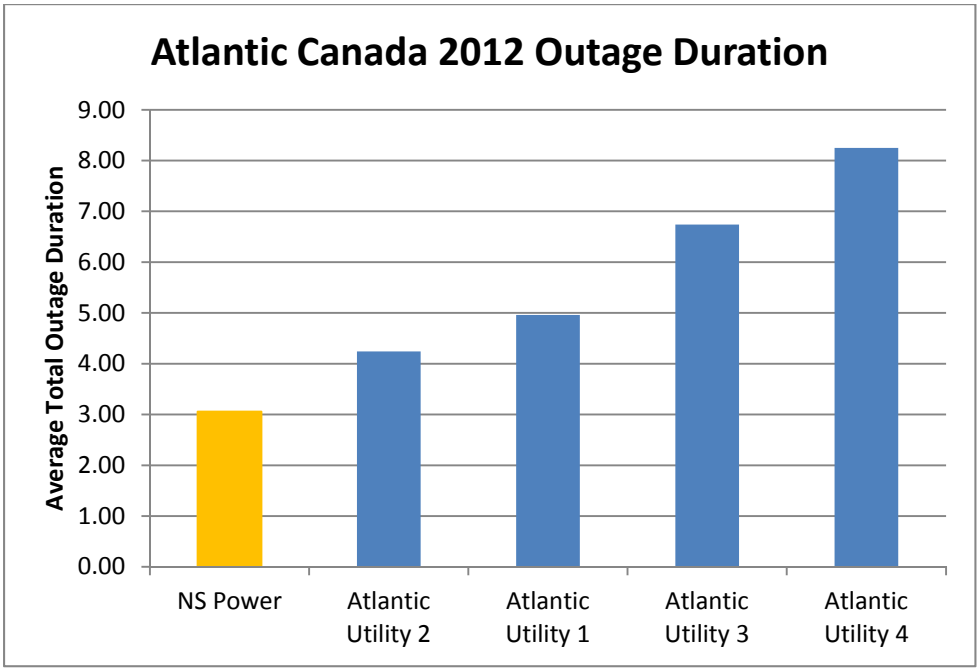
Notwithstanding our asset management strategy, reasonable operating risk remains. NS Power's fleet of generators continues to age, and as such, repair and refurbishment work will be necessary to sustain them. In addition, there will be a requirement for traditionally base-loaded units to transition towards flexible, wind-following service. Given the evolution of steam unit utilization, it is possible that NS Power will experience a greater number of Unforeseen and Unbudgeted (U&U) capital items in the coming years, whether they are the result of normal routine inspection schedules or other circumstances.

Reliability

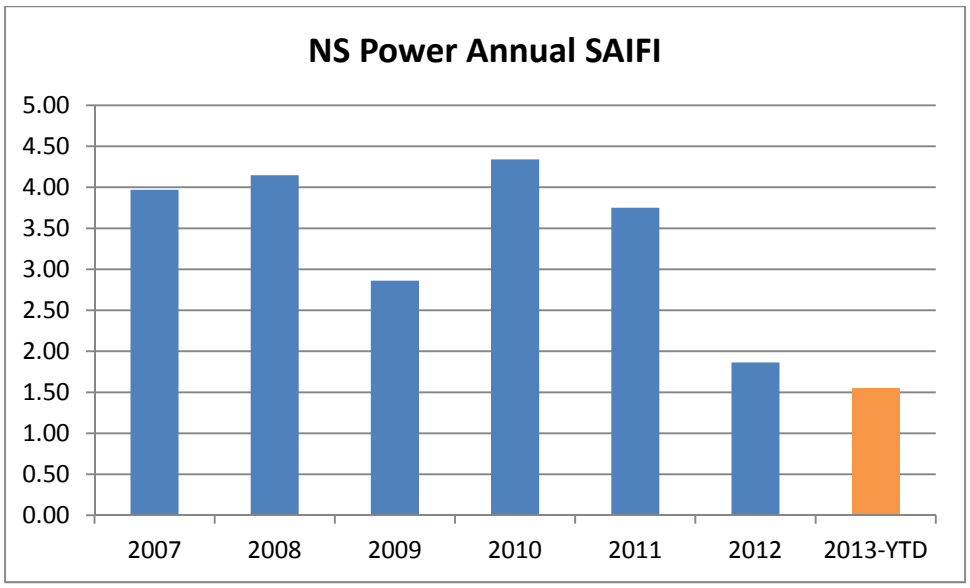
NS Power has made significant investment in improving the reliability of our transmission and distribution system. This investment represents approximately $100 million of capital improvements introduced incrementally over the last several years. The majority of this investment has been completed, with the remaining expenditures to occur between the remainder of 2013, 2014, and 2015.

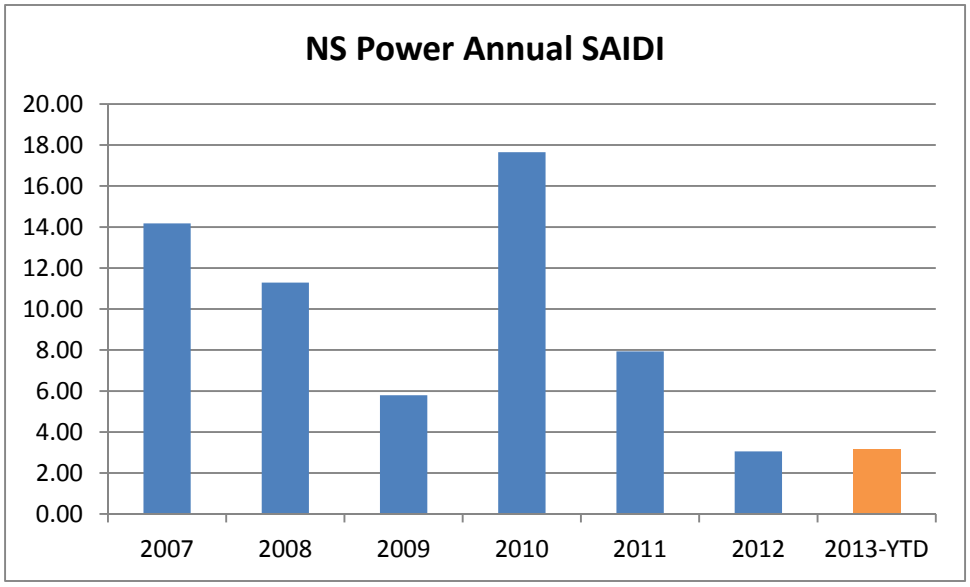
As a result of these and similar investments, and as described more fully in section 10.1.7, NS Power has accomplished a step-change improvement in reliability for NS Power customers. 2012 was a best-ever year for reliability in Nova Scotia. In 2012, NS Power ranked best among Atlantic utilities in metrics for Outage Frequency and Duration, as seen in the charts below.


Atlantic Canada 2012 Outage Frequency
Average Outage Frequency
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
NS Power
Atlantic Utility 1
Atlantic Utility 3
Atlantic Utility 2
Atlantic Utility 4


Atlantic Canada 2012 Outage Duration
Average Total Outage Duration
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
NS Power
Atlantic Utility 2
Atlantic Utility 1
Atlantic Utility 3
Atlantic Utility 4

Year-to-date 2013 statistics are trending towards continued positive results in System Average Interruption Frequency (SAIFI) and Duration Indices (SAIDI) as shown in the charts below.





In 2014, investments in reliability are focused on aging assets, deteriorated equipment replacements, system performance improvements, technology improvements, storm hardening and vegetation management.

Renewable Energy

NS Power continues to invest in renewable energy assets and projects to meet Nova Scotia's legislated renewable electricity requirements in 2015 and beyond.

NS Power's system includes several hydro generating facilities. These facilities operate on 17 watersheds and include 155 dams and 54 generating units in 33 power houses. These assets are in varied condition, and many are well over 50 years old. As such, capital investment in our hydro system is intended to keep these systems running reliably, consistent with provincial renewable electricity requirements.

In addition to hydro investments, NS Power continues to pursue wind projects to assist in meeting our RES requirements. The Sable Wind Project will be submitted to the UARB prior to year-end 2013 and is included in the Forecast for Subsequent Approval listing.

1.2 Economic Analysis Model and Stakeholder Engagement

In early 2013, consultants for the Small Business Advocate (SBA) and the Consumer Advocate (CA) were engaged to obtain their input on revisions to NS Power's Capital Expenditure Justification Criteria (CEJC). Highlights of that engagement process included NS Power's commitment to expand the revenue requirement directive found in the ACE Plan and make changes to the Economic Analysis Model (EAM).

Economic Analysis Model

The Economic Analysis Model is provided in support of economically justified projects. The new EAM has shifted to a Revenue Requirement model as the basis for project alternative selection. Barring other mitigating circumstances, the project alternative with the lowest revenue requirement will be the preferred option. Moreover, various sensitivity analyses were added to test for variations in:

1) capital investment
2) avoided costs, and
3) timing of the project.

The incremental replacement energy costs and generating plant capacity factors used in the

EAM were derived using Plexos dispatch optimization software. The system assumptions in the Plexos model are consistent with the most recent set of General Rate Application assumptions.

The scope of many of the projects presented in the 2014 ACE plan is to ensure the continued reliable operation of existing assets. Often, replacement can be more costly than refurbishment for these projects (such as CI 44351 – LIN Mill Refurbish 2014) and is not anticipated to provide longer life or additional benefits as compared to the refurbishment. Depending on equipment condition, full replacement of equipment is often not required to extend the life as all components may not age in the same manner. In these cases, replacement is not considered to be a viable option, and is not evaluated further.

Stakeholder Engagement

NS Power also worked with the consultants for the SBA and CA to discuss the following UARB 2013 ACE Plan directives:

> …The impact of capital expenditures on future customer rates should be an integral part of the 2014 ACE Plan project selection.[4]
>
> The Board directs that the parties discuss the issue of affordability and whether it can be incorporated into the ranking or justification criteria in the CEJC discussions.[5]

It was determined that rate impacts, revenue requirement, and affordability were best examined as part of NS Power's ongoing efforts to reduce overall capital expenditures. NS Power's approach aims to select, defer or cancel eligible projects which are first brought forward internally for evaluation per the criteria found in the CEJC.

[4] NS Power 2013 ACE Plan, UARB Order, NSUARB - P-128.13, June 4, 2013, page 2.
[5] NS Power 2013 ACE Plan, UARB Order, NSUARB - P-128.13, June 4, 2013, page 2.

2 2013 ACE Plan Follow-up

2.1 2013 Capital Items Pending Submission

The following table identifies projects included in the 2013 ACE Plan as items for subsequent approval, but not yet submitted to the Board this year. This table also includes Unforeseen & Unbudgeted (U&U) capital work orders for 2013. These items are not yet ready for submission to the UARB and therefore are not included in the 2014 ACE Plan for approval. NS Power anticipates these projects will be filed for approval in late 2013. These 2013 projects will carry over into 2014 and total $32 million of 2014 forecast spending. These projects total an estimated $71.6 million over multiple years which includes the $32 million of 2014 spending. These budget numbers are estimates at the time the 2014 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	2014 Budget ($)	Project Total ($)
Steam			
42982	TUC6 - Gland Steam Supply *This project provides for the gland steam supply for Unit 6.*	909,671	1,308,372
	Total New Steam Spending for Subsequent Approval	**$909,671**	**$1,308,372**
Wind			
40785	Sable Wind *Construction of NS Power's approximate 49% share of a 13MW Wind Farm.*	12,049,654	13,198,950
	Total New Wind Spending for Subsequent Approval	**$12,049,654**	**$13,198,950**
	Total New Generation Spending for Subsequent Approval	**$12,959,325**	**$14,507,321**
Transmission			
43684	Interconnection Substation South Canoe Wind Project *Interconnection and Network Upgrade work associated with the South Canoe Wind Farm.*	2,081,677	6,688,062
43683	South Canoe Wind Project Transmission Line *Interconnection and Network Upgrade work associated with the South Canoe Wind Farm.*	2,150,556	5,193,391

CI #	Project Title	2014 Budget ($)	Project Total ($)
43681	South Canoe Wind Project Substation Network Upgrades *Interconnection and Network Upgrade work associated with the South Canoe Wind Farm.*	1,711,375	3,761,382
43676	Interconnection Substation Sable Wind Project *Interconnection and Network Upgrade work associated with the Sable Wind Farm.*	988,300	988,300
43674	Sable Wind Network Upgrades *Interconnection and Network Upgrade work associated with the Sable Wind Farm.*	767,344	767,344
43675	Transmission Interconnection Facilities Sable Wind Project *Interconnection and Network Upgrade work associated with the Sable Wind Farm.*	279,224	279,224
	Total New Transmission Spending for Subsequent Approval	**$7,978,475**	**$17,677,703**
Distribution			
40320	LED Street Light Conversion *LED Streetlight deployment program.*	8,664,772	35,374,908
	Total New Distribution Spending for Subsequent Approval	**$8,664,772**	**$35,374,908**
General Plant			
40648	IT - Field Mobility System *The Field Mobility project will automate the work order management and time entry process for Power Line Technicians (PLTs).*	1,863,648	3,340,935
41705	Milton Hydro Office Renovation and Upgrade *This project provides for infrastructure repairs and improvements at the facilities at the Milton Hydro Office.*	545,946	716,836
	Total New General Plant Spending for Subsequent Approval	**$2,409,594**	**$4,057,771**
	Total Capital Items for Subsequent Approval	**$32,012,166**	**$71,617,703**

2.2 2013 ACE Capital Items Deferred / Cancelled

NS Power's list of deferred and cancelled capital work orders relative to the revised 2013 ACE Plan are noted in the table below.

This list reflects NS Power's efforts to reduce capital expenditures and is longer than in past years. Continued diligence in the form of inspections, operational observations and assessments, allows projects to be re-validated and re-prioritized over the course of the year. Deferring or cancelling these capital projects assisted NS Power in reducing its 2013 capital spend from a budget of $246M to a currently forecasted $206M. Of the 50 projects listed below, eight of these projects were included in the revised 2013 ACE Plan for approval. 15 of these projects were listed in the ACE Plan to be filed separately as individual capital items. The remaining 27 projects were less than $250,000. These 50 projects were originally included in the revised 2013 ACE Plan with a forecasted spend of $22.4 million in 2013.

CI	Project Title	2013 ACE Project Total	Cancelled / Deferred
Generation			
33142	CT - Burnside #4 Engine Restoration And Upgrade *NS Power continued to develop its operational and investment strategies, incorporating findings from the Renewable Energy Integration Study. This work is now planned to begin in 2014, with completion in 2015.*	7,000,000	Deferred
20758	HYD - Nictaux Pipeline Replacement & Intake Refurbishment *The work on this project was re-evaluated, and determined that it can be deferred until 2015.*	4,379,301	Deferred
43747	TUC4 - Hot Section Overhaul *The scope of this project has been included in the scope of CI 43906 – TUC4 U&U Engine Refurbishment.*	3,190,583	Cancelled
40283	HYD - Wrights Lake Dam Refurbishment *Personnel continue to work towards optimizing the design for this project.*	2,487,980	Deferred
30162	POT - Bunker C tank refurbishment *Plant and Engineering personnel have continued to monitor the condition of the tank, and evaluate solutions to mitigate risk.*	1,079,465	Deferred
43607	HYD - Malay Falls Unit Overhaul	692,652	Deferred

CI	Project Title	2013 ACE Project Total	Cancelled / Deferred
	A condition assessment of this unit was completed in 2013, and determined that some components were in better health than anticipated. Scope of what is required in the near-term is reduced, and can be deferred.		
43035	POT - South BFP Refurbishment *Assessment of equipment performance indicated this refurbishment work could be delayed until the unit outage in 2015. The equipment will undergo evaluation work in the 2014 planned outage to validate scope.*	505,535	Deferred
43127	HYD - 4th Lake Penstock Refurbishment *Further investigation revealed the scope was smaller than anticipated, and was addressed under the H001 Routine.*	441,243	Cancelled
37885	POT - Lubrication and Chemical Storage *This project was deferred while plant personnel continued to evaluate options, and seek a cost-efficient solution.*	429,891	Deferred
43424	TRE5 Analytical Panel *The risk associated with this work was determined to be low enough to defer until 2014.*	382,109	Deferred
43155	CT-BGT2 Air Intake Structure Refurbishment *A review of the condition of this asset indicated that this work could be deferred. This deferral will also facilitate design of an optimized solution.*	316,941	Deferred
41664	TRE5 Precip Refurbishment *Recent inspections by the engineering team reduced the risk profile, and deferred this one year.*	306,057	Deferred
43567	TUC3 CW Screen *Inspection of the screens was completed in 2013, and confirmed that this work could be deferred until 2014.*	293,903	Deferred
42943	TUC2 - T-G Areas Fire Protection *Evaluation of this work confirmed it could be deferred, and mitigating measures are in place. The work will now be completed in 2014 and aligned with the unit's planned outage.*	283,088	Deferred
43407	TRE5 Cable Rooms Fire Protection	238,743	Deferred

CI	Project Title	2013 ACE Project Total	Cancelled / Deferred
	Risk on this project was evaluated such that it can be deferred until 2014. In addition, feedback from insurers review in 2013 will be incorporated.		
42973	TUC - #1 and 2 WTP DCS upgrade *Internal inspection and risk assessment has determined this work could be deferred until 2014.*	233,981	Deferred
42728	LIN 1 & 2 U&U Seasonal Layup *Changing operating strategies and evolving scope definition has resulted in deferral of submission for this project. Note, this project has been re-titled to "Unit Lay-up Program".*	225,930	Deferred
43207	LIN 4160 Motor Refurbishment *Continued evaluation of motor operation, condition, and the resulting risk profile has allowed for deferral of this project.*	223,862	Deferred
42938	TUC - Unit 1 South BFP Refurbishment *Forecast utilization of this unit in the near-term has reduced the criticality of this work.*	208,236	Deferred
43429	TRE5 Lube Oil Cooler Retube *Engineering assessment has deemed the risk to be acceptable, so the work has been deferred until 2014.*	183,832	Deferred
42937	TUC-LMs East Gas Compressor Overhaul *This project has been deferred based on internal risk and condition assessment.*	155,900	Deferred
43666	TUC - Replace Hydrazine with DEHA *NS Power is undertaking a phased approach to elimination of Hydrazine at Steam Plants. Hydrazine was replaced with DEHA at Trenton and Point Aconi in 2013. Lingan and Tufts Cove will be addressed in 2014. In the 2014 ACE Plan, this project has been revised to be solely for TUC1. CIs 45493, 45494 and 43627 have been introduced for TUC2, TUC3 and LIN respectively.*	155,449	Deferred
43114	POA - Screw Cooler Trough Replace *Current blends of fuel are less abrasive on the screws. Engineering team will continue to repair as needed, monitor and evaluate.*	155,217	Deferred
42979	TUC - HFO Line Support Refurbishment *An evaluation of the HFO pipe supports was completed, and determined that this work could be deferred.*	154,269	Deferred

CI	Project Title	2013 ACE Project Total	Cancelled / Deferred
43159	Burnside #1 & 2 and VJ Annunciation Units Upgrade to DAS *As the investment strategy for Combustion Turbines has developed, this work has been re-prioritized and deferred to 2015.*	150,210	Deferred
42939	TUC2 CW Pump Refurbishment *An engineering review confirmed that a temporary repair could be completed to defer this work. The pump refurbishment is now planned for 2014.*	148,202	Deferred
43244	POA - Stack Lighting *The components required to repair the lighting were located, and recent operation of the stack lighting has been reliable. The parts are no longer supported, and replacement of the lighting is anticipated for 2015.*	147,709	Deferred
43420	CTs - Burnside air dryer system upgrade *Further condition assessment confirmed this work can be deferred while Engineering and Operations personnel continue to assess options. Air dryers at all three liquid-fired CT locations require upgrades, and will be upgraded in a phased approach with the air dryer at Tusket first based on engineering evaluation.*	131,817	Deferred
43125	HYD - 4th Lake Butterfly Valve Actuator Replacement *Components for refurbishment were not commercially available as anticipated. The Hydro team continues to work toward finding a technically-viable solution for this work.*	129,250	Deferred
39777	TUC - Ferrous Sulphate System Upgrade *Further testing of the liquid system of Tufts Cove Unit 2 is required to validate project requirements.*	121,400	Deferred
43408	TRE 4kV Motor Refurbishments 2013 *Evaluation of motor condition in 2012 allowed for deferral of some planned refurbishments to 2013. No additional motors were identified for refurbishment in 2013, and therefore the 2013 project has been cancelled.*	116,996	Cancelled
37544	TRE5 - Coal MCC Transformer Replace *The PCB content is within allowable limits, and the condition of the transformer was evaluated to be acceptable in 2013. It was therefore determined that the work could be deferred to 2014.*	92,141	Deferred
30955	LIN Fire System Valve Upgrade	86,772	Deferred

CI	Project Title	2013 ACE Project Total	Cancelled / Deferred
	Further evaluation of risk has confirmed that this work can be deferred. If high risk valves are identified, smaller portions of the work can be executed as needed.		
43412	TRE5 Breaker Refurbishments *Evaluation of breakers in 2012 allowed for some of the planned work to be deferred to 2013. No additional breakers were identified for refurbishment in 2013, therefore this work has been deferred.*	86,217	Deferred
37982	CTs - BGT#3 AVR Replacement *Due to needs of the fleet, the planned outage for this unit was re-scheduled during the year. Specialized contractors selected to complete this work were not able to complete the work in the new outage window, and an assessment confirmed the delay could be accepted.*	77,403	Deferred
39982	TRE - Gauge Replacements *The Canadian Nuclear Safety Commission inspection of these valves in 2013 identified no concerns. It was therefore determined that replacement of these gauges could be deferred.*	75,236	Deferred
43413	TRE6 Breaker Refurbishments *Evaluation of breakers in 2012 allowed for some of the planned work to be deferred to 2013. No additional breakers were identified for refurbishment in 2013, therefore this work has been deferred.*	73,961	Deferred
42944	TUC3 - Replace Boiler Drum North PSV *Revised inspection report indicates repair work is still feasible, and no replacement is required at this time.*	71,275	Deferred
43146	CTs - VJ Air Dryer System Upgrade *Further condition assessment confirmed this work can be deferred while Engineering and Operations personnel continue to assess options. Air dryers at all three liquid-fired CT locations require upgrades, and will be upgraded in a phased approach with the air dryer at Tusket first based on engineering evaluation.*	65,495	Deferred
Transmission			
43324	L6513 Rebuild/upgrade line terminals *Project pending decision on Maritime Link application.*	16,100,000	Deferred
43682	South Canoe Line Upgrades(L-5535 and L-5541)	7,437,544	Cancelled

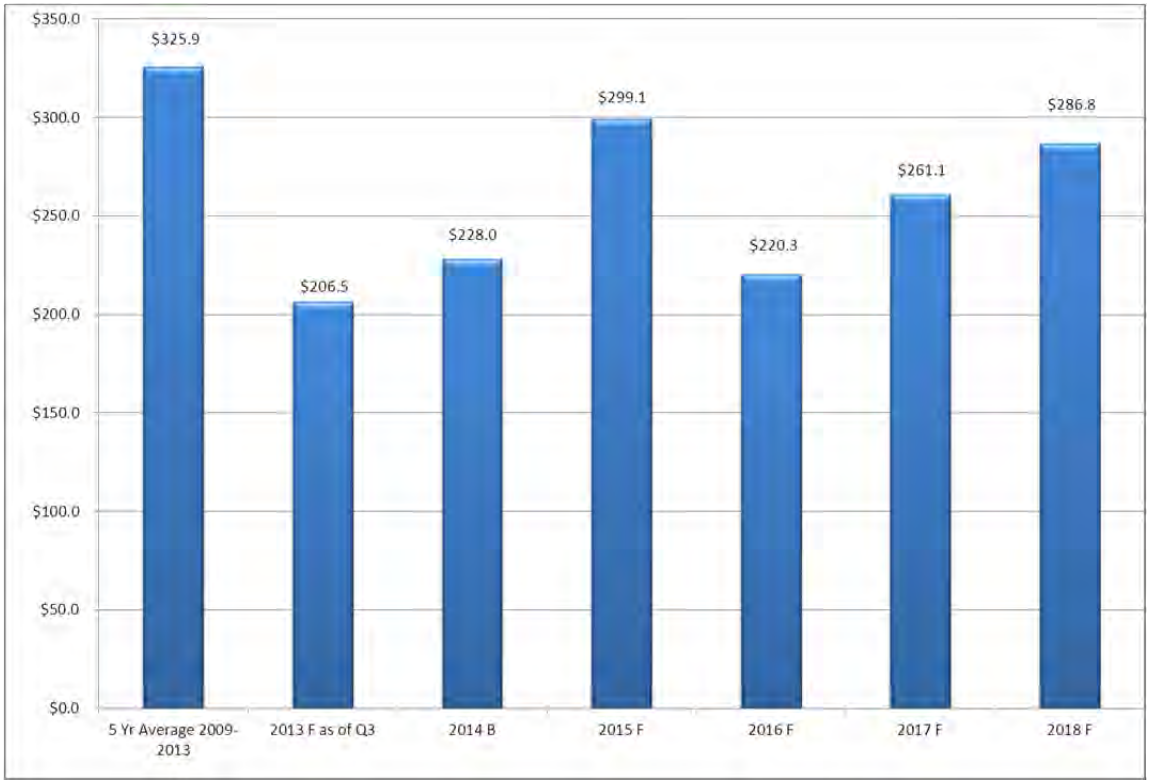
CI	Project Title	2013 ACE Project Total	Cancelled / Deferred
	Through more detailed scoping, this project is no longer necessary to support the South Canoe Wind Project.		
43684	Interconnection Substation South Canoe Wind Project *The work originally expected to be completed in 2013 was solely engineering. The engineering work will now be completed in early 2014. No delay in the construction of the transmission line.*	6,484,289	Deferred
43681	South Canoe Wind Project Substation Network Upgrades *The work originally expected to be completed in 2013 was solely engineering. The engineering work will now be completed in early 2014. No delay in the construction of the transmission line.*	4,766,785	Deferred
43683	South Canoe Wind Project Transmission Line *The work originally expected to be completed in 2013 was solely engineering. The engineering work will now be completed in early 2014. No delay in the construction of the transmission line.*	4,430,958	Deferred
41520	Harbour East Substation *A further study was completed that showed this was not required in 2013.*	3,420,719	Deferred
43291	Protection Risk Reduction 67N-Onslow 230KV *The preliminary engineering work being completed to properly scope the project is occurring in late 2013. This will be submitted to the Board as a Subsequent Submission in 2014.*	2,416,341	Deferred
43486	89H-511 Add Battery, Battery Charging Set, RTU and Replace Breaker *After further scoping, the risk of failure on this asset was deemed acceptable and was deferred from the 2013 capital plan. The condition of the assets supported the deferral of this project.*	421,477	Deferred
43223	101S-Woodbine Transfer Switch Replacement *As part of the effort to reduce the 2013 Capital plan, the risk associated with this project was deemed acceptable and was deferred until 2014. The condition of the existing switch supported the deferral of this project.*	48,768	Deferred
Distribution			
43468	LED Street Light Conversion Phase 2 *This project is now included in CI# 40320 - LED Street Light Conversion*	46,827,461	Cancelled

CI	Project Title	2013 ACE Project Total	Cancelled / Deferred
General Plant			
41442	IT - Advanced Laptop Security *The project was evaluated against other priorities, and the risk associated with deferring the work has been deemed acceptable to defer execution to 2014.*	94,404	Deferred

3 Capital Spending History and Forecast Overview

3.1 Historical, Budget and Forecast

(Millions of Dollars)



F = Forecast, B=Budget in above figure

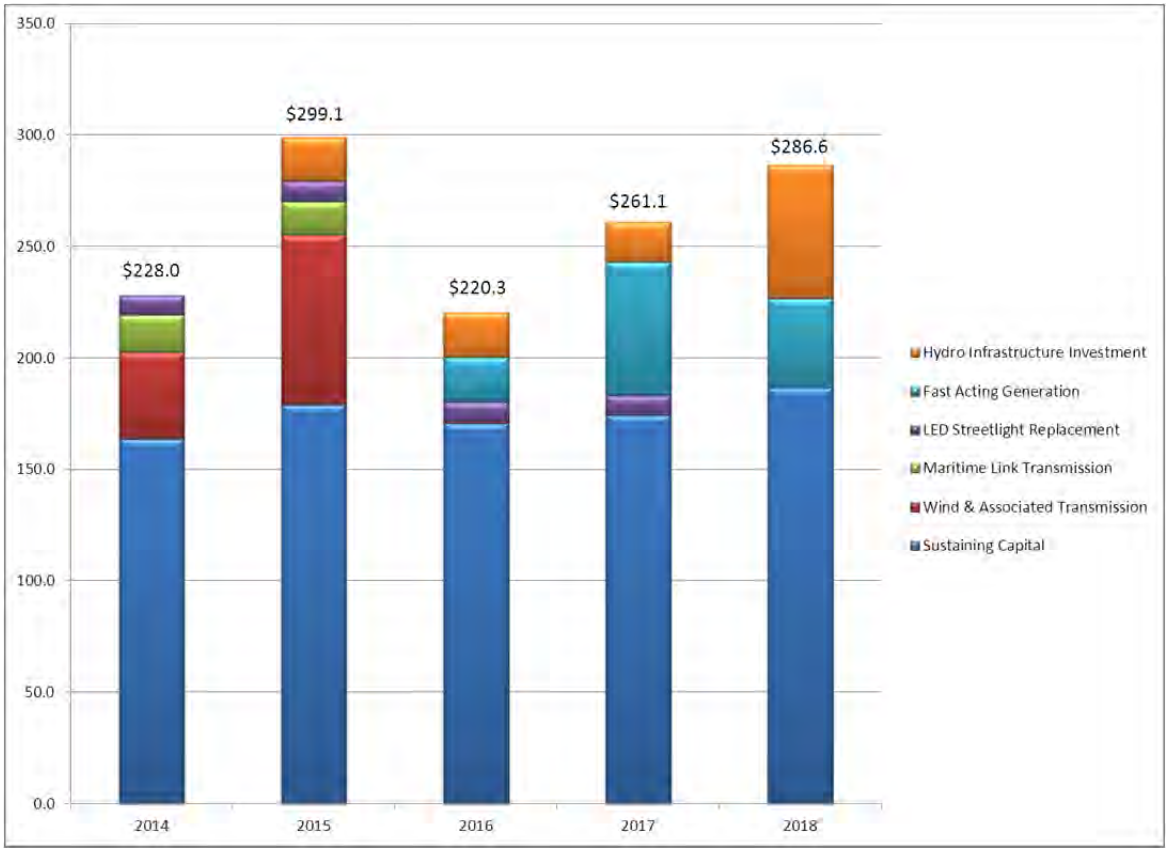
3.2 Total Annual Capital Expenditures by Function

(Millions of Dollar)

Year	2009 Actual	2010 Actual	2011 Actual	2012 Actual	Approved Revised 2013 ACE Plan	Forecast 2013 as of Q3	ACE Plan 2014	Forecast 2015	2016	2017	2018
Generation	$133.3	$129.0	$85.4	$88.7	$66.4	$63.6	$58.8	$92.0	$101.2	$140.4	$163.7
New Renewables	31.7	256.0	66.2	53.2	34.8	14.5	30.9	66.3	0.8	0.0	0.0
Transmission	22.7	45.1	58.4	45.4	41.6	33.1	51.8	52.6	28.3	28.9	29.5
Distribution	52.3	59.6	62.4	68.7	66.7	64.6	59.0	60.2	61.4	62.6	63.9
General Plant	39.6	54.0	42.5	28.5	36.4	30.7	27.5	28.0	28.6	29.1	29.7
Total	**$279.7**	**$543.7**	**$315.0**	**$284.5**	**$246.0**	**$206.5**	**$228.0**	**$299.1**	**$220.3**	**$261.1**	**$286.8**

3.3 5-Year Annual Capital Expenditure

NS Power's capital forecast for 2014 – 2018 is shown below broken out by investment type. The Sustaining Capital portion of the annual forecasts is more certain that the Strategic Capital profile. The Sustaining Capital estimates are built up from well understood maintenance and replacement programs while Strategic Capital reflects projections of spending that are known or are anticipated to be necessary to meet system requirements related to legislation or, as in the case of the fast acting generation, may be made necessary by the transition of NS Power's generating fleet. Specifically, integrating the significant wind generation in place and under development may require the addition of new fast-acting generation. This requirement is likely to be refined through the Integrated Resource Planning process to occur during 2014. Accordingly, the identified expenditures for Fast-Acting Generation profiled in 2016 through 2018 are at this time forecasts and not firm plans. These may be shifted further into the future or deleted if deemed avoidable.



Year	2014	2015	2016	2017	2018
Sustaining Capital	163.9	179.2	170.7	174.3	186.8
Wind & Associated Transmission	38.8	76.1	0.8	0.0	0.0
Maritime Link Transmission	16.6	15.1	0.0	0.0	0.0
LED Streetlight Replacement*	8.7	8.8	8.8	8.8	0.0
Fast Acting Generation	0.0	0.0	20.0	60.0	40.0
Hydro Infrastructure Investment	0.0	20.0	20.0	18.0	60.0
Total	**$228.0**	**$299.1**	**$220.3**	**$261.1**	**$286.8**

*LED Streetlight Replacement while listed separately is considered sustaining capital.

4 2014 Annual Capital Expenditure Plan

4.1 Summary of Expenditures

The following table provides the proposed 2014 capital investment by approval category for NS Power's ACE Plan filing. This Application seeks UARB approval of the 2014 routine capital and other 2014 projects, which total $94.1 million of forecast spending in 2014. Certain items do not require UARB approval, but are included in the Company's annual capital plan for transparency and stakeholders' information. The 2014 ACE Plan budget also includes spending on multi-year projects that were previously approved by the UARB.

2014 ACE Plan Spend	2014 UARB Approval Request ($M)	UARB Approval Not Required ($M)	Capital Items Forecast for Later Filing & Approval in 2013/2014 ($M)	Previously Approved Capital Projects with 2014 Carryover ($M)	2014 ACE Plan ($M)
Capital Item Approval Sought through the 2014 ACE Process (Including Routine Capital Projects)	94.1				**94.1**
Capital Items Submitted for Later Approval in 2013			32.0		**32.0**
Capital Items Submitted for Later Approval in 2014			37.1		**37.1**
2014 Carryover Projects				43.8	**43.8**
Capital Items Less Than $250K		10.9			**10.9**
Point Aconi Capital Spend		10.1			**10.1**
2014 ACE Plan	**$94.1**	**$21.0**	**$69.1**	**$43.8**	**$228.0**

**Routine Capital spending represents $72.7 million of total spending in 2014. Excluding the costs of $0.4 million associated with Point Aconi Routines, NS Power is seeking approval of $72.3 million of Routine spending in 2014.*

Capital item justifications are based on the Capital Expenditure Justification Criteria (CEJC) as approved by the Board in 2013. The CEJC provides the Board and stakeholders with assurance that NS Power is using approved economic, financial and technical criteria to ensure that its capital expenditures provide the maximum value to its customers. NS Power recently concluded stakeholder discussions on revisions to the new CEJC. The Summary CEJC was approved by the UARB on September 18, 2013.

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

4.2 2014 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 $21.9 million of spending in 2014, with a total forecast spending of $24.9 million.

Tab #	CI #	Project Title	2014 Budget ($)	Project Total ($)
Hydro				
G01	42666	HYD - Tusket #2 Overhaul	373,966	657,684
G02	44968	HYD - Wreck Cove Unit 2 Excitation System	580,329	601,088
G03	44887	HYD - Sissiboo Pipeline Replacement	455,068	475,082
G04	45189	HYD - Upper Lake Falls #2 Overhaul	441,716	441,716
Total New Hydro Spending			**$1,851,079**	**$2,175,569**
Steam				
G05	44888	PHB - Boiler Refurbishment 2014	742,129	742,129
G06	44732	TRE5 Boiler Refurbishment	626,649	626,649
G07	44351	LIN Mill Refurbish 2014	536,481	536,481
G08	45126	TRE5 Continuous Emissions Monitor for Mercury Measurement	515,698	515,698
G09	42939	TUC2 - South Circulating Water Pump Refurbishment	431,536	431,536
G10	44717	TUC2 - Condenser Vacuum Pump Replacement	428,783	428,783
G11	43168	LIN CW Pump Refurbish and Upgrade	417,461	417,461
G12	44731	TRE5 Coal System Upgrades	413,416	413,416
G13	43424	TRE5 Analytical Panel	393,825	393,825
G14	44350	LIN4 Boiler Refurbish 2014	382,503	382,503
G15	44590	POT - Water Treatment Plant Siding Replacement	360,523	360,523
G16	37885	POT - Lubrication and Chemical Storage Facility	335,090	343,763
G17	44729	TUC - Station & Unit Transformer Connection Cable Replacement	313,042	313,042
G18	42943	TUC2 - T-G Areas Fire Protection	292,621	292,621
G19	43567	TUC3 - CW travelling screens refurbishment	283,750	283,750
G20	44725	TRE5 Baghouse Filter Replacements	260,875	260,875
G21	44352	LIN CW Screen Refurbish	255,007	255,007
Total New Steam Spending			**$6,989,387**	**$6,998,060**
Gas Turbine				

Tab #	CI #	Project Title	2014 Budget ($)	Project Total ($)
G22	45116	BGT1 GG4C-1D Engine Refurbishment	1,152,807	1,152,807
G23	43153	CT - TUC4 Control Upgrade	535,493	535,493
Total New Gas Turbine Spending			**$1,688,300**	**$1,688,300**
Total New Generation Spending			**$10,528,766**	**$10,861,930**
Transmission				
T01	43205	L5510 Insulator Replacements	734,641	3,191,398
T02	44974	2014 PCB Equipment Removals	1,172,392	1,172,392
T03	44980	2014 Transmission Switch and Breaker Replacements	1,095,553	1,095,553
T04	43672	82V-T1 Transformer Rewind	728,491	936,380
T05	45033	L7001 Replacements	813,226	813,226
T06	44977	3W Breaker, Switch & Cable Replacements	401,463	401,463
T07	44983	Reactor Bank Breaker Replacements	385,032	385,032
T08	44985	Replace 230kV Kearney Disconnect Switch Assemblies	319,246	319,246
T09	44973	2014 Substation Recloser Replacements	307,115	307,115
T10	44982	New Spare Transformer to Replace 20W-T51	291,660	291,660
T11	44975	Sacrificial Anode Installation Program Phase 1	290,047	290,047
Total New Transmission Spending			**$6,538,868**	**$9,203,513**
Distribution				
D01	43217	24C-442G Hwy 16 Rebuild Phase 1	800,769	800,769
D02	44826	2014 Build-to-Roadside	791,268	791,268
D03	45046	2014 PCB Phase-out for Pole Top Transformers	779,620	779,620
D04	43177	103W-311 Gold River Reconductor Phase 3	377,721	377,721
D05	44759	16N-301 - Stewiacke - Load Transfer	258,816	258,816
D06	44833	99V-312 - Highbury New Feeder	256,828	256,828
Total New Distribution Spending			**$3,265,021**	**$3,265,021**

Tab #	CI #	Project Title	2014 Budget ($)	Project Total ($)
General Plant				
Outage Performance				
GP01	43227	2014 RTU Replacements	687,839	687,839
Total Outage Performance			**$687,839**	**$687,839**
Telecommunications				
GP02	44967	2014 Multiplexer Network Upgrades	435,618	435,618
GP03	44966	2014 Microwave System Capacity Upgrade	397,729	397,729
Total New Telecommunications Spending			**$833,346**	**$833,346**
Total New General Plant Spending			**$1,521,185**	**$1,521,185**
Total New Capital Spending			**$21,853,840**	**$24,851,650**
Total Routine Capital Spending			**$72,275,566**	**$72,275,566**
Total Capital Items for which Approval is Sought			**$94,129,406**	**$97,127,215**

4.3 2014 ACE Plan Capital Items Forecast for Subsequent Approval

The following table identifies 2014 projects that are not yet ready for submission to the UARB, and that NS Power anticipates will be filed for approval throughout 2014. NS Power estimates $37.1 million of spending in 2014 on these projects which are currently estimated for total spending of $83.8 million. The budget numbers indicated below are estimates as NS Power needs additional time to refine the specific project budget proposals. This section of the Company's filing is designed to provide an indication of these anticipated 2014 projects, as requested by the Board.

CI #	Project Title	2014 Budget ($)	Project Total ($)
Hydro			
44248	HYD - MacMillan Dam D-7 Refurbishment *This project is for refurbishment of an embankment dam and spillway at Wreck Cove to correct stability and spill capacity deficiencies.*	4,795,607	5,279,936
43067	HYD - Cheticamp Dam D-1 Refurbishment *This project is for the refurbishment of an embankment dam at Wreck Cove to ensure its compliance with Canadian Dam Safety criteria for freeboard and stability.*	694,750	4,313,991
41142	HYD - St. Margaret's Fish Passage *This project is to construct a new fish ladder adjacent to main dam on the Saint Margaret's Bay Hydro system.*	296,958	3,163,840
44978	HYD - Wreck Cove Automation *This project is to modernize and automate the Wreck Cove facility for more efficient trouble-shooting and unit monitoring.*	381,782	805,604
44669	HYD - Wreck Cove Fire Suppression Upgrades *This project is for the upgrade of the fire protection systems at Wreck Cove to comply with NFPA code requirements.*	333,589	333,589
Total New Hydro Spending for Subsequent Approval		**$6,502,686**	**$13,896,959**
Gas Turbine			
33142	CT - Burnside #4 Unit Restoration *This project provides for work required to bring the Burnside Unit 4 back in service.*	767,439	3,704,398

CI #	Project Title	2014 Budget ($)	Project Total ($)
29065	CTS BGT Replace Halon Fire Protection System *This project is for the replacement of the halon fire protection system at the Burnside CT facility with a system which uses an environmentally-friendly substance. The manufacture and import of new halon, or import of bulk used halon into Canada, is prohibited under the federal Ozone-depleting Substances Regulations.*	356,702	356,702
43155	CT - BGT2 Air Intake Structure Refurbishment *This project will refurbish the Burnside Unit 2 air intake structure to prevent debris from entering the turbine intake.*	306,586	306,586
	Total New Gas Turbine Spending for Subsequent Approval	**$1,430,728**	**$4,367,687**
Steam			
30162	POT - Bunker C tank refurbishment *This project provides for the refurbishment of the Bunker C tank which has experienced wall thinning from corrosion and pitting.*	2,125,931	2,239,835
44730	TRE5 Turbine Main and Control Valves Refurbishments *This project is to refurbish the TRE5 turbine main and control valves. Materials will be procured in 2014 for planned execution in 2015.*	306,807	731,359
42728	Unit Lay-up Program *Due to the seasonal operation of coal-fired units (Lingan 3 in 2014) work needs to be undertaken to preserve the assets and ensure they are ready to be placed in service when needed. This project is for procurement and installation of new assets to ensure we have this capability.*	79,893	330,650
45180	ICP - Rail Line Bridge Work *Work on the Rail Line Bridge is required to extend the life of the asset, and defer the need for complete replacement.*	308,108	308,108
45392	TRE Bunker C System Refurbishments *The scope of this project is upgrades and refurbishments to the Bunker C system for environmental management and improved reliability.*	288,886	288,886
45178	ICP - Rail Centre Shop Roof *This project will address deterioration of the Rail Centre Shop Roof.*	265,725	265,725
45326	LIN1 PAC System Improvements *This project is required to update the LIN1 Mercury control equipment to achieve regulatory targets.*	227,641	262,986

CI #	Project Title	2014 Budget ($)	Project Total ($)
45327	LIN2 PAC System Improvements *This project is required to update the LIN2 Mercury control equipment to achieve regulatory targets.*	227,641	262,986
45328	LIN3 PAC System Improvements *This project is required to update the LIN3 Mercury control equipment to achieve regulatory targets.*	227,641	262,986
45329	LIN4 PAC System Improvements *This project is required to update the LIN4 Mercury control equipment to achieve regulatory targets.*	227,641	262,986
	Total New Steam Spending for Subsequent Approval	**$4,285,914**	**$5,216,507**
	Total New Generation Spending for Subsequent Approval	**$12,219,329**	**$23,481,153**
Transmission			
43324	L6513 Rebuild / Upgrade Line Terminals *This is a network upgrade project required to support the Maritime Link Investment. Approximately $6 million of this capital project is to address thermal clearance issues that are needed regardless of the Maritime Link project being completed.*	8,456,500	16,141,774
43678	Separate L8004/L7005 on Canso Crossing Double Circuit Tower *This is a network upgrade project required to support the Maritime Link Investment, pending approval of that project.*	2,241,664	10,818,967
45066	Upgrade L6511 and L7019 Thermal Rating *This is a network upgrade project required to support the Maritime Link Investment, pending approval of that project.*	3,775,982	7,707,849
44987	L7003 Upgrades *This project provides for the increase of clearances on L-7003 in order to meet Canadian Standards Association requirements.*	971,776	6,859,667
45306	George Street Substation Addition *This project provides for the addition of a new substation on George Street in Sydney*	362,477	3,771,492
45067	67N Onslow 345 KV Node Swap *This is a network upgrade project required to support the Maritime Link Investment, pending approval of that project.*	2,150,875	3,006,487

CI #	Project Title	2014 Budget ($)	Project Total ($)
43291	Protection Risk Reduction 67N-Onslow 230KV *This project provides the costs to upgrade the protection system at 67N-Onslow (230kV) to comply with Northeast Power Coordinating Council (NPCC) bulk power system protection risk reduction plan.*	2,486,992	2,486,992
44984	9C Aberdeen Transmission Line Installation *This project provides for the cost of construction of a short line tap and connection of live line sectionalizing capable switches at the 9C Aberdeen substation.*	846,755	846,755
44970	2014 Steel Tower Refurbishments *This project provides for the refurbishment of deteriorated steel towers.*	492,271	492,271
	Total New Transmission Spending for Subsequent Approval	**$21,785,291**	**$52,132,253**
Distribution			
45027	535N - Powell Road Partial Conversion Phase 1 *This project provides for the costs to complete a partial conversion of 535N Powell Road.*	357,418	357,418
	Total New Distribution Plant Spending for Subsequent Approval	**$357,418**	**$357,418**
General Plant			
44671	IT - Oracle Financials Upgrade *This project will upgrade NS Power's version of E-Business to the current release to ensure the provision of financial applications across the business.*	1,491,343	6,633,731
45106	IT - Printer Fleet Refresh *This project will replace the existing fleet of NS Power's Multi-Function Device (MFD) printers. The current lease agreement is approaching the end of its term.*	500,000	500,000
44713	IT - Safety Health and Wellness Tracking System *This project is for implementation of a software solution to improve and streamline health and safety planning, tracking and reporting.*	358,924	358,924

CI #	Project Title	2014 Budget ($)	Project Total ($)
45036	ArcMap Design Software *This project provides for the purchase of the ArcMap Design Software*	344,459	344,459
	Total New General Plant Spending for Subsequent Approval	**$2,694,726**	**$7,837,114**
	Total Capital Items for Subsequent Approval	**$37,056,765**	**$83,807,939**

4.4 2014 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 but are provided for transparency and stakeholder information.

CI #	Project Title	2014 Budget ($)	Project Total ($)
Hydro			
45330	HYD-WRC C3 Culvert Replacement	116,396	116,396
16379	HYD-Mink Lake Dam Replacement	75,555	75,555
	Total Hydro Items Less Than $250,000	**$191,951**	**$191,951**
Steam			
43027	POT - Refurbish Dust Collection Area Explosion System	240,050	240,050
43407	TRE5 Cable Rooms Fire Protection	233,634	233,634
41664	TRE5 Precip Refurbishment	231,670	231,670
41226	LIN - Boiler Feed Pump Proportional Valve Replacements - Unit #1	231,420	231,420
42973	TUC - #1, 2 and 4 WTP DCS upgrade	227,093	227,093
43164	LIN1 Boiler Refurbishment	224,975	224,975
43162	LIN2 Boiler Refurbish	200,309	200,309
44722	TRE5 Low Load Valve Replacement	200,103	200,103
44626	TUC - Asbestos Abatement Program 2014	194,686	194,686
44727	TUC3 - DCS Upgrade Phase 3	190,866	190,866
44716	TUC2 - North Boiler Feed Pump Refurbishment	190,110	190,110
44627	TUC - No. 3 Elevator Control System Replacement	180,292	180,292
43429	TRE5 Lube Oil Cooler Retube	178,095	178,095
45044	LIN - Fire Protection Improvements	171,594	171,594

CI #	Project Title	2014 Budget ($)	Project Total ($)
44733	TRE6 Coal System Upgrades	165,857	165,857
41159	LIN Reclaim Feeders Replacement	165,315	165,315
44586	POT - Asbestos 2014	146,024	158,220
45058	LIN4 Turbine Valves Refurbishment	157,152	157,152
42937	TUC-LMs East Gas Compressor Overhaul	154,583	154,583
44721	TRE Ash Site Covering (2014)	150,814	150,814
43627	LIN Hydrazine Replacement	150,234	150,234
45110	PHB - Ash Handling Improvements (Phase 1)	150,104	150,104
44738	TUC3 - Battery bank inverter & charger replacement	148,104	148,104
44737	TUC2 - Battery bank inverter & charger replacement	148,076	148,076
45266	TRE6 6A Screens Refurbishment	147,725	147,725
44739	TUC2 - Replace precip & rapper control	147,562	147,562
44766	TRE5 5-3 Pulverizer Refurbishment	146,040	146,040
44720	TRE Asbestos Abatement 2014	145,008	145,008
45108	LIN34 Inclined Bottom Ash Conveyor Upgrade	144,600	144,600
44740	TUC3 - Precip field power supply	143,371	143,371
44723	TRE6 Bottom Ash Chain Replacement	143,250	143,250
44587	POT - Selective ash site capping 2014	142,076	142,076
44734	TRE6 High Energy Piping Snubbers	138,332	138,332
43666	TUC1 - Replace Hydrazine with DEHA	134,648	134,648
45494	TUC3 - Replace Hydrazine with DEHA	135,764	135,764
43050	POT - Replace drum dose skids	133,369	133,369
43350	LIN Replace D Coal Belts	130,823	130,823
22426	TRE 5-1 Air Heater Outlet Expansion Joint Replacement	129,569	129,569
44361	LIN4 Replace Boiler Fronts	117,924	117,924
45493	TUC2 - Replace Hydrazine with DEHA	116,313	116,313
45181	ICP - Rail Line Road Crossing Upgrades	116,267	116,267
43038	POT - FeS04 dosing control system	109,749	109,749
44589	POT - Replace overhead door at A-mill	108,401	108,401
45114	PHB - Analytical Panel	105,045	105,045
45246	LIN - CW MCC Refurbishment	101,682	101,682
44358	LIN4 Replace Low Load Lines and Valve	100,402	100,402
44719	TUC - 4KV Breaker Replacement	97,011	97,011
44588	POT - Transitional Metals Ion Chromatograph	96,147	96,147
37544	TRE5 - Coal MCC Transformer Replacement	90,927	90,927
44355	LIN Crusher Dumper Fire Protection Replacement	85,131	85,131
44362	LIN 3 4 Feedwater Valves	78,492	78,492
45185	TRE PAC System Improvements	78,285	78,285
44726	TUC - 600V Breaker Replacement	74,535	74,535
44768	TRE 4kV Breakers 2014	73,493	73,493

CI #	Project Title	2014 Budget ($)	Project Total ($)
44728	TUC - 4KV/600V Motor Refurbishment 2014	73,324	73,324
45045	PHB - Evacuation alarm	72,280	72,280
45184	POT - PAC system improvements	70,556	70,556
42971	TUC2 - DCS Upgrade	56,631	56,631
43410	TRE Forklift Replacement	55,713	55,713
45032	TRE Turbine Supervisory System	50,856	50,856
45059	LIN - Membrane Replacements RO	50,475	50,475
44353	LIN 4160 and 600V Breaker Refurb	50,200	50,200
44736	TUC2 - DC Battery Bank Replacement	49,870	49,870
43416	TRE5 Resin Replacement	45,199	45,199
45174	PHB - Fire System Upgrades	26,820	26,820
45172	PHB - Dust Mitigation in Electrical Rooms	26,626	26,626
	Total Steam Items Less Than $250,000	**$8,571,645**	**$8,583,841**
Gas Turbine			
44787	CT - DC Battery Bank Replacement	118,936	118,936
42050	CT - Tusket Air Dryer Upgrade	103,428	103,428
37982	CT - BGT3 AVR Replacement	75,141	75,141
44786	BGT1 - Oil Filter Upgrade	24,944	24,944
	Total Gas Turbine Items Less Than $250,000	**$322,449**	**$322,449**
	Total Generation Items Less Than $250,000	**$9,086,045**	**$9,098,242**
Transmission			
44990	104S Switch Replacement and Addition	161,471	161,471
43223	101S-Woodbine Transfer Switch Replacement	49,093	49,093
	Total Transmission Items Less Than $250,000	**$210,565**	**$210,565**
Distribution			
44832	73W-411G - East Dalhousie - Load Shift	237,511	237,511
44827	2014 Distribution Cutout Replacements	180,944	180,944
45026	639N - Mount Thom Overload	181,132	181,132
45043	57 Main Ave Primary Service Upgrade	101,070	101,070
	Total Distribution Items Less Than $250,000	**$700,657**	**$700,657**

CI #	Project Title	2014 Budget ($)	Project Total ($)
General Plant			
44972	2014 Telecom Building Replacement	218,455	218,455
44965	2014 Telecom 48VDC Battery & Charger Replacements	154,654	154,654
44969	Replace Multiplexer and Teleprotection Equipment 2014	145,733	145,733
45054	Replace Radio Tower for Methals Hydro	126,880	126,880
44714	IT - Network Security Monitoring	117,433	117,433
43238	E-Clipboard Project	101,337	101,337
41442	IT - Advanced Laptop Security	84,464	84,464
	Total General Plant Items Less Than $250,000	**$948,957**	**$948,957**
	Total Capital Items Less Than $250,000	**$10,946,224**	**$10,958,420**

4.5 2014 ACE Plan Capital Items – Point Aconi Generating Station

This table provides the Point Aconi capital projects for 2014. These projects do not require UARB Approval.

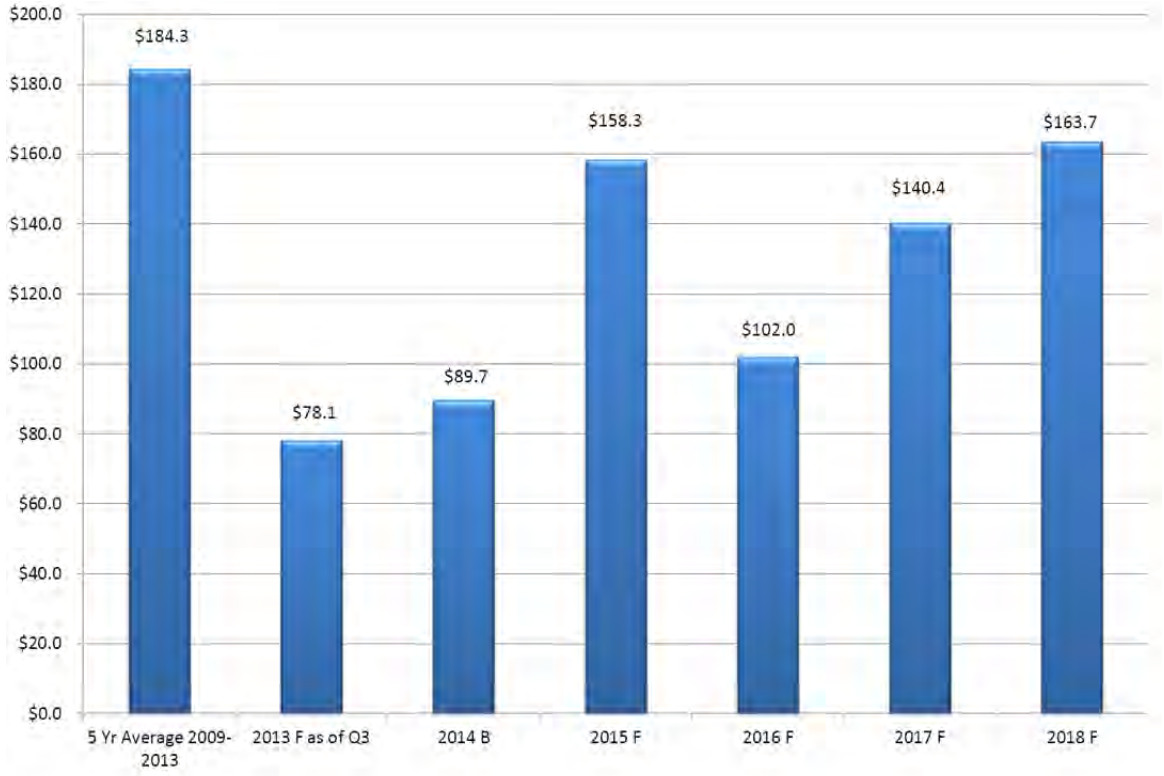
CI #	Project Title	2014 Budget ($)	Project Total ($)
44646	POA - Refractory Replacement 2014	731,118	731,118
45029	POA - Auxiliary Boiler Replacement	609,642	609,642
44686	POA - LP Gland Packing Replacement	591,022	591,022
44707	POA - HP / IP Seal Repair	570,191	570,191
43135	POA - AVR Replacement	468,396	468,396
44780	POA - Turbine Fire Suppression	346,332	346,332
45047	POA - Boiler Refurbishment 2014	236,132	236,132
44647	POA - Boiler Arrowhead Replacements 2014	190,843	190,843
43114	POA - Screw Cooler Trough Replacement	186,072	186,072
44711	POA - Emissions Capture Program Purchase	150,744	150,744
44649	POA - Miscellaneous Valve Component Replacement 2014	85,077	85,077
44648	POA - Expansion Joint Refurbishment 2014	65,452	65,452
44650	POA - 4KV 600V Breaker Refurbishment Program 2014	54,903	54,903
	Total Point Aconi New Spending	**$4,285,924**	**$4,285,924**
	Point Aconi Carryover Spending	**$5,362,623**	**$5,657,153**
	Point Aconi Routine Spending		
25647	POA DCMS Equipment Replacement	19,775	19,775

CI #	Project Title	2014 Budget ($)	Project Total ($)
21485	POA - Kelly Rock Limestone Quarry	19,775	19,775
21484	POA Plant Tools & Equipment	52,530	52,530
10718	POA - Routine Equipment Replacement	210,880	210,880
27858	POA Roofing Routine	97,139	97,139
33865	POA Heat Rate Routine	38,814	38,814
	Point Aconi Routine Spending	**$438,913**	**$438,913**
	Total Point Aconi Capital Spending	**$10,087,460**	**$10,381,990**

Note: $92,080 of the above is General Plant spend (CI 25647, 21485, and 21484) included in table 8.1 and excluded from table 5.1.

5 Generation

(Millions of Dollars)



F = Forecast, B=Budget in above figure

Note: Large increase in 2015 is due to investment in South Canoe Wind Project, increased investment in Hydro infrastructure and Fast Acting Generation. This detail is shown in Section 10.1.4 – 2011 ACE Plan Directive 12.

5.1 Generation – Highlights

The focus for Generation capital investments in 2014 is the continued expansion of renewable generation, hydro infrastructure renewal and sustaining the current asset base. The $89.7 million Generation capital investment plan for 2014 is comprised of the following:

i	New 2014 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)	$10.5
ii	2013 Capital Items Pending Submission to be filed in or prior to the Q4 2013 capital work order package. (As provided in Section 2.1)	13.0
iii	New 2014 capital spending for projects with total estimated project spend greater than $250,000 for subsequent approval. (As provided in Section 4.3)	12.2
iv	New capital spending for projects with total estimated spend less than $250,000 for which approval is not sought. (As provided in Section 4.4)	9.1
v	Point Aconi Generating Station Capital Spending. (As provided in Section 4.5)	10.0
vi	Carry-over capital spending. (As provided in Section 5.2)	31.2
vii	Routine capital Spending. (As provided in Section 9.1)	3.7
	Total 2014 Generation Capital Investment Plan	$89.7 M
	Request for ACE Approval (Items i + vii)	$14.3M

5.2 Generation – Carry-over Capital Spending Summary

Project Number	CI #	Project Title	Start Date	Final Date	Previous Expenditure ($)	2014 Budget ($)	Subsequent Spending ($)	Total Estimate ($)
Hydro Generation Plant								
H517	16374	HYD Gaspereau Dam Safety Remedial Works	2007/04	2014/12	5,379,955	4,862,611	0	10,242,566
H660	17581	HYD - Weymouth Electrical Replacement	2012/07	2015/10	29,152	807,719	380,352	1,217,223
H638	23125	HYD - Sissiboo Falls - Electrical Equipment Replacement	2011/12	2014/09	138,169	755,642	0	893,811
H629	12079	HYD - SHH - RUF 1&2 Runner Replacement	2011/10	2015/12	451,222	158,663	158,663	768,547
H689	27507	HYD - Sheet Harbour - Ruth Falls Penstock Butterfly Valve Replacements	2013/07	2014/09	565	722,884	0	723,448
H646	42648	HYD - Harmony Fish Ladder	2012/03	2014/12	70,338	466,545	0	536,882
H653	41145	HYD - Mersey - Upper Lake Falls Rip Rap Replacement	2012/05	2014/10	15,238	386,074	0	401,311
H649	41140	HYD - Sissiboo Falls - Tailrace Concrete Refurbishment	2012/04	2014/08	137,891	186,091	0	323,981
	Total Hydro Generation Plant				**$6,222,529**	**$8,346,227**	**$539,014**	**$15,107,770**
Steam Generation Plant								
S661	39029	Port Hawkesbury Biomass Project	2010/11	2014/12	208,373,179	176,333	0	208,549,512
S985	18448	TUC - Cooling Water System Biofouling Control	2012/03	2014/02	1,477,911	2,065,816	0	3,543,727
S901	35083	LIN 2011 Ash Site Sealing and Capping	2011/11	2015/06	277,635	496,427	387,472	1,161,534
S852	41265	TUC - Oil Dock Piling Refurbishment	2011/08	2014/04	1,266,728	279,817	0	1,546,545
SA70	41441	TRE - Siding Replacement	2012/06	2014/12	252,963	287,819	0	540,782
SC15	44372	TRE U&U Bulk Caustic Storage Tank	2013/09	2014/05	0	223,316	0	223,316
SB17	41229	LIN - Cable Spreading Rooms Fire Protection	2013/09	2014/06	64,628	89,429	0	154,057
SA05	41525	TRE5 - 5-1 Pulverizer Refurbishment	2012/03	2014/09	71,104	74,117	0	145,221
SC16	43425	TRE5 HP Dosing Skid	2013/09	2014/03	105,348	17,471	0	122,819
	Total Steam Generation Plant				**$211,889,496**	**$3,710,544**	**$387,472**	**$215,987,513**
Gas Turbine Generation Plant								
G163	43154	CT - Critical Spares for LM6000 Combustion Turbines	2013/06	2014/12	165,000	296,981	0	461,981
	Total Gas Turbine Generation Plant				**$165,000**	**$296,981**	**$0**	**$461,981**

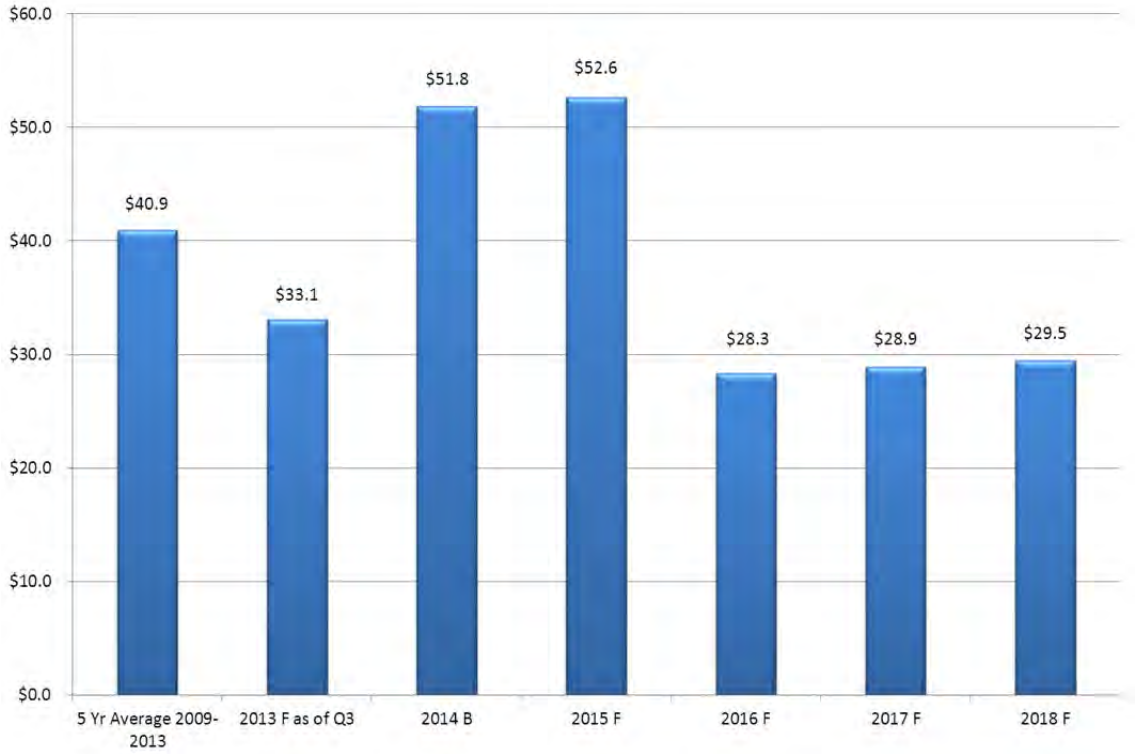
Project Number	CI #	Project Title	Start Date	Final Date	Previous Expenditure ($)	2014 Budget ($)	Subsequent Spending ($)	Total Estimate ($)
Wind Generation Plant								
W117	42127	South Canoe Wind Project	2012/01	2016/06	6,807,296	18,798,767	67,092,339	92,698,401
	Total Gas Turbine Generation Plant				**$6,807,296**	**$18,798,767**	**$67,092,339**	**$92,698,401**
Total Generation Carry Over Spending					**$225,084,321**	**$31,152,518**	**$68,018,825**	**$324,255,664**

5.3 Generation – New 2014 Capital Items for ACE Plan Approval

Tab #	CI #	Project Title	2014 Budget ($)	Project Total ($)
Hydro Generation Plant				
G01	42666	HYD - Tusket #2 Overhaul	373,966	657,684
G02	44968	HYD - Wreck Cove Unit 2 Excitation System	580,329	601,088
G03	44887	HYD - Sissiboo Pipeline Replacement	455,068	475,082
G04	45189	HYD - Upper Lake Falls #2 Overhaul	441,716	441,716
Total Hydro Generation Plant			**$1,851,079**	**$2,175,569**
Steam Generation Plant				
G05	44888	PHB - Boiler Refurbishment 2014	742,129	742,129
G06	44732	TRE5 Boiler Refurbishment	626,649	626,649
G07	44351	LIN Mill Refurbish 2014	536,481	536,481
G08	45126	TRE5 Continuous Emissions Monitor for Mercury Measurement	515,698	515,698
G09	42939	TUC2 - South Circulating Water Pump Refurbishment	431,536	431,536
G10	44717	TUC2 - Condenser Vacuum Pump Replacement	428,783	428,783
G11	43168	LIN CW Pump Refurbish and Upgrade	417,461	417,461
G12	44731	TRE5 Coal System Upgrades	413,416	413,416
G13	43424	TRE5 Analytical Panel	393,825	393,825
G14	44350	LIN4 Boiler Refurbish 2014	382,503	382,503
G15	44590	POT - Water Treatment Plant Siding Replacement	360,523	360,523
G16	37885	POT - Lubrication and Chemical Storage Facility	335,090	343,763
G17	44729	TUC - Station & Unit Transformer Connection Cable Replacement	313,042	313,042
G18	42943	TUC2 - T-G Areas Fire Protection	292,621	292,621
G19	43567	TUC3 - CW travelling screens refurbishment	283,750	283,750
G20	44725	TRE5 Baghouse Filter Replacements	260,875	260,875
G21	44352	LIN CW Screen Refurbish	255,007	255,007
Total Steam Generation Plant			**$6,989,387**	**$6,998,060**
Gas Turbine Generation Plant				
G22	45116	BGT1 GG4C-1D Engine Refurbishment	1,152,807	1,152,807
G23	43153	CT - TUC4 Control Upgrade	535,493	535,493
Total Gas Turbine Generation Plant			**$1,688,300**	**$1,688,300**
Total Generation New Spending			**$10,528,766**	**$10,861,930**

6 Transmission

(Millions of Dollars)



F = Forecast, B=Budget in above figure

6.1 Transmission – Highlights

The focus for Transmission capital investments in 2014 continues to reflect localized customer load growth and system reliability, as well as transmission required to integrate renewable projects (subject to UARB approval of that project). The $51.8 million Transmission capital investment plan for 2014 is comprised of the following:

i	New 2014 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)	$6.5
ii	2013 Capital Items Pending Submission to be filed in or prior to the Q4 2013 capital work order package. (As provided in Section 2.1)	8.0
iii	New 2014 capital spending for projects with total estimated project spend greater than $250,000 for subsequent approval. (As provided in Section 4.3)	21.8
iv	New capital spending for projects with total estimated spend less than $250,000 for which approval is not sought. (As provided in Section 4.4)	0.2
v	Carry-over capital spending. (As provided in Section 6.2)	7.0
vi	Routine capital Spending. (As provided in Section 9.1)	8.3
	Total 2014 Transmission Capital Investment Plan	$51.8M
	Request for ACE Approval (Items i + vi)	$14.8M

6.2 Transmission – Carry-over Capital Spending Summary

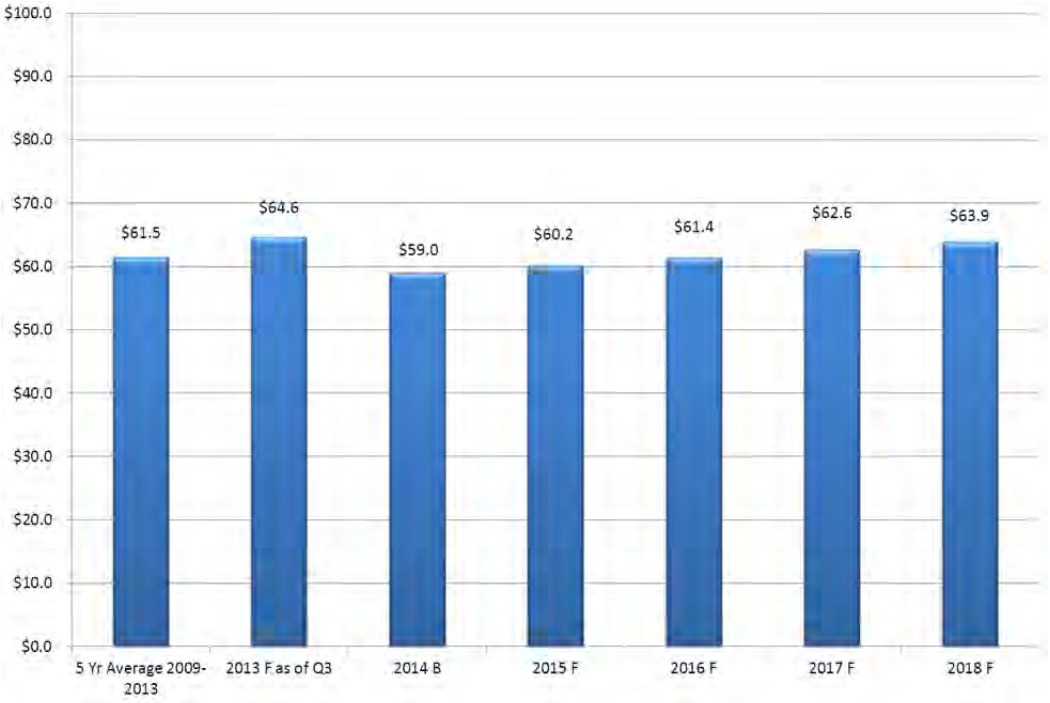
Project Number	CI#	Project Title	Start Date	Final Date	Previous Expenditure ($)	2014 Budget ($)	Subsequent Spending ($)	Total Estimate ($)
Transmission Plant								
T703	40317	Additional Water Street Transformer & Low Side 25 kV Breakers	2011/06	2014/05	3,123,256	608,410	0	3,731,666
T713	41432	L7009 Upgrades & Maintenance	2012/03	2014/04	2,616,335	912,491	0	3,528,825
T755	43293	Protection Upgrade Brushy Hill (138KV)	2012/09	2014/01	2,338,246	8,479	0	2,346,725
T768	43786	2013 L8002 Tower Refurbishment	2013/03	2015/05	1,158,006	505,756	368,302	2,032,064
T783	43369	New Mobile Transformer 15MVA (138-69kV -26,4-13_2kV)	2013/08	2014/09	14,808	1,672,988	0	1,687,796
T754	43292	Protection Risk Reduction 120H-Brushy Hill 230KV	2012/12	2014/07	535,107	1,016,408	0	1,551,514
T745	41535	2012 Steel Tower Painting	2012/05	2014/05	914,723	527,935	0	1,442,658
T778	43726	Replace 3N-T51 Transformer	2012/11	2014/06	200,000	908,026	0	1,108,027
T776	43427	62N-510 Breaker & Control Building Replacements	2013/04	2014/04	49,515	534,898	0	584,413
T699	41536	2012 Reliability Technologies Transmission	2011/08	2014/03	396,718	18,266	0	414,984
T712	41439	Mobile Refurbishments 5P & 6P	2012/02	2014/05	232,491	164,590	0	397,081
T761	43222	2013 Substation Insulator and Cut-Out Replacements	2013/01	2014/12	154,871	157,399	0	312,269
Total Transmission Plant					**$11,734,075**	**$7,035,645**	**$368,302**	**$19,138,021**
Total Transmission Carry Over Spending					**$11,734,075**	**$7,035,645**	**$368,302**	**$19,138,021**

6.3 Transmission – New 2014 Capital items for ACE Plan Approval

Tab #	CI #	Project Title	2014 Budget ($)	Project Total ($)
Transmission Plant				
T01	43205	L5510 Insulator Replacements	734,641	3,191,398
T02	44974	2014 PCB Equipment Removals	1,172,392	1,172,392
T03	44980	2014 Transmission Switch and Breaker Replacements	1,095,553	1,095,553
T04	43672	82V-T1 Transformer Rewind	728,491	936,380
T05	45033	L7001 Replacements	813,226	813,226
T06	44977	3W Breaker, Switch & Cable Replacements	401,463	401,463
T07	44983	Reactor Bank Breaker Replacements	385,032	385,032
T08	44985	Replace 230kV Kearney Disconnect Switch Assemblies	319,246	319,246
T09	44973	2014 Substation Recloser Replacements	307,115	307,115
T10	44982	New Spare Transformer to Replace 20W-T51	291,660	291,660
T11	44975	Sacrificial Anode Installation Program Phase 1	290,047	290,047
Total Transmission Plant			**$6,538,868**	**$9,203,513**
Total Transmission New Spending			**$6,538,868**	**$9,203,513**

7 Distribution

(Millions of Dollars)



F = Forecast, B=Budget in above figure

7.1 Distribution – Highlights

The focus for Distribution capital investments in 2014 continues to reflect localized customer load growth and customer reliability. The $59 million Distribution capital investment plan for 2014 is comprised of the following:

i	New 2014 capital spending for projects with total estimated project spend greater than $250,000 and for which approval is sought. (As provided in Section 7.3)	$3.3
ii	2013 Capital Items Pending Submission to be filed in or prior to the Q4 2013 capital work order package. (As provided in Section 2.1)	8.7
iii	New 2014 capital spending for projects with total estimated project spend greater than $250,000 for subsequent approval. (As provided in Section 4.3)	0.4
iv	New capital spending for projects with total estimated spend less than $250,000 for which approval is not sought. (As provided in Section 4.4)	0.7
v	Carry-over capital spending. (As provided in Section 7.2)	0.7
vi	Routine capital Spending. (As provided in Section 9.1)	45.3
	Total 2014 Distribution Capital Investment Plan	$59.0M
	Request for ACE Approval (Items i + vi)	$48.6M

7.2 Distribution – Carry-over Capital Spending Summary

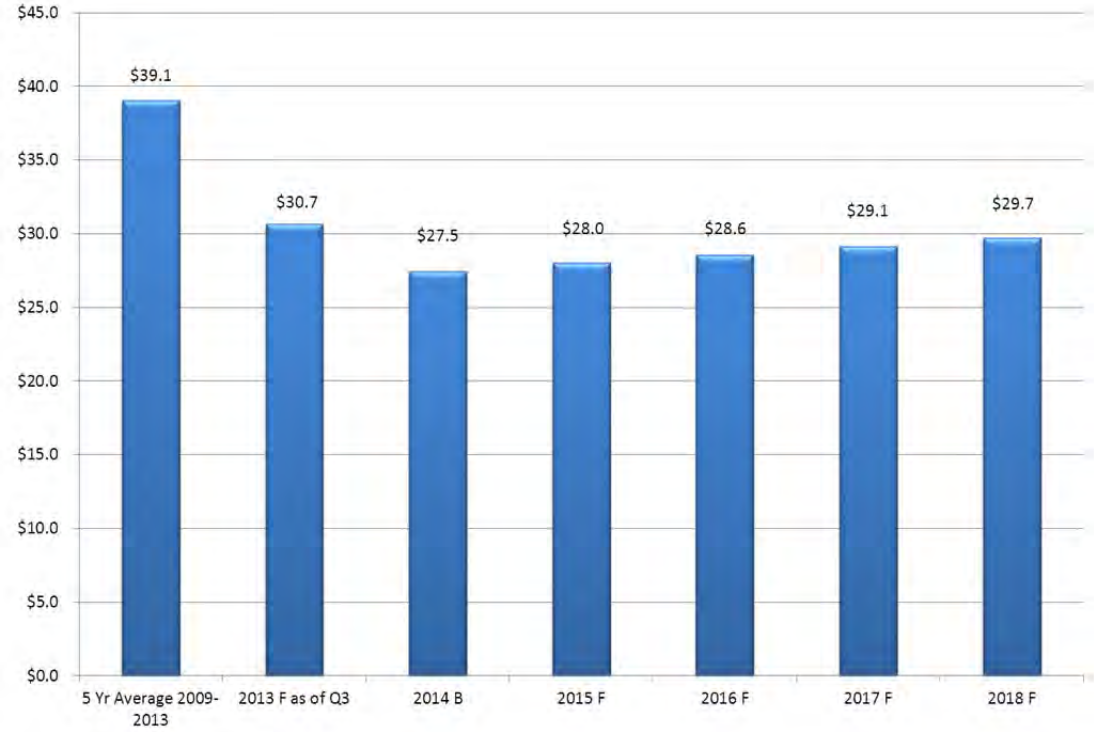
Project Number	CI #	Project Title	Start Date	Final Date	Previous Expenditure ($)	2014 Budget ($)	Subsequent Spending ($)	Total Estimate ($)
Distribution Plant								
D442	41349	2012 Off Road To Roadside	2012/06	2014/03	2,066,596	59,329	0	2,125,925
D389	41534	2012 Reliability Technologies Distribution	2011/09	2014/09	916,463	380,854	0	1,297,317
D440	41339	2012 Distribution Feeder Ties	2012/02	2014/03	566,734	85,404	0	652,139
D418	41383	2012 Halifax Underground Feeder Replacement	2012/03	2014/03	531,341	121,998	0	653,339
D517	43278	Halifax 4kV Conversion Part-1	2013/05	2014/03	173,706	100,172	0	273,878
Total Distribution Plant					**$4,254,840**	**$747,757**	**$0**	**$5,002,597**
Total Distribution Carry Over Spending					**$4,254,840**	**$747,757**	**$0**	**$5,002,597**

7.3 Distribution – New 2014 Capital Items for ACE Plan Approval

Tab #	CI #	Project Title	2014 Budget ($)	Project Total ($)
Distribution Plant				
D01	43217	24C-442G Hwy 16 Rebuild Phase 1	800,769	800,769
D02	44826	2014 Build-to-Roadside	791,268	791,268
D03	45046	2014 PCB Phase-out for Pole Top Transformers	779,620	779,620
D04	43177	103W-311 Gold River Reconductor Phase 3	377,721	377,721
D05	44759	16N-301 - Stewiacke - Load Transfer	258,816	258,816
D06	44833	99V-312 - Highbury New Feeder	256,828	256,828
Total Distribution Plant			**$3,265,021**	**$3,265,021**
Total Distribution New Spending			**$3,265,021**	**$3,265,021**

8 General Plant

(Millions of Dollars)



F = Forecast, B=Budget in above figure

8.1 General Plant – Highlights

General Plant capital investment in 2014 focuses primarily on Information Technology and control system related projects and vehicle purchases. The $27.5 million General Plant capital investment plan for 2014 is comprised of the following:

i	New 2014 capital spending for projects with total estimated project spend greater than $250,000 and for which approval is sought. (As provided in Section 8.3)	$1.5
ii	2013 Capital Items Pending Submission to be filed in or prior to the Q4 2013 capital work order package. (As provided in Section 2.1)	2.4
iii	New 2014 capital spending for projects with total estimated project spend greater than $250,000 for subsequent approval. (As provided in Section 4.3)	2.7
iv	New capital spending for projects with total estimated spend less than $250,000 for which approval is not sought. (As provided in Section 4.4)	0.9
v	Point Aconi Generating Station Capital Spending. (As provided in Section 4.5)	0.1
vi	Carry-over capital spending. (As provided in Section 8.2)	4.8
vii	Routine capital Spending. (As provided in Section 9.1)	15.0
	Total 2014 General Plant Capital Investment Plan	$27.5M
	Request for ACE Approval (Items i + vii)	$16.5 M

8.2 General Plant – Carry-over Capital Spending Summary

Project Number	CI #	Project Title	Start Date	Final Date	Previous Expenditure ($)	2014 Budget ($)	Subsequent Spending ($)	Total Estimate ($)
Telecommunications								
P850	40261	Newtonville SR500 Multipoint Radio System Replacement	2011/02	2014/03	316,546	86,629	0	403,176
P888	41420	Upgrade Multiplexer Network Manager	2012/03	2014/03	223,687	86,000	0	309,687
P915	43174	2013 Telecom Building Replacement Project Horton Lake	2013/05	2014/08	80,270	126,717	0	206,988
P885	41404	Multiplexer Group Replacement	2012/03	2014/03	94,788	59,553	0	154,341
Total Telecommunications					**$715,291**	**$358,900**	**$0**	**$1,074,191**
Computers								
P855	40278	OMS Replacement	2011/04	2014/10	1,604,887	2,506,423	0	4,111,311
P845	40743	IT - NSPI Intranet	2011/03	2014/08	584,911	149,562	0	734,473
P917	43346	TUC-LMs East Gas Compressor Overhaul	2013/06	2014/04	464,175	151,321	0	615,496
P911	43272	SCADA-EMS Hardware Replacement	2013/01	2014/03	356,584	107,295	0	463,879
P899	41403	GIS Enterprise License Agreement	2012/08	2016/12	165,000	92,500	100,000	357,500
Total Computers					**$3,175,558**	**$3,007,101**	**$100,000**	**$6,282,658**
Equipment Replacement								
P897	41433	2012 New RTU Deployment	2012/06	2014/09	620,459	444,220	0	1,064,679
P910	43221	2013 New RTU Deployment	2013/06	2014/06	198,514	533,047	0	731,561
Total Equipment Replacement					**$818,972**	**$977,268**	**$0**	**$1,796,240**
Other General Property								
P834	40103	U&U Load Control Demonstration	2010/10	2014/12	3,803,854	489,938	0	4,293,792
Total Other General Property					**$3,803,854**	**$489,938**	**$0**	**$4,293,792**
Total General Plant Carry Over Spending					**$8,513,675**	**$4,833,206**	**$100,000**	**$13,446,881**

8.3 General Plant – New 2014 Capital Items for ACE Plan Approval

Tab #	CI #	Project Title	2014 Budget ($)	Project Total ($)
Equipment Replacement				
GP01	43227	2014 RTU Replacements	687,839	687,839
Total Equipment Replacement			**$687,839**	**$687,839**
Telecommunications				
GP02	44967	2014 Multiplexer Network Upgrades	435,618	435,618
GP03	44966	2014 Microwave System Capacity Upgrade	397,729	397,729
Total New Telecommunications Spending			**$833,346**	**$833,346**
Total New General Plant Spending			**$1,521,185**	**$1,521,185**

9 Routine Capital Program

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

9.1 Routine Capital Spending by Function Yr/Yr

	2012 Actual ($)	2013 Budget ($)	2013 Forecast ($)	2014 ACE Plan ($)
Generation				
Generation Equipment Replacements	4,657,616	4,554,160	2,980,016	3,097,805
Generation Other Hydro	661,751	701,971	478,792	385,649
Generation Other Thermal	287,054	339,916	149,862	241,346
	5,606,421	5,596,047	3,608,670	3,724,800
Transmission				
Transmission Substation Replacement, Add'ns/Mod'ns	3,248,988	4,028,279	2,815,786	2,864,329
Primary Equipment Spares	202,492	415,000	133,278	215,000
Protection Modification & Replacement	402,047	598,865	398,115	418,163
Transmission Line Replacement, Add'ns/Mod'ns	4,986,146	6,661,556	5,100,429	4,677,539
Transmission Right-of-Way Widening		538,610	133,701	117,230
	8,839,672	12,242,310	8,581,308	8,292,260
Distribution				
Meters	2,164,486	2,578,179	1,898,930	2,476,304
Distribution Upgrades and Replacement	19,371,450	22,082,117	19,163,063	19,858,097
New Customers	24,152,551	24,148,457	20,990,261	21,541,437
Joint Use	1,497,387	880,122	860,920	670,157
Distribution Right-of-Way Widening	974,261	2,539,685	1,944,925	746,227
	48,160,134	52,228,560	44,858,100	45,292,221
General Plant				
Work Vehicles	5,613,901	6,392,626	1,402,585	5,587,552
Tools and Test Equipment	924,847	1,453,886	1,433,092	1,376,639
Telecommunications	884,237	888,448	909,936	933,819
Computing Asset Management	1,051,917	3,448,963	1,769,933	3,282,870
Property Improvements and Furniture	2,367,180	3,855,001	3,855,000	2,280,000
Other	1,496,845	1,713,213	1,214,047	1,505,404
	12,338,928	17,752,137	10,584,592	14,966,284
Total Routine Capital Spending	**$74,945,155**	**$87,819,054**	**$67,632,669**	**$72,275,566**

Note 1: The entire Routine program totals $72.7million including Pt. Aconi routines. The totals presented above and in the following information do not include Point Aconi routines.

9.2 Routine Capital Spending Project Breakdown Yr/Yr

Project #	CI #	Project Title	2012 Actual ($)	2013 Budget($)	2013 Forecast($)	2014 ACE Plan($)
G001	10634	CT - Routine Equipment Replacements	127,808	151,710	204,744	122,945
H001	11622	HYD - Routine Equipment Replacement	739,044	757,372	600,633	509,052
H004	27867	HYD-Roofing Routine	266,610	213,458	99,229	167,948
S001	23428	GS - Routine Capital	104,422	135,000	139,199	135,000
	10645	POT - Routine Equipment Replacement	286,439	276,060	218,772	219,626
	10673	TRE - Routine Equipment Replacement	341,126	353,084	328,628	299,049
	43646	PHB - Routine Equipment Replacement	0	398,265	320,660	357,321
	10621	TUC - Routine Equipment Replacement	568,515	464,964	412,880	337,878
	10626	LIN - Routine Equipment Replacement	576,016	461,196	339,161	375,982
S004	27856	TRE - Roofing Routine	111,728	605,936	188,166	88,862
	27855	POT - Roofing Routine	180,890	319,140	0	197,575
	27854	TUC - Roofing Routine	115,383	175,470	4,893	143,166
	27857	LIN - Roofing Routine	1,110,408	112,760	0	11,070
G008	38899	CTs Tooling Routine	16,590	28,000	28,206	20,000
W001	41830	Wind - Routine Equipment Replacement	112,637	101,745	94,846	112,332
		Generation Equipment Replacements Total	**$4,657,616**	**$4,554,160**	**$2,980,016**	**$3,097,805**
H005	35583	HYD - Oil Release Risk Assessment	262,567	283,580	161,770	207,592
H006	35584	HYD - Gate Refurbishment	399,184	418,391	317,021	178,057
		Generation Hydro Total	**$661,751**	**$701,971**	**$478,792**	**$385,649**
S005	33871	TUC-Heat Rate Routine	66,560	70,574	5,535	48,801
	33867	POT-Heat Rate Routine	83,162	81,027	59,179	47,149
	33869	TRE-Heat Rate Routine	23,432	85,104	10,638	73,397
	33863	LIN-Heat Rate Routine	113,900	103,211	74,511	72,000
		Generation Thermal Total	**$287,054**	**$339,916**	**$149,862**	**$241,346**
T003	23120	Provincial-Trans Substation Primary	1,976,914	2,665,492	2,042,029	2,017,875
T004	23121	Provincial - Substation Additions & Replacements	1,272,074	1,362,787	773,757	846,454
		Transmission Subs Replace, Adds/Mods Total	**$3,248,988**	**$4,028,279**	**$2,815,786**	**$2,864,329**
T018	14973	Primary Equipment Spares	202,492	415,000	133,278	215,000
		Primary Equipment Spares Total	**$202,492**	**$415,000**	**$133,278**	**$215,000**
T016	14841	Protection Modification & Replacement	402,047	598,865	398,115	418,163
		Protection Modification & Replacement Total	**$402,047**	**$598,865**	**$398,115**	**$418,163**

Project #	CI #	Project Title	2012 Actual ($)	2013 Budget($)	2013 Forecast($)	2014 ACE Plan($)
T001	23115	Provincial Transmission Line Replace	829,688	839,657	1,478,345	844,924
T011	23118	Provincial - Planned Trans Line Replacement	4,156,457	5,821,899	3,622,084	3,832,614
		Transmission Line Replacements Total	**$4,986,146**	**$6,661,556**	**$5,100,429**	**$4,677,539**
T010	43827	Transmission Right-of-Way Widening	0	538,610	133,701	117,230
		Transmission Right-of-Way Widening Total	**$0**	**$538,610**	**$133,701**	**$117,230**
D009	26496	Meter Routine	2,164,486	2,578,179	1,898,930	2,476,304
		Meters Total	**$2,164,486**	**$2,578,179**	**$1,898,930**	**$2,476,304**
D005	23158	Unplanned Replace Deteriorated	8,832,904	9,514,851	8,945,172	9,232,511
D006	23135	Regulatory Replacements - Province	1,204,064	1,415,763	1,313,327	951,526
D008	23361	Provincial Storm	993,353	2,504,578	2,004,576	2,482,675
D051	29038	System Performance Improvement Routine	512,065	440,176	209,137	307,387
D055	23137	Planned Replacement Of Distr	7,829,064	8,206,749	6,690,850	6,883,997
		Distribution Upgrades and Replacement Total	**$19,371,450**	**$22,082,117**	**$19,163,063**	**$19,858,097**
D004	26716	New Customer Upgrades	7,712,193	7,187,286	7,279,981	7,385,274
D018	23511	Primary Equipment Spares - Distribution	249	150,000	120,000	150,000
D061	39766	New Customers - Residential	10,067,394	11,005,924	8,367,524	8,442,778
D062	39770	New Customers - Commercial	6,372,715	5,805,247	5,222,757	5,563,386
		New Customers Total	**$24,152,551**	**$24,148,457**	**$20,990,261**	**$21,541,437**
D007	23136	Contractual Replacements (Joint Use)	1,497,387	880,122	860,920	670,157
		Joint Use Total	**$1,497,387**	**$880,122**	**$860,920**	**$670,157**
D010	23127	Provincial Widening	974,261	2,539,685	1,944,925	746,227
		Right of Way Widening Total	**$974,261**	**$2,539,685**	**$1,944,925**	**$746,227**
P006	20945	Replacement and Additional Work Vehicles	140,113	199,485	199,067	192,500
P009	16192	Mobile Transformer & Track Routine	24,681	98,337	68,835	71,052
P063	39304	Class 3 Work Vehicle Replacements	429,920	289,308	-2,495	280,000
P062	39305	Work Vehicle Replacements	3,462,116	4,046,691	653,754	3,334,000
P061	40236	Transportation Vehicle Replacements	1,557,071	1,758,805	483,424	1,710,000
		Work Vehicles Total	**$5,613,901**	**$6,392,626**	**$1,402,585**	**$5,587,552**
P002/P016		Meter Shop - Tools and Equipment	849,630	1,378,886	1,365,528	1,299,639
P015	11611	Hydro Production Tools, Test Equipment	75,216	75,000	67,564	77,000
		Tools and Test Equipment Total	**$924,847**	**$1,453,886**	**$1,433,092**	**$1,376,639**

Project #	CI #	Project Title	2012 Actual ($)	2013 Budget($)	2013 Forecast($)	2014 ACE Plan($)
P025	16365	Mobile Radio Routine	83,966	82,018	94,568	87,362
P027	16551	Telecommunication Radio and Fibre Optics	155,937	159,224	151,819	157,912
P028	16550	Telecommunication Systems Replace & Modifications	460,791	470,506	489,225	508,645
P814	38243	Telecommunications Spares	183,544	176,700	174,324	179,900
		Telecommunications Total	**$884,237**	**$888,448**	**$909,936**	**$933,819**
P010	16073	SCADA Improvements Routine	76,291	151,996	151,972	155,128
P031	29114	NS Power Non-CGI Infrastructure	865,337	3,079,862	1,464,842	2,925,230
P040	28522	CTs DCMS Routine	7,056	18,202	20,102	20,000
	25667	POT - DCMS Equipment Replacement Routine	0	31,000	44,186	32,000
	25626	TRE - DCMS Equipment Replacement Routine	44,924	41,627	5,256	39,513
	25646	TUC - DCMS Equipment Replacement Routine	37,848	76,276	41,429	76,200
	25668	LIN - DCMS Equipment Replacement Routine	20,460	50,000	42,147	34,800
		Computing Asset Management Total	**$1,051,917**	**$3,448,963**	**$1,769,933**	**$3,282,870**
P001/P030		Property Improvement and Furniture	2,367,180	3,855,001	3,855,000	2,280,000
		Property Improvement and Furniture Total	**$2,367,180**	**$3,855,001**	**$3,855,000**	**$2,280,000**
P012/P041		Other (HYD - Security Improvement & FAC - Land Acquisition)	614,736	933,213	701,519	864,655
P816	38897	FAC Enviro Property Remed Routine	298,343	297,000	177,751	208,000
P815	38896	FAC Environment Site Assess Routine	163,036	183,000	124,777	132,749
P032	38848	Purchasing Equip & Warehouse Routine	420,729	300,000	210,000	300,000
		Other Total	**$1,496,845**	**$1,713,213**	**$1,214,047**	**$1,505,404**
Routine Capital Spending			**$74,945,155**	**$87,819,054**	**$67,632,669**	**$72,275,566**

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

*POA amounts related to routines can be found in Section 4.5.

9.3 2014 Routine Capital Spending Project Details

Generation

Project #	CI #	Project Title	ACE 2014 Plan ($)
G001	10634	CTs - Routine Equipment Replacement	122,945
H001	11622	HYD - Routine Equipment Replacement	509,052
H004	27867	HYD - Roofing Routine	167,948
S001	23428	GS - Routine Capital	135,000
	10645	POT - Routine Equipment Replacement	219,626
	10673	TRE - Routine Equipment Replacement	299,049
	10621	TUC - Routine Equipment Replacement	337,878
	43646	PH Biomass- Routine Equipment Replacement	357,321
	10626	LIN - Routine Equipment Replacement	375,982
S004	27856	TRE - Roofing Routine	88,862
	27855	POT - Roofing Routine	197,575
	27854	TUC - Roofing Routine	143,166
	27857	LIN - Roofing Routine	11,070
G008	38899	CTs Tooling Routine	20,000
W001	41830	Wind - Routine Equipment Replacement	112,332
		Generation Equipment Replacements Total	$3,097,805
H005	35583	HYD Oil Release Risk Assessment	207,592
H006	35584	HYD - Gate Refurbishment Routine	178,057
		Generation Hydro Total	$385,649
S005	33871	TUC - Heat Rate Routine	48,801
	33867	POT - Heat Rate Routine	47,149
	33869	TRE - Heat Rate Routine	73,397
	33863	LIN - Heat Rate Routine	72,000
		Generation Thermal Total	$241,346
Generation Total			**$3,724,800**

Transmission

Transmission Substation Replacements, Additions and Modifications

	ACE 2014 Forecast ($)
T003 Provincial: Transmission Substation Primary Equipment	
Unplanned failures	810,000
90H-502 capacitor bank breaker replacement	150,000
91H concrete foundation repairs	125,000
91H-GT1 rads replacement	100,000
37W-T1 rads replacement (Lockeport)	60,000
Gravel for 85S, 50N, 7N, 62N, 67N, 74N, 19C, 24C, 57C	50,000
SF6 bus repairs at 88S Lingan (Phase 2)	30,000
Replace oil containment pits at 17V and 45V	93,000
3 transformer surface refurbishments (103H, 99W, 36V)	96,000
90H & 30N Footing Remediation	175,000
Replace 2S-513A switch	14,500
Replace recloser switches (81S-305A/D, 81S-306A/D, 81S-307A/D, 81S-308A)	65,000
Replace 81S-312 load break switch	9,375
Re-gasket 87W-T62 transformer	25,000
Replace rads on 70W-T51 and 70W-T53	120,000
Replace battery bank at 17V St. Croix	20,000
Replace 3 CT's at 20V Five Points	40,000
Replace Calisto units on 1H-T61 and 1H-T62	35,000
Total T003 Provincial: Transmission Substation Primary Equipment	$2,017,875
T004 Provincial- Substation Additions & Replacements	
Unknown additions	81,471
Trench COTA 138kV bushing replacements	118,893
45V Transformer and Breaker Meter	13,929
3 x Large Voltage Regulators at 20V Five Points	117,861
Air Conditioning Projects	235,721
Install On-line Oil Filtration units	53,573
Install On-line Transformer Monitoring (Pilot Project - Year 2)	214,292
New DC distribution panel at 22W Barrington Passage	10,715
Total T004 Provincial- Substation Additions & Replacements	$846,454
Total Transmission Substation Replacements, Additions and Modifications	$2,864,329

		ACE 2014 Forecast ($)
Primary Equipment Spares		
T018 Primary Equipment Spares		
	Spare 138 kV breaker	136,341
	Spare 69 kV breaker	78,659
Total Primary Equipment Spares		**$215,000**
Protection Modification & Replacement		
T016 Protection Modification & Replacement		
	L-6020 & L-6021 Add Perm & TT	97,053
	43V Replace Protection on L-5017	39,290
	43V Replace Protection on L-5022	28,740
	Replace 230 kV SPS at 67N Onslow	49,017
	Replace 230 kV SPS at 2C Port Hastings	49,017
	Replace MCTI Relays	35,738
	L-6537 Add Fault Location at 5S	14,895
	Replace Sync Check relay at 5S	14,895
	9W Tusket UVLS	14,895
	Unplanned Relay Replacement	74,623
Total Protection Modification & Replacement		**$418,163**
Transmission Line Replacement, Additions / Modifications		
T001 Provincial Transmission Line Replacement (Unplanned)		
The forecast funding for T001 has stayed at the same level as 2013 budget levels.		$844,924
T011 Provincial- Planned Transmission Line Replacement		
LINE #	Description	
5012	Tufts Cove to Imp. Oil	84,331
5011	Farrel St to Imp. Oil	57,153
5058	Springhill to Pugwash	95,361
6515	4c to 2c	112,732
5510	Bridge Ave to Malay Falls	83,325
5559	Whyco to SW Margaree	44,700
Navigation Lighting	Various locations provincially	18,366
6549	Glen Tosh to Wreck Cove	39,156
5028	Onslow to Stewiacke @ Lafarge	162,346
5040	Onslow to Tatamagouche	841,434
5524	4c Lochaber Rd to 57c Salmon River	64,370
6503	Onslow to Trenton	767,684

		ACE 2014 Forecast ($)
6516	Hastings to VJ	535,272
7004	Dalhousie Mountain to Hastings	688,365
Inspection Driven work	1 to 6 month inspections	238,017
T011 Provincial- Planned Transmission Line Replacement		$3,832,614
Transmission Line Replacement Total		**$4,677,539**

Transmission Line Replacement, Additions/Modifications

T010 Provincial Transmission Right of Way Widening

This forecast is developed based on the known level of widening in the current year.

Line	Current Line Height	Dominant Tree Height	Tree Density	Slope	Current Clear Width	Increased Width	Line Security Improvement	Spans	Distribution Substations	Avg Customer Impact	Tree Contact Duration (hrs)	Interruption Frequency	ACHI ($)	2014 ACE Plan ($)
L-5531	7.3	19.8	1567	0	11	5	90	50	77V, 13V	4,152	5.32	0.33	2,980	117,230

Overall $/ACHI	$ 39.34

Transmission Total **$117,230**

Meters

Item #	Prg #	Meter Type	Meter Style	Description	2014 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	230	I-210+c	GE	T/R, 2W, 4Jaw, KW/KVA dmd	140	127.00	17,780.00
1.5 Element, 120-240 volt							
3	N/A	C1S	Centron	240V, 200A, 3W,4 Jaw, 5 dial	16,000	26.50	424,000.00
4	219	SS1S1T	Sentinel	S/C, 3W, 4Jaw, TOU (KWH) c/w L.C. (ETS)	700	155.25	108,675.00
5	231	SS1S2D	Sentinel	S/C, 3W, 4Jaw, KW/KVA dmd	500	143.75	71,875.00
6	236	SS1S1L	Sentinel	S/C, 3W, 4Jaw, (KWH) c/w modem & L.P.	50	373.75	18,687.50
2.0 Element, 120-480 volt							
7	N/A	CN1S	Centron	120V,200A,3W,5Jaw(9o,clock pos:), 5 dial	1100	83.00	91,300.00
8	226	SS2S2D	Sentinel	S/C, 3W, 5Jaw(9 o,clock pos:) KW/KVA dmd,(Mult: 25)	100	143.75	14,375.00
9	233	SS2S1T	Sentinel	S/C, 3W, 5Jaw(9 o,clock pos:)TOU (KWH) c/w L.C.(ETS)	60	155.25	9,315.00
10	235	SS3S3L	Sentinel	T/R, 3W, 8Jaw, KW/KVA dmd, c/w modem, L.P.	20	373.75	7,475.00
11	297	SS3S2D	Sentinel	T/R, 3W, 8Jaw, KW/KVA dmd	50	143.75	7,187.50
2.5 Element, 120-347 volt							
12	228	SS2S2D	Sentinel	T/R, 4W, 13Jaw, KW/KVA dmd	200	121.00	24,200.00
13	234	SS5S3L	Sentinel	T/R,4W, 13Jaw, KW/KVA dmd c/w modem, L.P.	90	373.75	33,637.50
14	273	SS5S3L	Sentinel	T/R, 4W, 13 Jaw, KW/KVA dmd, modem, LP (5 min int)	2	414.00	828.00
3.0 Element, 120-347 volt							
15	247	SS4S0D	Sentinel	S/C, 4 W, 7Jaw, (KWH)	300	121.00	36,300.00
16	218	SS4S3L	Sentinel	T/R, 4W, 13Jaw, KW/KVA dmd, c/w modem, L.P.	45	373.75	16,818.75
17	222	SS4S2D	Sentinel	S/C, 4W, 7Jaw, KW/KVA dmd, (Mult 25)	600	121.00	72,600.00
18	223	SS4S2D	Sentinel	T/R, 4W, 13Jaw, KW/KVA dmd	200	121.00	24,200.00

Item #	Prg #	Meter Type	Meter Style	Description	2014 Forecast	Current Unit Cost ($)	Capital for meters ($)
19	275	SS4S3L	Sentinel	T/R, 4W, 13 Jaw, KW/KVA dmd, modem, LP (5 min int)	2	373.75	747.50
20	243	SS4S3L	Sentinel	T/R, 4W, 13Jaw, KW/KVA, dmd, c/w modem, L.P, KYZ	14	414.00	5,796.00
				Total Meters	20,373		$1,001,934
				Misc Meters "ION"	4	5,000.00	20,000
				CT and PT requirements			150,000
				Wire Adapters and switches			75,000
				Total Materials			1,246,934
				Applied Overhead			713,370
				Labour			516,000
				D009 Meters Total			$2,476,304

		ACE 2014 Forecast
Distribution Upgrades and Replacement		
D005 Unplanned Replacement Deteriorated Equipment		
	The forecast was developed based on an estimated 3,578 person days of work at a unit cost of $2,581/person day. This budget is based on historic levels.	$9,232,511
D006 Regulatory Replacements		
	The forecast is developed based on past experiences or information from various government agencies. This amount may vary based on current year decisions by these agencies.	$951,526
D008 Provincial Storm		
	This forecast is developed based on past experience. There can be significant variation in this amount based on yearly storm activity.	$2,482,675
D051 System Performance Improvement		
	85S - Switch Replacement	18,567
	62N-411/62N-414 Transfer Scheme between Lawrence Blvd. and MacGregor Ave	82,520
	Esksoni & East Bay - Replace Hydraulic Reclosers with Electronic	61,890
	Bear River - 4 kV conversion - Convert 2400 volt stepdown to 7200 volt to remove the 4kV spur in the town of Bear River.	144,410
Total D051 System Performance Improvement		$307,387
D055 Planned Replacement of Distribution Equipment		
	Bin Work (Work resulting from NS Power's distribution line inspection program that has been identified as requiring follow up within one year.)	1,842,426
	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	100,000
	4kV Vault Replacement	120,000
	MicMacMall Vault Upgrades	60,000
	126H Porters Lake Sub - Deteriorated Poles	9,489
	Hart Lake - Repole	309,794
	West Linden Road - Reconductor	35,851
	Mill Lake Road - Deteriorated Poles	37,459
	Boutlier's Cove Road - Reconductor	34,555
	Borgels Point: Deteriorated Poles	34,440

		ACE 2014 Forecast
	Windsor Deteriorated Poles	125,000
	Harrison Settlement - Rebuild	90,000
	3S-403 - Reinsulate and/or relocate to roadside	195,000
	Caribou Island	370,000
	Antigonish Town Loop Re-Insulate	180,000
	Livingston Cove Rebuild	85,000
	Aylesford Reliability - Ph2 Kingston	289,554
	Albany New - Rebuild	344,864
	93V-312 - Little Brook - Reconductor	187,208
	Gates Mountain Road	72,111
	519W - Molega Lake - Deteriorated Stepdown	78,276
	Chemin de Lest Reconductor	143,640
	16W-301 - Rebuild Ross Durkee Rd	189,331
Total D055 Planned Replacement of Distribution Equipment		$6,883,997
Distribution Upgrades and Replacement Total		**$19,858,096**
New Customers		
D004 New Customer Upgrades		
	This forecast is for the upgrading and replacement work required due to new load on the system. Costs are forecasted based on historical spend.	$7,385,274
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.	$8,442,778
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.	$5,563,386
Total New Customers		**$21,541,438**

		ACE 2014 Forecast
Joint Use Total		
	This forecast is developed based on prior spending levels and any known project activity for both Joint Use requests from Nova Scotia Power's Joint Use Partner, Bell Aliant and from other communication utility requests.	$670,157
Right of Way Widening Total		
	This forecast is developed based on the known level of widening in the current year.	$746,227
Distribution Total		**$45,292,221**

Right-of-Way Widening Total

This forecast is developed based on an identified level of widening in the current year. The spend in this Routine reflects the work that will be required to widen the following rights-of-way to standard.

Line	General Location	Region	Line Height	Dominant Tree Height	Density	Slope	Clear Width	Increased Width	Line Security	Average Storm Tree Contacts CHI	ACHI	Spans	Cost/Span ($)	Costs ($)	$/ACHI
13V-303	*North Range Cross Road area*	*West*	12.5	17	1050	1.5	3	3.09	52	4,394	2,285	55	1,000	70,351	30.8
13V-303	*Purdy Road area, Digby*	*West*	12.25	185	775	0	3	3.09	45	4,394	1,977	100	800	102,328	51.8
13V-303	*Sissiboo Rd area, Digby*	*West*	11	15.3	1000	0	0.16	5.93	80	4,394	3,515	115	1,000	147,097	41.8
1V-443	*Vaughn to New Ross*	*West*	11	18	889	3	3	3	47	14,384	6,760	155	800	158,608	23.5
1N-405	*Nuttby Mtn., Truro*	*Central*	11	12	975	0	3	3	100	4,938	4,938	66	900	75,979	15.4
36V-302	*Gospel Road, Port Williams*	*West*	10	17.25	825	0	1.5	4.59	61	9,161	5,588	50	800	51,164	9.2
30N-411	*Lower Maccan Rd, Amherst*	*Central*	10	17.3	1600	8.3	0	6.09	73	5,980	4,365	60	1,000	76,746	17.6
22V-323G	*North River Road, Alton*	*West*	11	17	1225	0	1	5	66	8,898	5,873	50	1,000	63,955	10.9
									Totals	**56,541**	**35,301**	**651**		**$746,227**	**$21.1**

Work Vehicles	Quantity	Unit Price ($)	ACE 2014 Forecast ($)
P006 Replacement and Additional Work Vehicles			
Reel and Pole Trailers	7	27,500	192,500
Total P006 Replacement and Additional Work Vehicles			$192,500
P009 Mobile Transformer & Track			
This forecast is developed based on estimated repairs or modifications to off-road track machines or the mobile transformers.			$71,052
P061 Transportation Vehicle Replacements	60	29,750	1,785,000
		Salvage	(75,000)
			$1,710,000
P062 Work Vehicle Replacements	5	255,000	1,275,000
	2	232,000	464,000
	4	235,000	940,000
	3	260,000	780,000
		Salvage	(125,000)
			$3,334,000
P063 Class 3 Work Vehicle Replacements	2	100,000	200,000
	1	80,000	80,000
			$280,000
Total Work Vehicles			**$5,587,552**

Tools and Equipment

Description	Quantity	Estimated Unit Cost ($)	Estimated Total ($)
Meter Shop Tools and Equipment			$50,000
Provincial Line Tools & Equipment			
Western Territory			
6 ton presses	6	1,600	9,600
Gator Tail rope and reel	4	3,900	15,600
Hydraulic saws	4	1,900	7,600
Y45 Press	1	4,000	4,000
Phasing Sticks	2	2,600	5,200

Tools and Equipment

Description	Quantity	Estimated Unit Cost ($)	Estimated Total ($)
Fiberglass Step	2	1,700	3,400
Hydraulic cutters	4	3,000	12,000
Radio Interference Equipment	1	10,000	10,000
Cable locators	2	5,500	11,000
10 kV Megger	1	3,500	3,500
Western Territory Total			$81,900
Eastern Territory			
Hydraulic Stick Saws	10	1,900	19,000
Gator Tail rope and reel	4	3,900	15,600
Patten Jumps , long 20-30ft, duckbill ends	12	2,000	24,000
Live Line Conductor Pulling Equipment Set	1	29,379	29,379
Eastern Territory Total			$87,979
Central Territory			
sets of dies for y-35 press for new sleeves	8	1,500	12,000
3 phase patten jumper sets - 15' - 2/0	6	2,200	13,200
Hydraulic Chain saw	3	2,200	6,600
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	4	1,800	7,200
Cable locating sonde fish tape	1	2,500	2,500
Box locator	2	2,000	4,000
Husky Robo Cutter (REC-Y33)	4	2,800	11,200
Battery powered cable cutters	1	2,600	2,600
TTR - Transformer Tested 3/0	1	2,500	2,500
Tension stringing kit	1	30,000	30,000
Man hole Retractor	1	3,000	3,000
Inverter	2	1,000	2,000
AMP Probe with universal attachment	2	1,500	3,000
Set of 3 DRAs for engineering	2	4,000	8,000
Flex CTs (set)	1	1,400	1,400
Power CTs (set)	1	1,400	1,400
Air Monitors	2	2,000	4,000
Tri-pod for man hole	1	5,000	5,000
Extenda Chain Saw	3	1,000	3,000
SP-100 Cutting Head	1	1,600	1,600

Tools and Equipment

Description	Quantity	Estimated Unit Cost ($)	Estimated Total ($)
Underground DRAs	1	7,500	7,500
Fault Detection and Load Monitoring Tool	1	7,500	7,500
Radio Ranger (for underground Fault location)	2	3,500	7,000
Meter Base Power Monitoring Device	1	3,000	3,000
Central Territory Total			$163,100
T&D Asset			
Breakdown Allowance	1	72,968	72,968
Portable Ground Sets	100	1,300	130,000
Rope Tester	4	2,918	11,672
Dielectric Rope	4	2,200	8,800
6 ton Presses for Rotational Spares	18	2,189	39,402
12 ton Presses for Rotational Spares	12	4,189	50,268
Hydraulic Drills for Rotational Spares	10	1,585	15,850
Stick Cleaner for PETC	1	15,000	15,000
Handheld Data Collection Units – PETC	2	2,500	5,000
T&D Asset Total			$348,960
Fleet			
Pressure Washer	1	2,500	2,500
Total Fleet			$2,500
Telecom			
T1 Test Set	2	10,000	20,000
7 GHz Test Set	1	35,000	35,000
Telecom Total			$55,000
System Maintenance			
Superules	4	1,200	4,800
High Powered Stabilized Binoculars	2	1,300	2,600
ATV Ramps	5	1,500	7,500
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
Breaker Analizer (PHA)	1	2,000	2,000

Tools and Equipment

Description	Quantity	Estimated Unit Cost ($)	Estimated Total ($)
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			$237,200
P002 Tools and Equipment Total			$976,639
P015 Hydro Production Tools & Test Equipment			$77,000
P016 Thermal Production Tools & Test Equipment			
POT Tools & Equipment			65,000
TUC Tools & Equipment			58,000
TRE Tools & Equipment			75,000
LIN Tools & Equipment			75,000
P016 Thermal Production Tools & Test Equipment Total			$273,000
Tools and Test Equipment Total			**$1,376,639**

Telecommunications

	ACE 2014 Forecast ($)
P025 Mobile Radio	
Repairs -Antennas, cables, etc. for Mobiles	39,242
Repairs - for Repeaters (MTR2000)	22,067
Replacement Radio Equipment Hardware and Upgrades	5,000
Test MTR2000 repeater spares & allocate	8,266
Equipment repairs – Nova	12,787
P025 Mobile Radio Total	$87,362
P027 Telecommunication Radio & Fibre Ops	
HVAC Replacement - 2 sites	110,306
Radio Site repairs	13,509
Generator Upgrades	13,661
Engineering for As Built Drawings	0
Reconfigure Generator Alarms at Sites	5,393
Misc. repairs	15,043
P027 Telecommunication Radio & Fibre Ops Total	$157,912
P028 Telecommunication Systems Replace & Modifications	
Replace Bayly & Marconi Multiplex Equipment	70,368
Upgrade site access (7705) equipment	66,969
Install Newbridge Shelves @ RAL and Move Circuits	40,453
Remove Bayly Mux Equipment	4,133
12 Volt Deep Cycle Batteries	15,870
Misc. Power Supplies	5,000
UPS Repairs/Replacements	5,000
Replace Ethernet Spread Spectrum Radios	22,006
Newbridge CPSS Audit Work	3,393
Upgrade Network Access to Sites	15,982
Misc. Alcatel equipment	16,000
Misc. Telecom eqpt.	12,500
Cable & Entrance Protection	15,000
Switched Communications (SOPS, etc.)	5,000
Misc. Fibre Optics (Replace NEC/ADC eqpt.)	40,368
Fibre Link (Substation to Radio Site)	21,576
Network Monitoring - replace net dogs	43,229
TMON Installation and Alarm Commissioning	16,533
Review and Update System Drawings	38,373
Replace Mobile Radio Database	26,476

Telecommunications

	ACE 2014 Forecast ($)
Replace Cable List Program	24,416
P028 Telecommunication Systems Replace & Modifications Total	$508,645
P814 Telecommunications Spares	
Alcatel-Lucent MDR8000 Microwave Radio	10,000
Multiplex equipment spares	50,000
Net Guardian Alarm Monitoring Equipment	24,000
MDS LEDR radio spares	43,200
MDS SD9, Transnet, INet	7,200
SEL 2505, 2506 Spares	8,000
Battery Charger Spare	10,000
Fibre Optics Equipment	20,000
Misc. spares	7,500
P814 Telecommunications Spares Total	179,900
Telecommunications Total	**$933,819**

Computing and Asset Management

Infrastructure Component	Asset Management Plan	Volume to be Refreshed	ACE 2014 Forecast ($)
P010 SCADA Improvements			
	This forecast is developed based on SCADA equipment/operator interfaces failures or modifications.		
P010 SCADA Improvements Total			$155,128
P031 NSPI IT Infrastructure			
Voice and Data Network	Network equipment that has or will reach seven (7) years old. (Measured in number of network ports.)		750,000
Servers	Servers that have or will reach six (6) years old.	10	426,500
Laptop and Desktop Computers	Computers that have or will reach four (4) years old.	800	1,395,780
	New laptop or desktop computers.	25	63,550
	New software licenses.		224,400
Power Supplies	Replaced after 10 years.	2	40,000
Accessories			25,000
P031 NSPI IT Infrastructure Total			$2,925,230

Computing and Asset Management

Infrastructure Component	Asset Management Plan	Volume to be Refreshed	ACE 2014 Forecast ($)
P040 DCMS Equipment Replacement			
	CTs DCMS Equipment Replacement		20,000
	LIN DCMS Equipment Replacement		34,800
	POT DCMS Equipment Replacement		32,000
	TRE DCMS Equipment Replacement		39,513
	TUC DCMS Equipment Replacement		76,200
			$202,513
Computing and Asset Management Total			**$3,282,871**
Property Improvement and Furniture			
P001	FAC - Property Improvements		2,105,000
P030	FAC - Lower Water Street		175,000
Property Improvement and Furniture Total			**$2,280,000**
Other			
P012	HYD - Security Improvement		764,655
P041	FAC - Land Acquisition Routine		100,000
P816	FAC - Environment Property Remediation		208,000
P815	FAC - Environment Site Assessment		132,749
P032	FAC - Equipment & Warehouse		300,000
Other Total			**$1,505,404**
General Plant Total			**$14,966,285**

10 Appendix

10.1 UARB ACE Plan Directives

NS Power received a number of Directives from prior ACE Plan Decisions. Responses to the Board's Directives are provided below.

10.1.1 2011 ACE Plan Directive 7 – Approximate Impact of 2014 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 improved the clarity of its estimate of the effect that the 2014 ACE Plan would have on revenue requirement over the five year timeframe 2014 - 2018.

The revenue requirement calculation below shows the effect on rate base and the underlying effect on revenue requirement. To the extent capital expenditures equal depreciation expense in a given year, there is no incremental effect on rate base or associated revenue requirement and therefore it is not included in the calculation.

The revenue requirement assessment factors in the following inputs:

- Incremental capital expenditures compared to forecast depreciation expense.
- Administrative overhead credit based on the prorated incremental capital to total capital expenditures.
- Depreciation expense based on 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 proration of incremental capital to total capital expenditures.
- 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.

This method does not address the revenue requirement effect should the capital projects not be completed or not completed on time. Examples are associated costs from such items 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 avoided cost benefits are not included in this revenue requirement calculation. Similarly, any resulting operating savings associated with a capital project are not incorporated. The revenue requirement calculation examines solely the incremental effects with rate base.

LONG-TERM CAPITAL PLANNING & REVENUE REQUIREMENT

NOVA SCOTIA POWER ($MM)	2014 ACE	2015	2016	2017	2018
Capital Expenditures (Spend)	$228.0	$299.2	$220.3	$261.1	$286.8
Less: Depreciation of all assets	171.9	177.7	186.0	191.4	197.5
Incremental Spend over Depreciation (Growth)	56.1	121.4	34.3	69.8	89.2
Incremental Spend as a portion of Total Spend	24.6%	40.6%	15.6%	26.7%	31.1%
Annual incremental revenue requirement	($3.5)	$3.2	$15.8	$3.0	$6.1
Cumulative incremental revenue requirement	($3.5)	($0.3)	$15.4	$18.4	$24.6
Expenses					
Fuel	-	-	-	-	-
OM&G	-	-	-	-	-
Administrative Overhead	(7.2)	(11.0)	(3.5)	(6.4)	(7.8)
Depreciation	0.6	3.3	2.5	5.8	8.7
Interest	1.2	5.0	8.3	10.4	13.6
AFUDC	(0.8)	(2.5)	(0.4)	(0.7)	(1.0)
Earnings before tax	2.7	4.8	8.4	9.3	11.1
Income Tax	1.8	0.9	2.0	1.3	0.7
Net Earnings	$0.9	$3.9	$6.4	$8.0	$10.5
Average incremental Net Book Value of projects in 5-year plan	27.8	114.6	189.6	237.5	309.7

Pursuant to Directive 13 of the Board's 2013 ACE Plan Decision, NS Power has broken out the revenue requirement effect of Work Support Facility projects. As NS Power has not determined the future planned investments in Work Support Facilities beyond 2014, the analysis assumes that the level of investment would increase by an inflation rate of 2 percent annually. The revenue requirement effect shown below includes the same factors as those used in the Long-Term Capital Planning & Revenue Requirement table.

LONG-TERM CAPITAL PLANNING & REVENUE REQUIREMENT OF WORK SUPPORT FACILITIES

NOVA SCOTIA POWER ($MM)	2014 ACE	2015	2016	2017	2018
Capital Expenditures (Spend)	$25.6	$26.1	$26.6	$27.1	$27.7
Less: Depreciation of all assets	19.3	15.5	22.4	19.9	19.1
Incremental Spend over Depreciation (Growth)	6.3	10.6	4.1	7.2	8.6
Incremental Spend as a portion of Total Spend	24.6%	40.6%	15.6%	26.7%	31.1%
Annual incremental revenue requirement	($0.1)	$0.7	$1.1	$0.6	$0.9
Cumulative incremental revenue requirement	($0.1)	$0.5	$1.6	$2.1	$3.0
Expenses					
Fuel	-	-	-	-	-
OM&G	-	-	-	-	-
Administrative Overhead	(0.5)	(0.8)	(0.3)	(0.5)	(0.6)
Depreciation	0.1	0.5	0.3	0.8	1.2
Interest	0.1	0.5	0.8	1.0	1.3
AFUDC	(0.1)	(0.2)	(0.1)	(0.1)	(0.1)
Earnings before tax	0.2	0.5	0.8	1.0	1.2
Income Tax	0.1	0.1	0.2	0.2	0.2
Net Earnings	$0.1	$0.4	$0.6	$0.8	$1.0
Average incremental Net Book Value of projects in 5-year plan	3.1	11.3	18.2	23.3	30.2

Lastly, in accordance with the 2013 Capital Expenditure Justification Criteria, the revenue requirement effect of all new economically justified projects included in the 2014 ACE Plan is shown below. The table below is a compilation of the revenue requirement calculations in the Economic Analysis Models of each economically justified capital item in the 2014 ACE Plan. Avoided expenses have been determined in the EAMs and included in the calculation below.

REVENUE REQUIREMENT OF ECONOMICALLY JUSTIFIED PROJECTS

NOVA SCOTIA POWER ($MM)	2014	2015	2016	2017	2018
Electric Revenue	($2.5)	($3.2)	($3.9)	($4.9)	($5.8)
Operating Expense	(0.4)	0.0	0.0	0.0	0.0
Avoided Expenses	(2.0)	(3.8)	(4.5)	(5.6)	(6.5)
Depreciation Expense	0.1	0.2	0.2	0.2	0.2
Interest	0.2	0.3	0.3	0.3	0.3
AFUDC	(0.1)	0.0	0.0	0.0	0.0
Earnings before taxes	(0.1)	0.1	0.2	0.2	0.2
Income taxes	(0.3)	(0.1)	(0.0)	(0.0)	0.0
Net Earnings	$0.1	$0.2	$0.2	$0.2	$0.2
Capital Expenditures (Spend)	6.5	0.0	0.0	0.0	0.0

10.1.2 2011 ACE Plan Directive 9 – Summary of 2014 ACE Plan Capital Items Related to NERC and/or NPCC Standards

CI #	Project Title	2014 ACE Plan ($)	Total Estimate ($)	2014 ACE Category
43291	Protection Risk Reduction 67N-Onslow 230KV	2,486,992	2,486,992	Subsequent Approval
43292	Protection Risk Reduction 120H-Brushy Hill 230KV	1,016,408	1,551,514	Carryover
NERC and/or NPCC Compliance Total		**$3,503,400**	**$4,038,506**	

** The primary justification for the projects listed is compliance with NERC Standards and/or NPCC Criteria. Other capital projects (e.g. generation projects that preserve reserve margins or maintain Black-Start Capability) provide important compliance benefits but these are secondary to the project primary justification.*

10.1.3 Directive 11 – Annual Ranking/ Prioritization of Capital Projects

Per 2011 ACE Plan directive 11 and 2013 ACE Plan directive 7, below is NS Power's capital project ranking criteria.

NS Power Capital Projects are 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 address customer reliability are evaluated based on factors related to performance targets (System Average Interruption Duration Index (SAIDI), System Average Interruption Frequency Index (SAIFI), Customer Average Interruption Duration Index (CAIDI), etc.). Business sustainability initiatives are evaluated based on their economic ranking.

The tables below identify the projects included in the 2014 ACE Plan, their ranking category and ranking value where applicable.

Generation

The Power Production Capital Project Ranking Matrix is used to determine the ranking for Generation projects. The projects are categorized according to the primary driver for the project: Safety, Environment, Business Sustainability or Productivity/Efficiency. Each of these categories is represented in the matrix, and populated with multiple criteria. The resultant ranking is dependent on which of the category-specific criteria the project meets, and has a maximum value of 9.0. 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.

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. All projects are reviewed by a review team to ensure the projects are justified and appropriate for inclusion in the ACE Plan.

Hydro – 2014 ACE Plan Capital Item Rankings

CI	Project Title	2014 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
44248	HYD - MacMillan Dam D-7 Refurbishment	4,795,607	New	Safety	9.00
43067	HYD - Cheticamp Dam D-1 Refurbishment	694,750	New	Safety	9.00
41142	HYD - St. Margaret's Fish Passage	296,958	New	Environment	7.50
44669	HYD - Wreck Cove Fire Suppression Upgrades	333,589	New	Safety	9.00
44978	HYD - Wreck Cove Automation	381,782	New	Business Sustainability	7.50
42666	HYD - Tusket #2 Overhaul	373,966	New	Business Sustainability	7.25
44968	HYD - Wreck Cove Unit 2 Excitation System	580,329	New	Business Sustainability	8.00
44887	HYD - Sissiboo Pipeline Replacement	455,068	New	Business Sustainability	8.00
45189	HYD - Upper Lake Falls #2 Overhaul	441,716	New	Business Sustainability	8.00
45330	HYD - WRC C3 Culvert Replacement	116,396	New	Business Sustainability	7.75
16379	HYD - Mink Lake Dam Replacement	75,555	New	Business Sustainability	7.50
35584	HYD - Gate Refurbishment Routine	178,057	New	Routine	9.00
27867	HYD - Roofing Routine	167,948	New	Routine	9.00
11622	HYD - Routine Equipment Replacements	509,052	New	Routine	9.00
35583	HYD - Oil Release Risk Assessment Remediation Routine	207,592	New	Routine	9.00

Steam – 2014 ACE Plan Capital Item Rankings

CI	Project Title	2014 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
30162	POT - Bunker C tank refurbishment	2,125,931	New	Environment	9.00
42982	TUC6 - Gland Steam Supply	909,671	New	Business Sustainability	8.00
44888	PHB - Boiler Refurbishment 2014	742,129	New	Business Sustainability	8.00
44730	TRE5 - Turbine Main and Control Valves Refurbishments	306,807	New	Business Sustainability	7.00
44732	TRE5 - Boiler Refurbishment	626,649	New	Business Sustainability	8.00
44351	LIN - Mill Refurbish 2014	536,481	New	Business Sustainability	8.00
45126	TRE5 - Continuous Emissions Monitor for Mercury Measurement	515,698	New	Environment	9.00
42939	TUC2 - South Circulating Water Pump Refurbishment	431,536	New	Business Sustainability	7.25
44717	TUC2 - Condenser Vacuum Pump Replacement	428,783	New	Business Sustainability	7.75
43168	LIN - CW Pump Refurbish and Upgrade	417,461	New	Business Sustainability	7.25
44731	TRE5 - Coal System Upgrades	413,416	New	Safety	7.50
43424	TRE5 - Analytical Panel	393,825	New	Business Sustainability	8.00
44350	LIN4 - Boiler Refurbish 2014	382,503	New	Business Sustainability	8.00
44590	POT - Water Treatment Plant Siding Replacement	360,523	New	Safety	7.50
37885	POT - Lubrication and Chemical Storage Facility	335,090	New	Safety	8.00
42728	Unit Lay-up Program	79,893	New	Business Sustainability	8.00
44729	TUC - Station & Unit Transformer Connection Cable Replacement	313,042	New	Business Sustainability	8.25
45180	ICP - Rail Line Bridge Work	308,108	New	Business Sustainability	7.00
42943	TUC2 - T-G Areas Fire Protection	292,621	New	Safety	9.00
45392	TRE - Bunker C System Refurbishments	288,886	New	Business Sustainability	8.00
43567	TUC3 - CW travelling screens refurbishment	283,750	New	Business Sustainability	7.00
45178	ICP - Rail Centre Shop Roof	265,725	New	Business Sustainability	7.00
45326	LIN1 - PAC System Improvements	227,641	New	Environment	9.00
45327	LIN2 - PAC System Improvements	227,641	New	Environment	9.00
45328	LIN3 - PAC System Improvements	227,641	New	Environment	9.00
45329	LIN4 - PAC System Improvements	227,641	New	Environment	9.00
44725	TRE5 - Baghouse Filter Replacements	260,875	New	Environment	7.50
44352	LIN - CW Screen Refurbish	255,007	New	Business Sustainability	8.00
43027	POT - Refurbish Dust Collection Area Explosion System	240,050	New	Safety	9.00
43407	TRE5 - Cable Rooms Fire Protection	233,634	New	Safety	8.00
41664	TRE5 - Precip Refurbishment	231,670	New	Environment	9.00
41226	LIN - Boiler Feed Pump Proportional Valve Replacements - Unit #1	231,420	New	Business Sustainability	7.50
42973	TUC - #1, 2 and 4 WTP DCS upgrade	227,093	New	Business Sustainability	7.00
43164	LIN1 - Boiler Refurbishment	224,975	New	Business Sustainability	8.00
43162	LIN2 - Boiler Refurbish	200,309	New	Business Sustainability	8.00
44722	TRE5 - Low Load Valve Replacement	200,103	New	Business Sustainability	8.50
44626	TUC - Asbestos Abatement Program 2014	194,686	New	Safety	9.00

CI	Project Title	2014 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
44727	TUC3 - DCS Upgrade Phase 3	190,866	New	Business Sustainability	7.00
44716	TUC2 - North Boiler Feed Pump Refurbishment	190,110	New	Business Sustainability	7.00
44627	TUC - No. 3 Elevator Control System Replacement	180,292	New	Business Sustainability	9.00
43429	TRE5 - Lube Oil Cooler Retube	178,095	New	Environment	7.25
45044	LIN - Fire Protection Improvements	171,594	New	Safety	7.50
44733	TRE6 - Coal System Upgrades	165,857	New	Safety	7.50
41159	LIN - Reclaim Feeders Replacement	165,315	New	Business Sustainability	7.50
44586	POT - Asbestos 2014	146,024	New	Safety	9.00
45058	LIN4 - Turbine Valves Refurbishment	157,152	New	Business Sustainability	8.00
42937	TUC - LMs East Gas Compressor Overhaul	154,583	New	Business Sustainability	8.00
44721	TRE - Ash Site Covering (2014)	150,814	New	Environment	7.50
43627	LIN - Hydrazine Replacement	150,234	New	Environment	9.00
45110	PHB - Ash Handling Improvements (Phase 1)	150,104	New	Business Sustainability	7.25
44738	TUC3 -Battery bank inverter & charger replacement	148,104	New	Business Sustainability	8.50
44737	TUC2 - Battery bank inverter & charger replacement	148,076	New	Business Sustainability	8.50
45266	TRE6 - 6A Screens Refurbishment	147,725	New	Business Sustainability	7.00
44739	TUC2 - Replace precip & rapper control	147,562	New	Environment	9.00
44766	TRE5 - 5-3 Pulverizer Refurbishment	146,040	New	Business Sustainability	7.00
44720	TRE - Asbestos Abatement 2014	145,008	New	Safety	7.50
45108	LIN34 - Inclined Bottom Ash Conveyor Upgrade	144,600	New	Business Sustainability	7.00
44740	TUC3 - Precip field power supply	143,371	New	Environment	9.00
44723	TRE6 - Bottom Ash Chain Replacement	143,250	New	Business Sustainability	8.00
44587	POT - Selective ash site capping 2014	142,076	New	Environment	9.00
44734	TRE6 - High Energy Piping Snubbers	138,332	New	Business Sustainability	8.00
45494	TUC3 - Replace Hydrazine with DEHA	135,764	New	Environment	9.00
43666	TUC1 - Replace Hydrazine with DEHA	134,648	New	Environment	9.00
43050	POT - Replace drum dose skids	133,369	New	Business Sustainability	7.50
43350	LIN - Replace D Coal Belts	130,823	New	Business Sustainability	8.00
22426	TRE 5-1 Air Heater Outlet Expansion Joint Replacement	129,569	New	Business Sustainability	7.25
44361	LIN4 - Replace Boiler Fronts	117,924	New	Business Sustainability	7.50
45493	TUC2 - Replace Hydrazine with DEHA	116,313	New	Environment	9.00
45181	ICP - Rail Line Road Crossing Upgrades	116,267	New	Business Sustainability	7.00
43038	POT - FeS04 dosing control system	109,749	New	Business Sustainability	9.00
44589	POT - Replace overhead door at A-mill	108,401	New	Safety	7.50
45114	PHB - Analytical Panel	105,045	New	Business Sustainability	8.00
45246	LIN - CW MCC Refurbishment	101,682	New	Safety	7.50
44358	LIN4 - Replace Low Load Lines and Valve	100,402	New	Business Sustainability	8.50
44719	TUC - 4KV Breaker Replacement	97,011	New	Business Sustainability	7.00
44588	POT - Transitional Metals Ion Chromatograph	96,147	New	Business Sustainability	7.50

CI	Project Title	2014 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
37544	TRE5 - Coal MCC Transformer Replacement	90,927	New	Environment	7.50
44355	LIN - Crusher Dumper Fire Protection Replacement	85,131	New	Safety	7.50
44362	LIN 3 4 Feedwater Valves	78,492	New	Business Sustainability	7.50
45185	TRE - PAC System Improvements	78,285	New	Environment	9.00
44726	TUC - 600V Breaker Replacement	74,535	New	Business Sustainability	7.00
44768	TRE - 4kV Breakers 2014	73,493	New	Business Sustainability	7.50
44728	TUC - 4KV/600V Motor Refurbishment 2014	73,324	New	Business Sustainability	7.00
45045	PHB - Evacuation alarm	72,280	New	Safety	9.00
45184	POT - PAC system improvements	70,556	New	Environment	9.00
42971	TUC2 - DCS Upgrade	56,631	New	Business Sustainability	7.00
43410	TRE - Forklift Replacement	55,713	New	Business Sustainability	7.50
45032	TRE - Turbine Supervisory System	50,856	New	Business Sustainability	7.50
45059	LIN - Membrane Replacements RO	50,475	New	Business Sustainability	7.50
44353	LIN - 4160 and 600V Breaker Refurb	50,200	New	Business Sustainability	7.00
44736	TUC2 - DC Battery Bank Replacement	49,870	New	Business Sustainability	8.50
43416	TRE5 - Resin Replacement	45,199	New	Business Sustainability	7.50
45174	PHB - Fire System Upgrades	26,820	New	Safety	7.50
45172	PHB - Dust Mitigation in Electrical Rooms	26,626	New	Environment	7.50
10626	LIN - Routine Equipment Replacements	375,982	New	Routine	9.00
10621	TUC - Routine Equipment Replacements	337,878	New	Routine	9.00
10645	POT - Routine Equipment Replacements	219,626	New	Routine	9.00
10673	TRE - Routine Equipment Replacements	299,049	New	Routine	9.00
43646	PHB - Routine Equipment Replacements	357,321	New	Routine	9.00
27856	TRE - Roofing Routine	88,862	New	Routine	9.00
27857	LIN - Roofing Routine	11,070	New	Routine	9.00
27854	TUC - Roofing Routine	143,166	New	Routine	9.00
27855	POT - Roofing Routine	197,575	New	Routine	9.00
23428	GS - Routine Capital	135,000	New	Routine	9.00
33863	LIN - Heat Rate Routine	72,000	New	Routine	9.00
33867	POT - Heat Rate Routine	47,149	New	Routine	9.00
33869	TRE - Heat Rate Routine	73,397	New	Routine	9.00
33871	TUC - Heat Rate Routine	48,801	New	Routine	9.00

Combustion Turbine – 2014 ACE Plan Capital Item Rankings

CI	Project Title	2014 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
33142	CT- Burnside #4 Unit Restoration	767,439	New	Business Sustainability	8.50
29065	CTs - BGT Replace Halon Fire Protection System	356,702	New	Environment	9.00
43155	CT - BGT2 Air Intake Structure Refurbishment	306,586	New	Business Sustainability	8.00
45116	BGT1 GG4C-1D Engine Refurbishment	1,152,807	New	Business Sustainability	8.50
43153	CT - TUC4 Control Upgrade	535,493	New	Business Sustainability	8.00
44787	CT - DC Battery Bank Replacement	118,936	New	Business Sustainability	8.00
42050	CT- Tusket Air Dryer Upgrade	103,428	New	Business Sustainability	8.00
37982	CT - BGT3 AVR Replacement	75,141	New	Business Sustainability	8.25
44786	BGT1 - Oil Filter Upgrade	24,944	New	Business Sustainability	7.50
10634	CT - Routine Equipment Replacements	122,945	New	Routine	9.00
38899	CTs Tooling Routine	20,000	New	Routine	9.00

Transmission & Distribution

Customer Operations (Transmission & Distribution) 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 low, medium and high. 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 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 – 2014 ACE Plan Capital Item Rankings

FP / CI Number	Project Title	2014 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
Transmission Capital Items Included in 2013 ACE Plan					
43324	L6513 Rebuild / Upgrade Line Terminals	8,456,500	New	Requirement to Serve	9.0
45066	Upgrade L6511 and L7019 Thermal Rating	3,775,982	New	Requirement to Serve	9.0
43291	Protection Risk Reduction 67N-Onslow 230KV	2,486,992	New	Regulatory	9.0
43678	Separate L8004/L7005 on Canso Crossing Double Circuit Tower	2,241,664	New	Requirement to Serve	9.0
45067	67N Onslow 345 KV Node Swap	2,150,875	New	Requirement to Serve	9.0
43683	South Canoe Wind Project Transmission Line	2,150,556	New	Requirement to Serve	9.0
43684	Interconnection Substation South Canoe Wind Project	2,081,677	New	Requirement to Serve	9.0
43681	South Canoe Wind Project Substation Network Upgrades	1,711,375	New	Requirement to Serve	9.0
44974	2014 PCB Equipment Removals	1,172,392	New	Regulatory	9.0
44980	2014 Transmission Switch and Breaker Replacements	1,095,553	New	Customer Reliability	8.4
43676	Interconnection Substation Sable Wind Project	988,300	New	Requirement to Serve	9.0

FP / CI Number	Project Title	2014 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
44987	L7003 Upgrades	971,776	New	Regulatory	8.5
44984	9C Aberdeen Transmission Line Installation	846,755	New	System Reliability	7.5
45033	L7001 Replacements	813,226	New	System Reliability	8.5
43674	Sable Wind Network Upgrades	767,344	New	Requirement to Serve	9.0
43205	L5510 Insulator Replacements	734,641	New	System Reliability	8.5
43672	82V-T1 Transformer Rewind	728,491	New	System Reliability	9.0
44970	2014 Steel Tower Refurbishments	492,271	New	System Reliability	8.0
44977	3W Breaker, Switch & Cable Replacements	401,463	New	System Reliability	7.5
44983	Reactor Bank Breaker Replacements	385,032	New	System Reliability	8.5
45306	George Street Substation Addition	362,477	New	Load Growth	8.0
44985	Replace 230kV Kearney Disconnect Switch Assemblies	319,246	New	System Reliability	8.5
44973	2014 Substation Recloser Replacements	307,115	New	Customer Reliability	8.5
44982	New Spare Transformer to Replace 20W-T51	291,660	New	System Reliability	8.0
44975	Sacrificial Anode Installation Program Phase 1	290,047	New	System Reliability	8.5
43675	Transmission Interconnection Facilities Sable Wind Project	279,224	New	Requirement to Serve	9.0
44990	104S Switch Replacement and Addition	161,471	New	System Reliability	8.5
43223	101S-Woodbine Transfer Switch Replacement	49,093	New	Customer Reliability	9.0
Distribution Capital Items Included in 2013 ACE Plan					
40320	LED Street Light Conversion	8,664,772	New	Regulatory	9.0
43217	24C-442G Hwy 16 Rebuild Phase 1	800,769	New	System Reliability	8.0
44826	2014 Build-to-Roadside	791,268	New	Customer Reliability	9.0
45046	2014 PCB Phase-out for Pole Top Transformers	779,620	New	Regulatory	9.0
43177	103W-311 Gold River Reconductor Phase 3	377,721	New	System Reliability	8.0
45027	535N - Powell Road Partial Conversion Phase 1	357,418	New	Overloaded Equipment	8.0
44759	16N-301 - Stewiacke - Load Transfer	258,816	New	Load Growth	8.0
44833	99V-312 - Highbury New Feeder	256,828	New	Load Growth	8.0
44832	73W-411G - East Dalhousie - Load Shift	237,511	New	Regulatory	8.0
45026	639N - Mount Thom Overload	181,132	New	Overloaded Equipment	8.0
44827	2014 Distribution Cutout Replacements	180,944	New	Customer Reliability	8.4
45043	57 Main Ave Primary Service Upgrade	101,070	New	Regulatory	8.5
Routine Capital Items Included in 2013 ACE Plan					
23118	Provincial - Planned Trans Line Replacement	3,832,614	Routine	Transmission	9.0
23120	Provincial-Trans Substation Primary	2,017,875	Routine	Transmission	9.0
23115	Provincial Transmission Line Replace	844,924	Routine	Transmission	9.0
23121	Provincial - Substation Additions & Replacements	846,454	Routine	Transmission	9.0
14841	Protection Modification & Replacement	418,163	Routine	Transmission	9.0
14973	Primary Equipment Spares	215,000	Routine	Transmission	9.0

FP / CI Number	Project Title	2014 ACE Budget ($)	Project Type	Ranking Category	Project Ranking
23137	Planned Replacement Of Distr	6,883,997	Routine	Transmission	9.0
26496	Meter Routine	2,476,304	Routine	Distribution	9.0
23158	Unplanned Replace Deteriorated	9,232,511	Routine	Distribution	9.0
39766	New Customers - Residential	8,442,778	Routine	Distribution	9.0
26716	New Customer Upgrades	7,385,274	Routine	Distribution	9.0
23361	Provincial Storm	2,482,675	Routine	Distribution	9.0
39770	New Customers - Commercial	5,563,386	Routine	Distribution	9.0
23127	Provincially Widening	746,227	Routine	Distribution	9.0
29038	System Performance Improvement Routine	307,387	Routine	Distribution	9.0
23135	Regulatory Replacements - Province	951,526	Routine	Distribution	9.0
23136	Contractual Replacements (Joint Use)	670,157	Routine	Distribution	9.0
23511	Primary Equipment Spares - Distribution	150,000	Routine	Distribution	9.0

General Plant – Capital Item Rankings

The projects brought forward under General Plant primarily involve information technology, telecommunications 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.

10.1.4 2011 ACE Plan Directive 12 - 2014 to 2016 Forecasted ACE Plan Expenditures by Functional Class and Spending Program

The Company does not anticipate a significant change in the investment level for projects 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 notable investments included in this ACE Plan. Investment levels from 2014-2016 are subject to change based on operating conditions, updated asset assessments, regulatory directives, or legislation.

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

(Millions of Dollars)	**2014 ACE**	**2015**	**2016**	**Project Total**
Sustaining Capital Investments				
Thermal Generation	39.98	41.57	42.40	
Hydro Generation	8.30	18.31	18.68	
Wind Generation	0.11	0.11	0.12	
Transmission	15.50	19.78	23.33	
Distribution	48.00	48.41	52.61	
General Property	20.14	17.88	24.58	
Notable Capital Investments				
General Plant:				
IT - Field Mobility System	1.86			2.00
Oracle Financials Upgrade	1.49	5.14		6.63
OMS Replacement	2.51			4.11
Replace Mobile Radio System		4.00	4.00	12.00
CEF Load Control Project	0.49			4.29
Additional Reliability Investment General Plant	0.98	1.00		
Distribution:				
Additional Reliability Investment Distribution	2.37	3.00		23.50
LED Lighting Replacement	8.66	8.80	8.80	35.37
Transmission:				
Additional Reliability Investment Transmission	0.14	3.00		18.00
Transmission Reliability	3.39	5.00	5.00	31.10
Transmission Reinforcement	8.21			45.90
Maritime Link Transmission*	16.63	15.05		31.68
Wind (& Associated Transmission):				
South Canoe and Sable Wind Farms*	30.85	66.30	0.80	105.15
Associated Transmission*	7.98	9.80		19.67
Hydro:				
Hydro Infrastructural Renewal*		20.00	20.00	118.00
MacMillan Dam	4.80			5.28
Gaspereau Dam Safety	4.86			10.24

(Millions of Dollars)	**2014 ACE**	**2015**	**2016**	**Project Total**
Steam and Gas Power Production:				
Burnside	0.77			3.70
Trenton Ash Site Capping / Closing		12.00		
Fast Acting Generation #1*			20.00	60.00
Total Annual Capital Investment	**$228.00**	**$299.15**	**$220.32**	

* These items are not included in the sustaining capital total referenced in Section 3.3.

10.1.5 2013 ACE Plan Directive 2 – Routine Expenditures

In the UARB's 2013 ACE Plan decision, NS Power was directed "to analyze the routine expenditures to determine what are the "like-for-like" totals", and "explain why those totals, if they are similar in magnitude to the Board's analysis, are growing at an annual rate in excess of inflation."

A summary of NS Power's total routine and like-for-like routine spending is provided below:

ANNUAL COST OF LIKE-FOR-LIKE ROUTINE REPLACEMENTS

NOVA SCOTIA POWER ($MM)	**2008 Actual**	**2009 Actual**	**2010 Actual**	**2011 Actual**	**2012 Actual**	**2013 Forecast**	**2014 ACE Plan**
Total Routine Spending	$59.9	$60.9	$64.5	$78.4	$74.9	$67.6	$72.3
Less:							
New Customers	22.6	20.3	20.4	22.2	24.2	21.0	21.5
System Growth and Performance	3.4	4.4	4.2	2.8	3.0	3.2	2.3
Other	0.2	0.3	0.9	1.4	1.3	1.2	1.4
Like-for-Like	33.7	35.8	39.0	52.0	46.4	42.3	47.1
Work Vehicles (Like-for-like)	0.2	0.1	0.1	6.5	5.6	1.4	5.6
Net (Like-for-like)	33.5	35.7	38.8	45.5	40.8	40.9	41.5

*Point Aconi amounts have been removed in order to reflect the spend totals that require UARB approval.

*Prior to 2011, Vehicles were primarily purchased under individual capital projects, not routines. The spending in 2008 – 2010 was in P006 – Replacement and Additional Work Vehicles and P009 – Mobile Transformer and Track Routine.

A decrease in routine spending is evident as total routine spending in 2012 was less than 2011. Based on NS Power's most recent projections for 2013, total routine spending is expected to be $67.6 million which is significantly less than both the approved routine spending of $87.8 million in the 2013 ACE Plan and 2012 actuals of $74.9 million.

When comparing the like-for-like totals, the most recent projects for 2013 show $40.9 million in spending. This is consistent with 2012 actuals and approximately $4.6 million less than 2011 actuals.

Routine classifications are determined by the primary classification of each routine project. If the majority of the work completed under the routine is like-for-like replacements, the routine was classified as like-for-like. New Customer routines, System Growth and Performance routines (such as heat rate, system improvement and right-of-way widening routines) and other routines (such as joint use and environmental assessment routines) were not included in the like-for-like totals. Work vehicle routines are predominantly like-for-like replacements and are shown separately to illustrate the increase related to the implementation of this routine in 2011.

NS Power addresses reactive items within routines by using the professional judgment of its engineers to assess the urgency of each job. At an overall routine level, NS Power actively evaluates and prioritizes work in order to manage costs within budget. Each month, NS Power monitors the activities within the routines to evaluate whether the work is necessary.

10.1.6 2013 ACE Plan Directive 13 – Discretionary Expenditures

In the UARB's 2013 ACE Plan Decision, the UARB directed NS Power

> …to provide information on how it will control discretionary expenditures in future ACE Plan filings.

Per the Capital Expenditure Justification Criteria filed with the UARB on August 30, 2013, the term "discretionary" has specific meaning related to capital work. A discretionary capital project has a "do nothing" alternative. Per the CEJC:

> Capital expenditures that are deemed to be discretionary are:
>
> - Investments that are incremental to an essential capital investment and which are made solely on the basis of economics; or

- New capital projects undertaken for the singular purpose of lowering net costs or generating net revenue thereby lowering overall costs to customers.

Generally with discretionary investments, the Company seeks projects that provide returns which minimize or reduce revenue requirement. Financial and strategic priorities may not permit the Company to undertake all, or even any, discretionary capital expenditures in any given year.

The "do nothing" option must be an alternative that carries with it an acceptable risk. If a capital project has a "do nothing" alternative that NS Power is willing to accept, the project must be shown to lower the overall revenue requirement. In this way, discretionary projects submitted for approval should demonstrate an economic benefit and lowered revenue requirement, and therefore should be pursued. Any project that does not have an acceptable "do nothing" alternative is considered essential, and the least cost, acceptable alternative (if more than one acceptable alternative exists) will be chosen.

In the context of the Board's 2013 ACE Plan Decision, "discretionary" capital work was linked to work support facility capital work orders. In this case, it would appear that "discretionary" took on the plain meaning of the word which is different from the CEJC definition noted above.

Work support facilities projects that NS Power submits for approval are typically not "discretionary": they should provide a clear benefit or are considered necessary. For example, Information Technology related capital projects, although not usually justified on economics, are frequently necessary due to a number of factors including obsolescence of previous technology, manufacturer support expiring, or improving work practices in line with industry trends. Such work orders will be assessed and submitted per the criteria found in the CEJC, and will describe the need for the project.

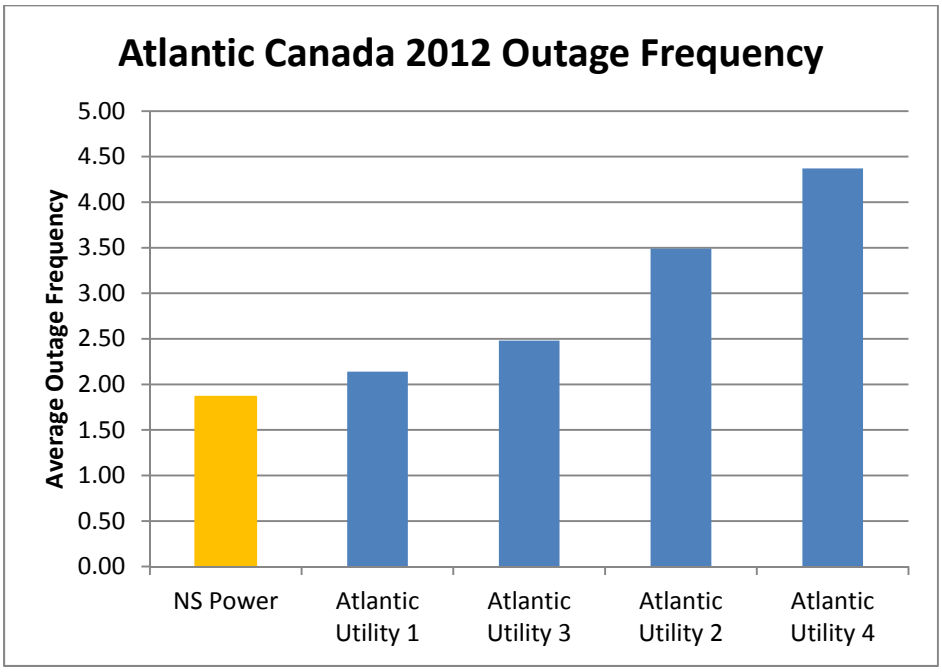
10.1.7 2013 ACE Plan Directive 14 – Impact of Reliability Projects

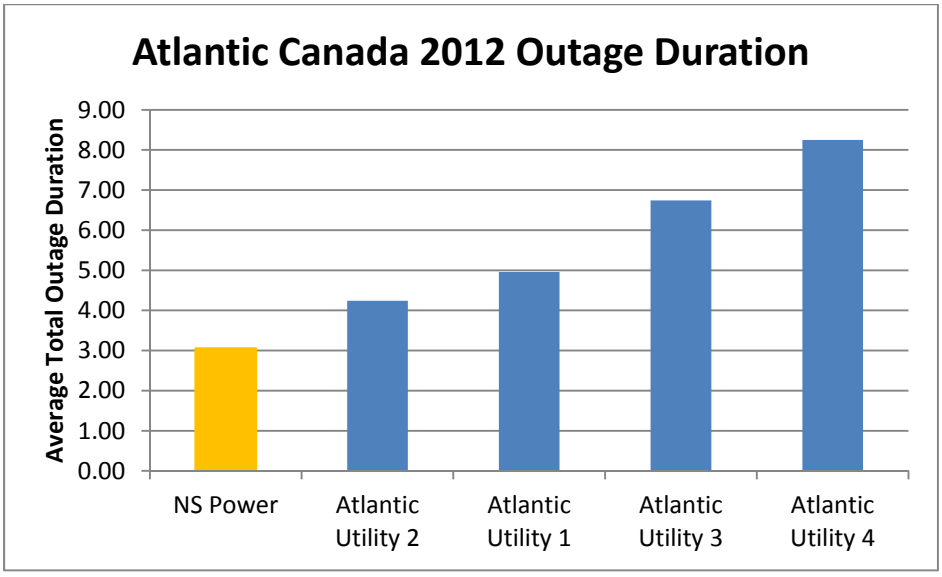
In the UARB's 2013 ACE Plan decision, the UARB advised

> …the Board expects NSPI to monitor the impact of the deferral of reliability projects in the original 2013 ACE Plan closely and to provide a report on the results in the next ACE Plan.

As discussed during the 2013 ACE Plan hearing, for 2012 NS Power had the best reliability in

Atlantic Canada (see table below), and the best CAIDI and SAIFI ever.





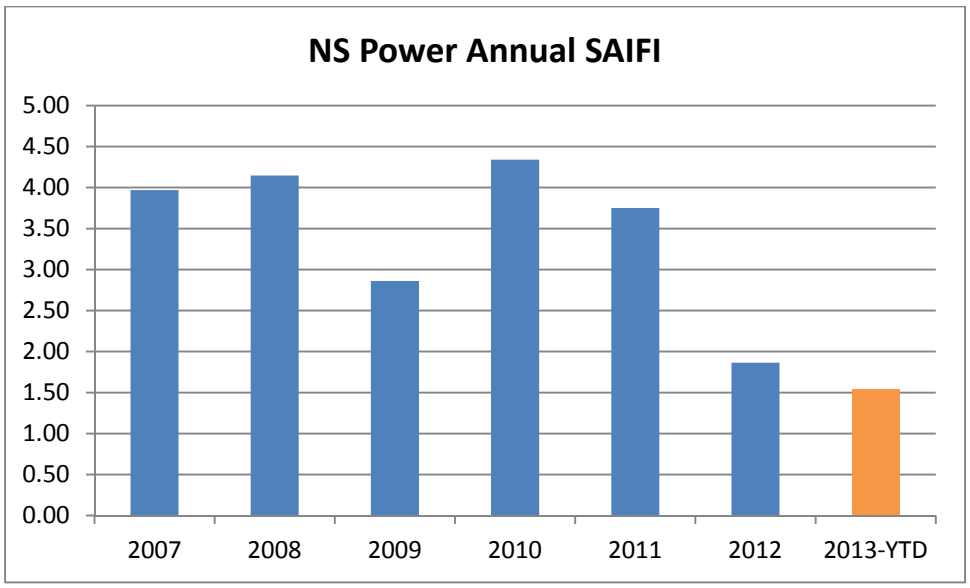
Given these reliability results, it was judged the right time to moderate expenditures in reliability. The majority of spend related to NS Power's reliability program has been completed. Per NS Power's revised 2013 ACE Plan expenditures, the remaining spend has been spread out between 2013, 2014 and 2015.

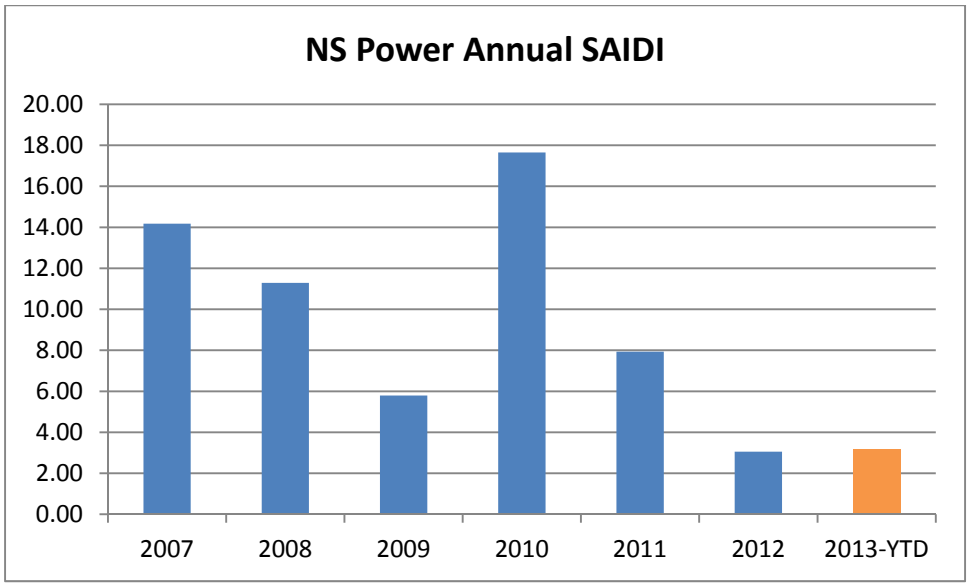
The following table presents the projects under the multi-year Reliability Investment Strategy that were either reduced or deferred from 2013:

Project	2013 Initial Forecast ($)	Reduction	2013 Adjusted Forecast
Provincial Distribution ROW Widening (D-010)	2,539,685	789,000	1,750,685
Provincial Transmission ROW Widening* (T010)	538,610	400,000	138,610
2013 Transmission Line Insulator Replacements (CI#43260)	2,470,579	2,250,000	220,579
2013 Transmission Switch & Breaker Replacements (CI#43266)	1,970,607	300,000	1,670,607
2013 Substation Insulator and Cut-Out Replacements (CI#43222)	303,216	150,000	153,216
2013 Substation Recloser Replacements (CI#43237)	1,851,657	468,000	1,383,657
2013 New RTU Deployment (CI#43221)	362,910	225,000	137,910
2013 Build-to-Roadside (CI#43258)	1,081,638	540,000	541,638
2013 Distribution Cutout Replacements (CI#43255)	618,065	200,000	418,065
2013 Distribution Feeder Ties (CI#43282)	389,595	150,000	239,595
2013 Distribution Reliability Technologies (CI#43276)	328,752	228,000	100,752
2013 Distribution Automation (CI#43188)	274,349	102,000	172,349
2013 Down-line Recloser Additions (CI#43189)	380,204	130,000	250,204
2013 Remote Communication on Reclosers (CI#43195)	137,750	65,000	72,750
2013 Halifax U/G Feeder Replacements (CI#43201)	770,794	770,794	-
2013 Feeder Exit Cables (CI#43216)	203,892	203,892	-

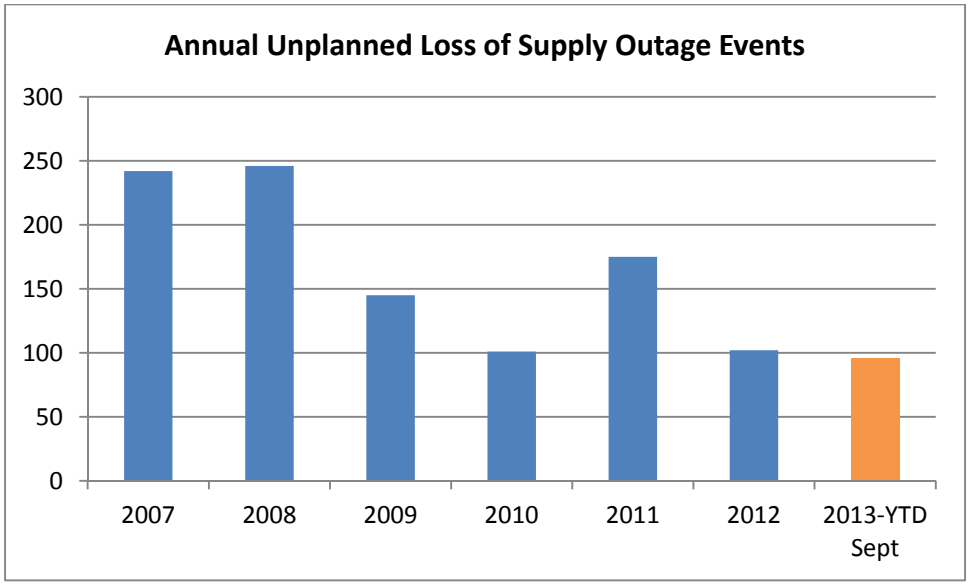
*2013 is the first year in which a transmission-specific ROW widening project was implemented (T010).

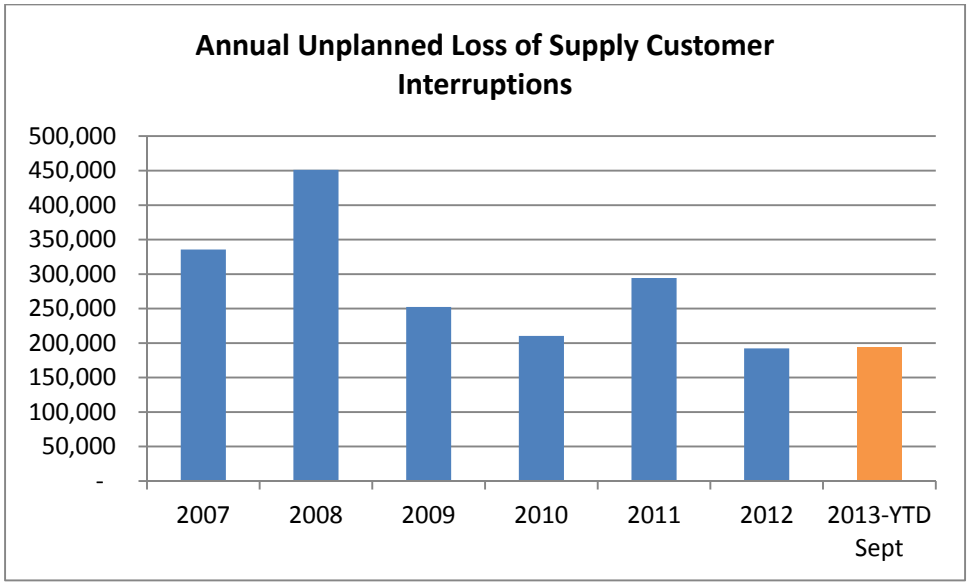
As can be seen in the “NS Power Annual SAIFI” and “NS Power Annual SAIDI” charts below, customers are experiencing fewer interruptions and shorter total duration of outages, and results for 2013 metrics are trending towards similar results as 2012. However, with time left in the year, these results can change.


NS Power Annual SAIFI
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
2007
2008
2009
2010
2011
2012
2013-YTD

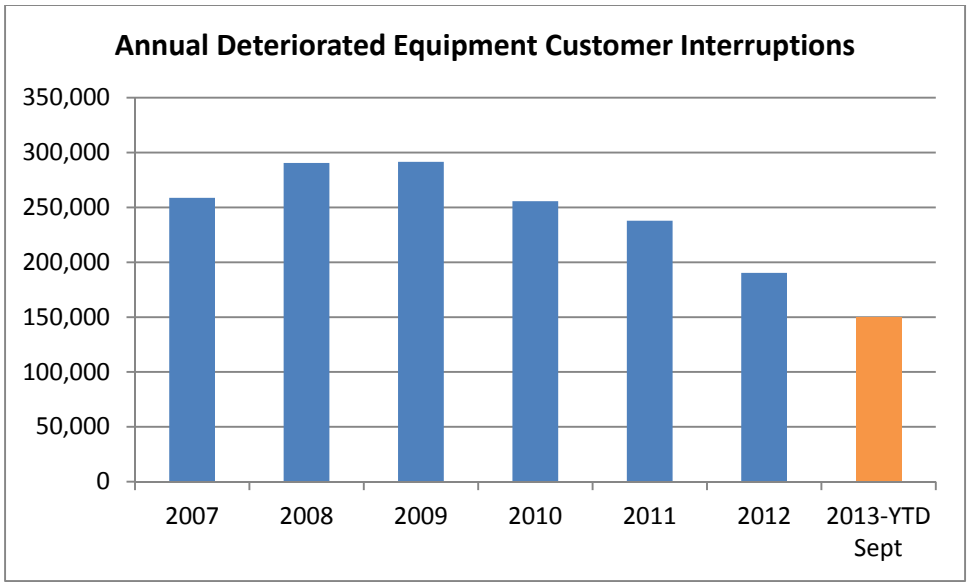

NS Power Annual SAIDI
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
2007
2008
2009
2010
2011
2012
2013-YTD

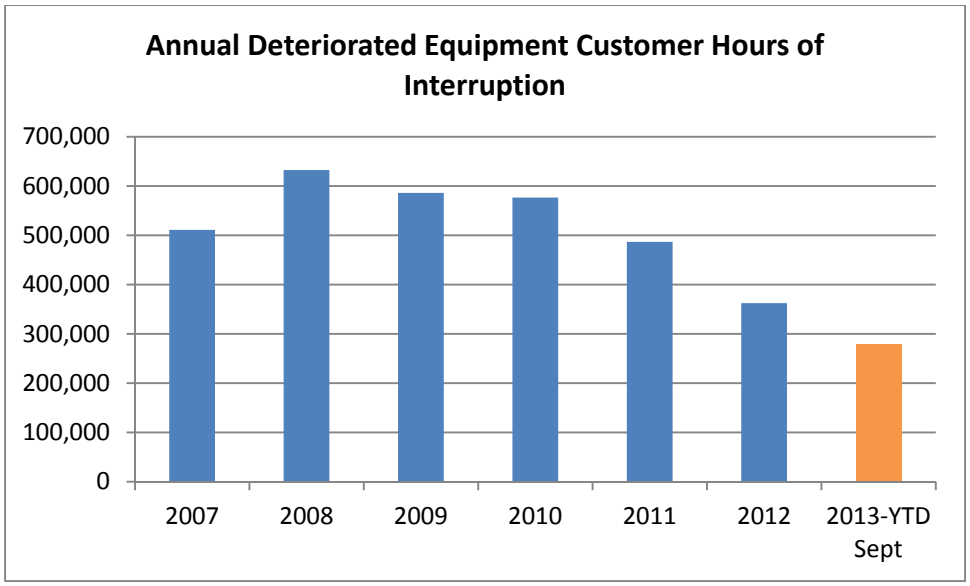
The following two charts demonstrate the number of outage events and total customers affected from loss of supply due to transmission line or substation events has improved.



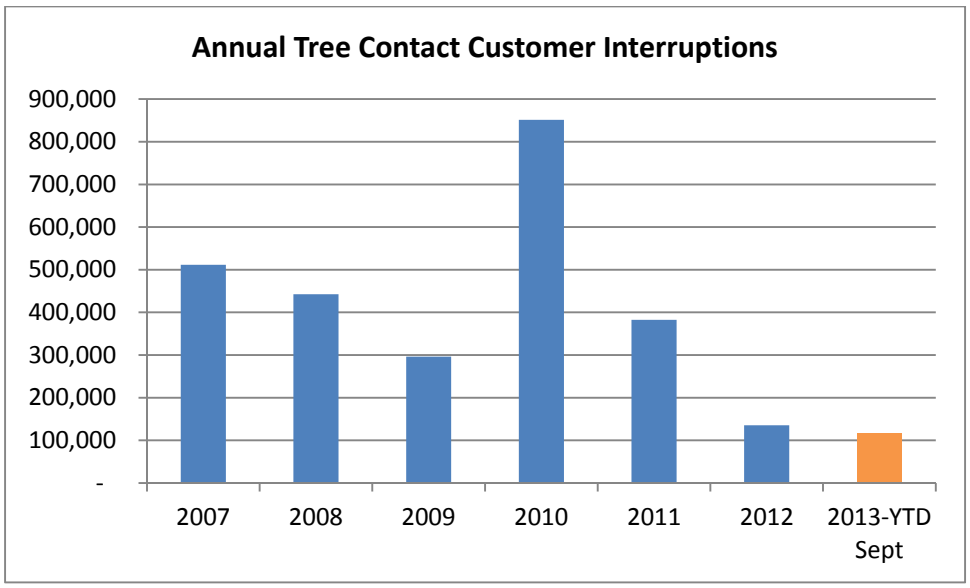


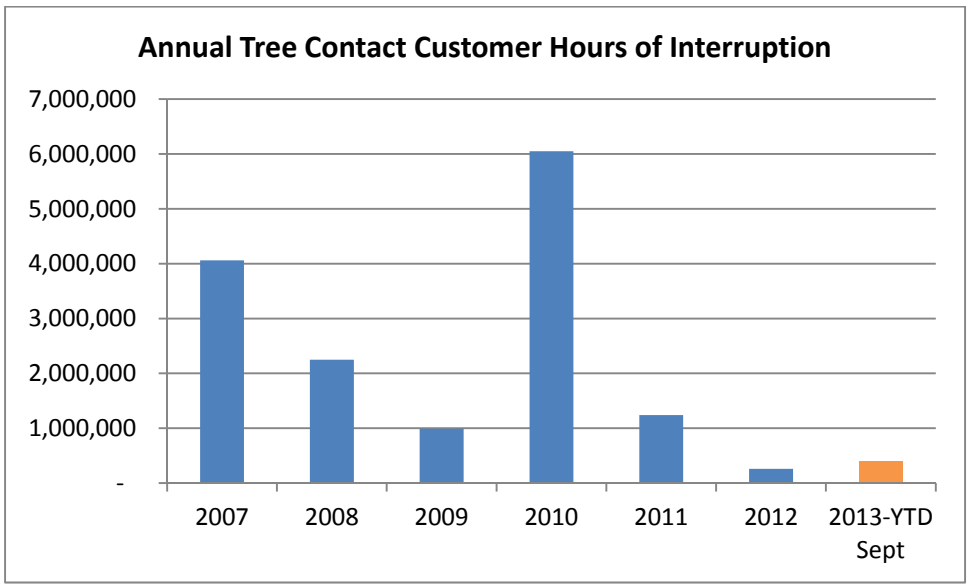
The following two charts demonstrate reliability gains realized through upgrades and replacements of targeted distribution equipment. There has been a steady improvement in both the customer interruptions and customer hours of interruption due to deteriorated equipment.





The following two charts demonstrate both customer interruptions and customer hours of interruptions due to tree contacts are trending towards improved customer reliability.





The multi-year Reliability Investment Strategy has resulted in a step-change towards improved reliability for NS Power customers. System reliability has been improved to a level where reductions and deferrals of reliability investments can be made for customer affordability, while sustaining similar overall reliability. NS Power continually monitors outages and performance of transmission, substation and distribution assets, and future investments will continue at an appropriate level to ensure affordable and reliable service.

10.1.8 2013 ACE Plan Directive 15 – Interruptible Customers

In the UARB's 2013 ACE Plan Decision, the UARB advised that

> …an annual report, as part of the ACE Plan filing, tracking interruptions to interruptible customers is useful and reasonable. The Board directs NSPI to provide this information in future ACE Plans.

The North American Electric Reliability Corporation (NERC) requires NS Power to maintain defined levels of Operating Reserve capacity (capacity or load that can be activated/reduced within ten minutes). While NS Power begins each day with a generation plan designed to serve all customers, including interruptible customers, and to maintain the required Operating Reserve, circumstances do arise where this reserve requirement cannot be met with available resources. In these situations, interruptible customers are called upon to temporarily cease their electricity consumption to serve firm customers and meet Operating Reserve requirements.

NS Power offers four tariffs that require customers to reduce their loads within 10 minutes when requested. The four tariffs are:

1) The Large Industrial Interruptible Rider (LIIR) Tariff
2) The Port Hawkesbury Paper Load Retention Mechanism (PHP LRM) Tariff
3) The Generation Replacement and Load Following (GR&LF) Rate
4) The Shore Power Tariff

The process for interruption of loads for each group is essentially the same: telephone notification with the requirement to reduce load within 10 minutes.

In exchange for allowing their load to be interrupted, interruptible customers receive a discount based on the avoided capital costs associated with peaking units that would otherwise have been required to serve peak load. If an interruptible customer is unable to comply with the provisions of their tariff, a penalty is applied.

The LIIR class was historically interrupted once or twice per year and would even experience periods where they were not called at all for several years. Comparatively, the last several years have seen more frequent interruptions. The largest change in conditions leading to these interruptions is the absence of the priority interruption provided by the customers subscribed

to the Extra Large Industrial tariff (paper mills). Increased difficulty in securing imports due to transmission constraints outside of the Nova Scotia system has also contributed. Below is a table summarizing interruptions in the LIIR customer class from 2009 to the present.

Year	LIIR Customers			
	Date	Number of LIIR customers interrupted	Estimated load interrupted (MW)	Estimated average duration
2009	January 26	26	80	2 hours
	April 9	25	67	1.5 hours
	December 1	7	30	1.2 hours
	December 17	25	82	1.5 hours
2010	February 1	8	25	40 minutes
2011	January 23	25	74	45 minutes
2012	N/A	0	0	
2013 (to end of October)	January 2	8	26	55 minutes
	January 3	2	16	1 hour
	January 16	22	69	40 minutes
	February 8	10	34	2 hours

NS Power has recently filed a pilot program for Board approval to improve the effectiveness of the LIIR tariff. The project aims to have NS Power control participating customers' load, which will enable this load to be counted as 10 minute reserve under NERC requirements which should reduce the number and duration of customer interruptions.

Below are tables summarizing recent interruptions to PHP LRT and the GR&LF customers.

PHP LRT Interruptions*		
Date	Load Interrupted (MW)	Estimated Average Duration
Jan 2, 2013	15	1.5 hours
Jan 3, 2013	11	50 minutes
Jan 16, 2013	37	1.75 hours
Feb 8, 2013	41	2.67 hours

*PHP LRT came into effect September 27, 2012.

GR&LF Interruptions*	
Date	**Estimated Average Duration**
Sept 6, 2012	1.5 hours
Dec 1, 2012	1.75 hours
Jan 2, 2013	1.58 hours
Jan 3, 2013	1 hour
Jan 6, 2013	1.25 hours
Jan 16, 2013	1.75 hours
Feb 8, 2013	2.75 hours

*There is no significant load relief associated with GR&LF interruptions.

All interruptions to these classes of customers were required to maintain the system operator's 10-minute reserve requirements and were executed in accordance with the applicable tariff.

10.2 2014 Capital Spending by Justification Criteria

Items in the 2014 ACE Plan have been developed using the newly revised 2013 CEJC. Definitions of the various criteria referenced in the following table are included in the CEJC.

(Millions of Dollars)

Justification Criteria*	2014 Budget	Individual Project Approval	Routine Spend	Less than $250K	Items for Later Filing 2014	Items for Later Filing 2013	Carryover	Pt. Aconi
Distribution System	56.6	3.3	42.8	0.7	0.4	8.7	0.7	0.0
Thermal	26.5	6.5	2.7	5.2	1.7	0.9	2.7	6.7
Work Support	25.6	1.5	13.6	0.9	3.3	1.9	4.3	0.0
Hydro	11.2	1.9	1.8	0.1	0.4	0.0	7.1	0.0
Health and Safety	11.1	1.4	0.0	1.9	5.8	0.5	1.4	0.0
Transmission Plant	52.0	6.5	8.3	0.4	21.8	8.0	7.0	0.0
Environmental	42.0	0.8	0.5	1.8	3.7	12.0	19.9	3.3
Metering Equipment	3.0	0.0	2.5	0.0	0.0	0.0	0.5	0.0
System Design	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Facilities/Land and Right-of-Way	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Total	**$228.0**	**$21.9**	**$72.3**	**$10.9**	**$37.1**	**$32.0**	**$43.8**	**$10.1**

*Details of justification sub-criteria are provided on the following page.

10.3 2014 Capital Spending by Justification Sub-Criteria

(Millions of Dollars)

Justification Sub-Criteria	2014 Budget	Individual Project Approval	Routine Spend	Less than $250K	Items for Later Filing 2014	Items for Later Filing 2013	Carryover
Distribution System							
Requirement to Serve	34.5	0.0	34.5	0.0	0.0	0.0	0.0
Pole Strength	6.9	0.0	6.9	0.0	0.0	0.0	0.0
Joint Use Agreement	0.7	0.0	0.7	0.0	0.0	0.0	0.0
Deteriorated Conductor	1.3	1.2	0.0	0.0	0.0	0.0	0.1
Equipment Replacement	9.8	0.8	0.0	0.3	0.0	8.7	0.1
Outage Performance	2.1	0.8	0.7	0.0	0.0	0.0	0.5
Overloaded Equipment	0.3	0.3	0.0	0.0	0.0	0.0	0.0
System Protection	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Distribution System	1.0	0.3	0.0	0.4	0.4	0.0	0.0
Total	**$56.6**	**$3.3**	**$42.8**	**$0.7**	**$0.4**	**$8.7**	**$0.7**
Work Support Facilities							
Buildings	3.0	0.0	2.6	0.0	0.3	0.0	0.1
Furniture & Fixtures	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Telecommunications	6.9	0.8	0.9	0.5	0.0	1.9	2.7
Computers / IT	6.7	0.0	3.1	0.3	2.7	0.0	0.5
Tools & Equipment	1.4	0.0	1.4	0.0	0.0	0.0	0.0
Vehicles	5.6	0.0	5.6	0.0	0.0	0.0	0.0
Equipment Replacement	1.7	0.7	0.0	0.0	0.0	0.0	1.0
Other	0.4	0.0	0.0	0.1	0.3	0.0	0.0
Total	**$25.6**	**$1.5**	**$13.6**	**$0.9**	**$3.3**	**$1.9**	**$4.3**

10.4 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) New Items

This category includes new, non-routine capital items.

(a) New Items with 2014 Completion - This category includes all new, non-routine capital items scheduled to start in 2014 and finish in 2014.

(b) New Items with Subsequent Completion - This category includes all new, non-routine capital items scheduled to start in 2014, but which will be completed beyond 2014.

2) Carryover Items

These are multi-year projects already approved in prior years with spending occurring in 2014 and beyond.

(a) Carryover Items with 2014 Completion - Includes items that will be completed during 2014.

(b) Carryover Items with Subsequent Completion - Includes items that will be completed beyond 2014.

3) Routine Capital Items

Routine Capital items are an annual allocation of capital to fund repetitive individual capital replacements.

(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.

10.5 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.

10.6 Quick Reference Sheet

2014 AFUDC Rate 7.78%*

*In compliance with the Board's directive from the 2013 ACE Plan decision, NS Power has adjusted its AFUDC rate (WACC) to the rate for 2014 approved in the 2013 General Rate Application. If NS Power requires an adjustment to the AFUDC rate, an interim application will be made pursuant to the provisions of the 2013 CEJC.

2014 O/H Rates

Generation		**Customer Operations**		**Shared Services**	
PP Regular	19.07%	Regular	81.12%	IT	45.62%
Hydro	23.22%	Contract	27.91%	T&C	46.95%
Contractor	9.77%	Vehicle	57.13%		

10.7 2014 Depreciation Rates

	2014
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%
Port Hawkesbury Biomass	2.50%
Point Tupper Marine Terminal	4.06%
International Coal Pier	2.60%
General	2.82%
Total Steam Production Plant	**2.82%**

	2014
Hydro 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 Hydro Production	**2.10%**

	2014
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%**

	2014
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%**

	2014
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%**

10.8 Summary of Economically Justified Projects

CI	Project	Alternative	Rank as Filed	As Filed	Capital Spend Increased 10%	Avoided Expenses Reduced 10%	Deferral of 1 year	Deferral of 2 years	Deferral of 3 years	Year 0/2013	Year 1/2014	Year 2/2015	Year 3/2016	Year 4/2017	Year 5/2018	Year 6 to end of life/2019+	Total
42666	Tusket #2 Overhaul	Overhaul Tusket Unit #2	1	(5,859,696)	(5,799,598)	(5,213,628)	389,308	725,967	1,034,306	(56,086)	(381,865)	(312,808)	(297,017)	(282,100)	(267,994)	(4,261,826)	(5,859,696)
42939	TUC2 S CW Pump Refurbishment	Refurbish Pump, Replace Bend	1	(474,538)	(434,302)	(386,849)	11,643	56,139	99,608	-	(30,715)	(18,845)	(32,689)	(45,039)	(56,006)	(291,244)	(474,538)
43153	CT - TUC4 Control Upgrade	Control System Upgrade, proposed	1	(4,963,907)	(4,916,742)	(4,420,352)	301,474	533,050	736,477	-	(350,778)	(204,978)	(194,739)	(296,734)	(281,614)	(3,635,066)	(4,963,907)
43168	LIN CW Pump Refurbish	Refurbish Pump	1	(2,482,927)	(2,446,251)	(2,197,958)	282,398	556,304	873,514	-	(316,452)	(254,675)	(311,805)	(363,230)	(471,777)	(764,989)	(2,482,927)
43424	TRE5 Analytical Panel	Analytical Panel Installation	1	(1,903,693)	(1,865,407)	(1,675,037)	184,293	380,864	555,384	-	(184,238)	(175,061)	(166,374)	(158,163)	(150,394)	(1,069,464)	(1,903,693)
43567	TUC3 CW Travelling Screens Structural Refurbishment	Refurbish Screens	1	(1,034,164)	(1,008,362)	(904,946)	25,274	48,082	63,695	-	(47,799)	(4,965)	(7,655)	(10,069)	(12,222)	(951,453)	(1,034,164)
44350	LIN4 Refurbish Boiler	Refurbish Boiler	1	(514,500)	(480,515)	(429,065)	34,012	98,992	213,536	-	(59,431)	(47,494)	(109,667)	(130,314)	(206,068)	38,474	(514,500)
44351	LIN 2014 Mill Refurbishments	Refurbish Mills	1	(754,533)	(705,306)	(629,853)	88,816	221,852	373,904	-	(108,242)	(108,709)	(145,410)	(199,356)	(255,698)	62,883	(754,533)
44352	LIN CW Screen Refurbishment	Refurbish CW Screens	1	(899,939)	(878,322)	(788,328)	83,042	224,012	373,449	-	(113,795)	(128,969)	(145,932)	(160,739)	(173,565)	(176,938)	(899,939)
44717	Tufts Cove Unit 2 North Vacuum Pump Replacement	North Vacuum Pump Replacement	1	(1,408,735)	(1,368,231)	(1,227,357)	20,597	94,865	162,601	-	(36,441)	(47,597)	(55,923)	(63,261)	(69,684)	(1,135,830)	(1,408,735)
44729	TUC - Station & Unit Transformer Connection Cable Replacement	Replace Cables	1	(5,127,634)	(5,096,970)	(4,584,207)	87,195	209,622	320,203	-	(84,490)	(101,215)	(100,282)	(99,352)	(98,419)	(4,643,875)	(5,127,634)
44732	TRE5 Boiler Refurbishments	Boiler Refurbishments	1	(1,178,783)	(1,122,695)	(1,004,817)	161,852	481,930	769,409	-	(216,350)	(284,933)	(273,733)	(418,441)	(401,220)	415,894	(1,178,783)
44887	Sissiboo Falls Pipeline Replacement	Replace Pipeline with FRP	1	(11,321,026)	(11,285,926)	(10,153,823)	97,837	217,976	360,491	-	(168,394)	(150,732)	(156,022)	(175,310)	(199,017)	(10,471,551)	(11,321,026)
44968	Wreck Cove Unit 2 Exciter Replacement	Replace Exciter	1	(37,422,460)	(37,373,145)	(33,630,899)	916,591	1,943,366	3,084,122	-	(72,588)	(892,759)	(1,022,527)	(1,135,901)	(1,234,249)	(33,064,436)	(37,422,460)
45189	HYD - Upper Lake Falls 2 Overhaul	Perform Overhaul	1	(4,658,895)	(4,621,969)	(4,156,080)	59,185	127,018	204,183	-	(111,948)	(48,142)	(72,030)	(93,279)	(112,090)	(4,221,405)	(4,658,895)
Summary of all Economically Justified Projects			**1**	**(80,005,429)**	**(79,403,742)**	**(71,403,199)**	**2,743,519**	**5,920,037**	**9,224,881**	**(56,086)**	**(2,283,525)**	**(2,781,880)**	**(3,091,806)**	**(3,631,290)**	**(3,990,016)**	**(64,170,826)**	**(80,005,429)**

10.9 Glossary of Terms

10-minute reserve	Generation capacity that can be held in reserve, to respond to upsets such as generation and transmission trips and shortfalls. This generation can be comprised of reserve capacity in on-line generators that can be ramped in 10 minutes, off-load fast-start generation than can be started and brought to full load in 10 minutes.
Black-Start Capability	Facilities that provide the system with capability to restart the system following a total collapse as required by NERC
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, biomass or wind as fuel for the process to create electrical energy.
Fast-Acting Generation	Generation that can respond quickly to make up for load changes, generation losses and regulate the interconnections at the agreed upon purchase/sales
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.
Volt-Ampere Reactive support	Facilities necessary to control and maintain the voltage on the system under all conditions to support and maintain power transfers.

Generation

CI Number: 42666

Title: HYD – Tusket #2 Overhaul

Start Date: 2012/03
Final Cost Date: 2015/03
Function: Generation
Forecast Amount: $657,684

DESCRIPTION:

The Tusket powerhouse was put into service in 1929 and much of the equipment is original. Annual preventative maintenance activities on Unit #2 in October 2010 indicated excessive wicket gate and runner tolerances, and indications of cracking. The unit was returned to service until interference between the operating ring and wicket gates prompted it to be taken out of service in May 2011. A detailed condition assessment of the mechanical components was undertaken to accurately determine what work is required to return Unit #2 to service. Work to be undertaken in this project will correct the following deficiencies: warped operating ring, bushing and linkage tolerances, runner replacement and blade hub refurbishment.

Summary of Related CIs +/- 2 years: None

JUSTIFICATION:

Justification Criteria: Hydro

Sub Criteria: Equipment Replacement

Why do this project?

The unit must be refurbished for it to operate safely and provide reliable service. If placed into service without completion of the overhaul, a failure of any one of the mechanical components would result in damage to additional components and significant downtime.

Why do this project now?

Tusket Unit #2 has been inoperable since May 2011. Operation of this unit is required for water management on the Tusket system. Since the unit was taken out of service, water has been spilling around this unit. Detailed condition assessment, scoping and resourcing efforts have been completed, and replacement blades have been procured. The blades are a long-lead item, and NS Power is now prepared to complete this work and return the unit to service in 2014.

Why do this project this way?

The damage to the blades is such that they are not repairable. Replacement of the blades is required to return the unit to service. Work planned under this project will return the unit to reliable, safe operation.

CI Number : 42666-H643 - HYD - Tusket #2 Overhaul **Project Number** H643

Parent CI Number : -

Cost Centre : 408 - 408-Tusket Hydro **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
001		001 - HYDRO Regular Labour		23,469	0	23,469
001		001 - Regular Labour (No AO)		64,494	0	64,494
001		001 - T&CS Regular Labour		7,238	0	7,238
004		004 - HYDRO Term Labour		8,900	0	8,900
004		004 - Term Labour (NO AO)		25,739	0	25,739
011		011 - Travel Expense		13,012	0	13,012
012		012 - Materials		[redacted]	0	[redacted]
013		013 - POWER PRODUCTION Contracts		32,453	0	32,453
041		041 - Meals & Entertainment		6,212	0	6,212
094		094 - Interest Capitalized		26,859	0	26,859
095		095-Hydro Term Labour AO		8,041	0	8,041
095		095-Hydro Regular Labour AO		13,329	0	13,329
095		095-COPS Contracts AO		16,693	0	16,693
095		095-Thermal & Hydro Contracts AO		1,487	0	1,487
095		095 - T&CS Regular Labour AO		1,797	0	1,797
001	024	001 - HYDRO Regular Labour	024 - HGP - Turbine (Hydro)	39,849	0	39,849
001	024	001 - Regular Labour (No AO)	024 - HGP - Turbine (Hydro)	0	0	0
001	024	001 - T&CS Regular Labour	024 - HGP - Turbine (Hydro)	0	0	0
004	024	004 - Term Labour (NO AO)	024 - HGP - Turbine (Hydro)	0	0	0
004	024	004 - HYDRO Term Labour	024 - HGP - Turbine (Hydro)	27,540	0	27,540
011	024	011 - Travel Expense	024 - HGP - Turbine (Hydro)	10,000	0	10,000
012	024	012 - Materials	024 - HGP - Turbine (Hydro)	[redacted]	0	[redacted]
013	024	013 - POWER PRODUCTION Contracts	024 - HGP - Turbine (Hydro)	0	0	0
016	024	016 - Tools & Equipment	024 - HGP - Turbine (Hydro)	431	0	431
004	085	004 - HYDRO Term Labour	085 Design	0	0	0
013	085	013 - POWER PRODUCTION Contracts	085 Design	0	0	0
028	085	028 - Consulting	085 Design	0	0	0
041	085	041 - Meals & Entertainment	085 Design	0	0	0
			Total Cost:	657,684	0	657,684
			Original Cost:	35,112		

42666 Tusket #2 Overhaul
Summary of Alternatives

Division :	Power Production	**Date :**	**17-Nov-13**
Department :	Hydro & Wind	**CI Number:**	42666
Originator :		**Project No. :**	H643

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Overhaul Tusket Unit #2	6.49%	-5,859,696	4,800,358	1	65.86%	1.6 years
B	Other	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Proceed with overhaul of the unit based on positive economic analysis.

Notes/Comments :

Overhaul Tusket Unit #2

Involves replacing the blades and restoring the unit to full operation. Avoided cost is based on unit being currently out of service until this work is performed and the unit returned to service.

Other

Leaving this unit out of service longer than necessary to complete repairs is not considered a viable option as it is required for water management on the Tusket system. Replacement of the unit instead of refurbishment is also known to be considerably more costly, and was not evaluated further here.

Test 3

Test 4

42666 Tusket #2 Overhaul
Summary of Sensitivities

Division :	Power Production	**Date :**	**17-Nov-13**
Department :	Hydro & Wind	**CI Number:**	42666
Originator :		**Project No. :**	H643

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Overhaul Tusket Unit #2	6.49%	-5,859,696	4,800,358	1	65.86%	1.6 years
B	Other	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Overhaul Tusket Unit #2	10%	-5,799,598	4,750,669	1	59.10%	1.7 years
B	Other	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
	Change: **A**		60,099	-49,689	0	-6.76%	0.1 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Overhaul Tusket Unit #2	-10%	-5,213,628	4,270,633	1	58.43%	1.8 years
B	Other	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
	Change: **A**		646,068	-529,725	0	-7.43%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	389,308	725,967	1,034,306	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

42666 Tusket #2 Overhaul
Avoided Cost Calculations

Division :	Power Production	**Date :**	**17-Nov-13**
Department :	Hydro & Wind	**CI Number:**	42666
Originator :		**Project No. :**	H643

Overhaul Tusket Unit #2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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)	8760	8760				
Totals	$430,624	$427,392	$0	$0	$430,624	$427,392
Total Capital Cost of Alternative						$657,684

Other

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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)	[redacted]					
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

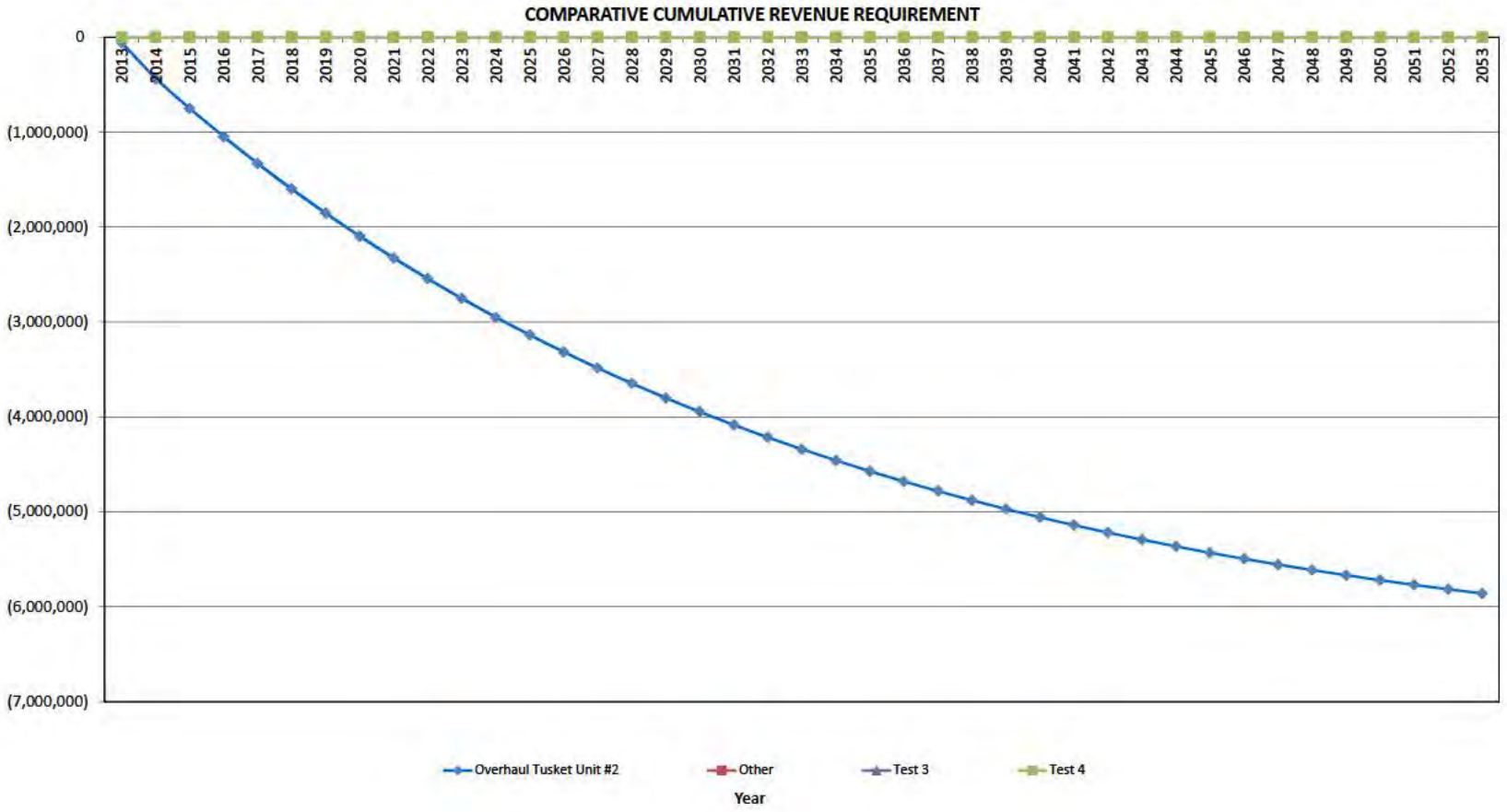
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	[redacted]					
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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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)	[redacted]					
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

42666 Tusket #2 Overhaul
Overhaul Tusket Unit #2

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	(256,420.7)	-	-	(256,420.7)	-	(256,420.7)	(256,420.7)	1.00	(256,420.7)
2014	-	-	430,624.1	(359,915.3)	23,579.1	577,310.3	70,708.8	(126,183.9)	(55,475.1)	(52,094.2)	0.94	(308,514.9)
2015	-	-	427,391.6	-	45,271 9	530,133.1	427,391.6	(118,457.1)	308,934.5	272,426.1	0.88	(36,088.8)
2016	-	-	435,939.5	-	41,650.1	486,730.1	435,939.5	(122,229.7)	313,709.8	259,777.5	0.83	223,688.7
2017	-	-	444,658.3	-	38,318.1	446,799.3	444,658.3	(125,965.4)	318,692.8	247,820.3	0.78	471,509.1
2018	-	-	453,551.4	-	35,252.7	410,063.1	453,551.4	(129,672.6)	323,878.8	236,503.9	0.73	708,013.0
2019	-	-	462,622.5	-	32,432.4	376,265.7	462,622.5	(133,358.9)	329,263.6	225,782.7	0.69	933,795.8
2020	-	-	471,874.9	-	29,837 8	345,172.1	471,874.9	(137,031.5)	334,843.4	215,615.5	0.64	1,149,411 3
2021	-	-	481,312.4	-	27,450 8	316,566.0	481,312.4	(140,697.1)	340,615.3	205,965.1	0.60	1,355,376 3
2022	-	-	490,938.7	-	25,254 8	290,248.3	490,938.7	(144,362.0)	346,576.6	196,797.6	0.57	1,552,173 9
2023	-	-	500,757.4	-	23,234.4	266,036.1	500,757.4	(148,032.1)	352,725.3	188,082.5	0.53	1,740,256.4
2024	-	-	510,772.6	-	21,375.6	243,760.9	510,772.6	(151,713.1)	359,059.5	179,791.6	0.50	1,920,048 0
2025	-	-	520,988.0	-	19,665.6	223,267.7	520,988.0	(155,410.0)	365,578.1	171,899.3	0.47	2,091,947 3
2026	-	-	531,407.8	-	18,092 3	204,413.9	531,407.8	(159,127.8)	372,280.0	164,382.3	0.44	2,256,329.6
2027	-	-	542,035.9	-	16,644 9	187,068.5	542,035.9	(162,871.2)	379,164.7	157,218.8	0.41	2,413,548 3
2028	-	-	552,876.7	-	15,313 3	171,110.6	552,876.7	(166,644.6)	386,232.0	150,388.9	0.39	2,563,937 3
2029	-	-	563,934.2	-	14,088 3	156,429.4	563,934.2	(170,452.2)	393,482.0	143,874.4	0.37	2,707,811.7
2030	-	-	575,212.9	-	12,961 2	142,922.7	575,212.9	(174,298.0)	400,914.9	137,658.2	0.34	2,845,469 9
2031	-	-	586,717.1	-	11,924 3	130,496.6	586,717.1	(178,185.8)	408,531.4	131,724.5	0.32	2,977,194.4
2032	-	-	598,451.5	-	10,970.4	119,064.5	598,451.5	(182,119.1)	416,332.3	126,058.6	0.30	3,103,253 0
2033	-	-	610,420.5	-	10,092.7	108,547.0	610,420.5	(186,101.6)	424,318.9	120,646.8	0.28	3,223,899 8
2034	-	-	622,628.9	-	9,285 3	98,870.9	622,628.9	(190,136.5)	432,492.4	115,476.4	0.27	3,339,376 2
2035	-	-	635,081.5	-	8,542 5	89,968.9	635,081.5	(194,227.1)	440,854.4	110,535.3	0.25	3,449,911 5
2036	-	-	647,783.1	-	7,859.1	81,779.0	647,783.1	(198,376.4)	449,406.7	105,812.4	0.24	3,555,723 8
2037	-	-	660,738.8	-	7,230.4	74,244.4	660,738.8	(202,587.6)	458,151.2	101,297.1	0.22	3,657,020 9
2038	-	-	673,953.6	-	6,651 9	67,312.5	673,953.6	(206,863.5)	467,090.1	96,979.5	0.21	3,754,000.4
2039	-	-	687,432.6	-	6,119 8	60,935.1	687,432.6	(211,207.0)	476,225.7	92,850.3	0.19	3,846,850.7
2040	-	-	701,181.3	-	5,630 2	55,068.0	701,181.3	(215,620.8)	485,560.5	88,900.7	0.18	3,935,751.4
2041	-	-	715,204.9	-	5,179 8	49,670.2	715,204.9	(220,107.8)	495,097.1	85,122.3	0.17	4,020,873.7
2042	-	-	729,509.0	-	4,765.4	44,704.2	729,509.0	(224,670.5)	504,838.5	81,507.3	0.16	4,102,380 9
2043	-	-	744,099.2	-	4,384 2	40,135.5	744,099.2	(229,311.7)	514,787.5	78,048.3	0.15	4,180,429 2
2044	-	-	758,981.2	-	4,033.4	35,932.4	758,981.2	(234,033.8)	524,947.4	74,738.1	0.14	4,255,167 3
2045	-	-	774,160.8	-	3,710 8	32,065.4	774,160.8	(238,839.5)	535,321.3	71,570.2	0.13	4,326,737 5
2046	-	-	789,644.0	-	3,413 9	28,507.8	789,644.0	(243,731.3)	545,912.7	68,538.1	0.13	4,395,275.6
2047	-	-	805,436.9	-	3,140 8	25,234.9	805,436.9	(248,711.8)	556,725.1	65,635.8	0.12	4,460,911 3
2048	-	-	821,545.6	-	2,889 5	22,223.7	821,545.6	(253,783.4)	567,762.2	62,857.6	0.11	4,523,768 9
2049	-	-	837,976.5	-	2,658.4	19,453.5	837,976.5	(258,948.6)	579,027.9	60,198.0	0.10	4,583,966 9
2050	-	-	854,736.1	-	2,445.7	16,904.9	854,736.1	(264,210.0)	590,526.1	57,651.7	0.10	4,641,618.6
2051	-	-	871,830.8	-	2,250 0	14,560.1	871,830.8	(269,570.0)	602,260.8	55,214.0	0.09	4,696,832.6
2052	-	-	889,267.4	-	2,070 0	12,403.0	889,267.4	(275,031.2)	614,236.2	52,880.0	0.09	4,749,712.6
2053	-	-	907,052.8	-	1,904.4	10,418.4	907,052.8	(280,596.0)	626,456.8	50,645.2	0.08	4,800,357.7
Total	**-**	**-**	**25,320,732.9**	**(616,336.0)**	**567,576.4**		**24,704,397.0**	**(7,673,478.5)**	**17,030,918.4**	**4,800,357.7**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(1,000,000)
(2,000,000)
(3,000,000)
(4,000,000)
(5,000,000)
(6,000,000)
(7,000,000)
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
2053
Overhaul Tusket Unit #2
Other
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: HYDRO
CI# / FP#: 42666
Title: HYD - Tusket #2 Overhaul
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Hydro River Staff - Construction	pd	370	$ 345	$ 127,813		
1.2	Engineering Staff	pd	19	$ 384	$ 7,238		
				Sub-Total	$ 135,050		
2	**012 Materials**						
2.1	New Turbine Blades	lot	1	[redacted]		Cost Support 1	
2.2	Misc materials	lot	1				
2.3							
2.4					$ -		
				Sub-Total	$ 330,140		
3	**013 Power Production Contracts**						
3.1	Contracts	lot	1	$ 32,453	$ 32,453		
3.2					$ -		
				Sub-Total	$ 32,453		
4	**016 Tools & Equipment**						
4.1	Tools	lot	1	$ 431	$ 431		
4.2					$ -		
				Sub-Total	$ 431		
5	**004 Term Labour**						
5.1	Hydro River Staff - Construction	pd	180	$ 345	$ 62,179		
					$ -		
				Sub-Total	$ 62,179		
6	**011 Travel Expenses**						
6.1	Travel Expenses	lot	1	$ 23,012	$ 23,012		
6.2					$ -		
				Sub-Total	$ 23,012		
7	**041 Meals and Entertainment**						
7.1	Meals	lot	1	$ 6,212	$ 6,212		
7.2					$ -		
				Sub-Total	$ 6,212		
8	**094 Interest Capitalized**						
8.1	AFUDC	lot	1	$ 26,859	$ 26,859		
8.2					$ -		
				Sub-Total	$ 26,859		
9	**095 Administrative Overhead**						
9.1	Regular Labour AO	lot	1	$ 15,126	$ 15,126		
9.2	Term Labour AO	lot	1	$ 8,041	$ 8,041		
9.3	Contracts AO	lot	1	$ 18,180	$ 18,180		
				Sub-Total	$ 41,348		
				Sub-Total (no AO, AFUDC)	$ 589,478		
				Total	$ 657,684		
10	**Original Cost**						
10.1					$ 35,112		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

Nova Scotia POWER
An Emera Company

GOODS & SERVICES TRAVEL SHEET (P-12-228)

SUPPLY INITIATIVE DATE: January 10, 2013

Scope: ☒NSPI ☐Emera ☐Affiliate:____

Supply Line Needed: *Replacement Runner Blades-Tusket*

Initiator: Jonathan Lorette Sponsor: _____ Stakeholders: NSPI

Sourcing Strategy: ☐Competitive Bid ☒RFP ☐Sole Source ☐Other:____

OPERATIONAL APPROVALS (Recommendation with signature page attached: ☐Yes ☐No)
(Include Director of IT for Computer Software and Hardware Purchases)

Approver	Title	Reviewed	Date
Jonathan Lorette	Engineering Lead, Hydro	☑	
Paul Warren	Plant Manager, Hydro & Wind Energy	☑	
Craig Sutherland	Director, Procurement & Real Estate	☑	
David Pickles	Director, Power Production	☑	Feb 7/13
		☐	

INTERNAL OPERATING AUTHORITY

Internal Operating Authority is required from the following Approver Category: Choose an item.

Approver	Reviewed	Date
Mark Sidebottom		

CONTRACT DOCUMENT EXECUTION & EXTERNAL COMMITMENT

Supplier: *Weir American Hydro Corporation*

Term: ____ Value: [redacted] Committed Volume of Spend: Y ☐ N ☒

Agreement Type: ☐Partial Supply ☒Supplier of Choice ☐Exclusive ☐Other:____

Review Required →	Y	N	Reviewer Name	Signature	Date
Public Relations	☐	☐			
Environmental	☐	☐			
Safety	☐	☐			
Security	☐	☐			
Finance/Treasury	☐	☐			
Code of Conduct	☐	☐			
Procurement	☐	☐			
Operational	☐	☐			
Legal	☐	☐			
Document Executors:	☐	☐			
	☐	☐			

Please return to Charlene Fraser L4A, Procurement & Real Estate, upon completion

Procurement Recommendation
Replacement Runner Blades - Tusket
December 2012

NOVA SCOTIA POWER
An Emera Company

Submitted To:

Jonathan Lorette, Hydro Engineering Lead
Paul Warren, Plant Manager, Hydro & Wind Energy
Craig Sutherland, Director, Procurement & Real Estate
Dave Pickles, Director, Power Production
Mark Sidebottom, Vice President, Power Generation & Delivery

Recommendation

The evaluation team recommends NSPI issue a Purchase Order to **Weir American Hydro Corporation** for the supply of four (4) replacement runner blades at a total delivered cost of CAD $[redacted] These blades are to be installed at the Tusket generating station during a unit overhaul in 2013.

American Hydro submitted the lowest-cost proposal in response to a Request for Proposals (RFP) issued in October 2012 for the supply of the blades. The unit overhaul was started early in 2012 under a PE to perform a condition assessment and disassemble the unit which was completed in the summer at which time a decision was made to replace the blades due to their condition. The main item submission will be in the 2013 ACE plan as a U&U CI# 42666 (NSPI project H643).

The lead time for delivery of the blades is 40 weeks after receipt of order. Pending approval of the PE project increase, this purchase is to be funded from a Preliminary Engineering (PE) account.

Scope of Supply & Services

- Dimensions of existing blades will be measured by the supplier to re-create blade dimensions and profiles
- The supplier will supply castings and machine four (4) replacement blades.
- The supplier will deliver the completed blades at the Milton Hydro shop.

Background/Drivers

The Tusket Generating Station has been taken out of service. The existing runner blades have been worn by cavitation to the point where they are not suitable for re-installation or economical to repair. Replacement of the blades has been determined to be the best value option to return the unit to service.

Procurement Recommendation
Replacement Runner Blades - Tusket
December 2012

NOVA SCOTIA POWER
An Emera Company

Procurement Process

In October of 2012, Request for Proposals P-12-228 was sent to three potential suppliers: Weir American Hydro Corporation, [redacted]., and [redacted]. Interested suppliers were offered a sample blade for examination. Weir American Hydro and [redacted] both received sample blades. [redacted] initially indicated their intent to respond to the Request for Proposals but did not follow up with shipping information for a sample blade, and declined to participate when NSPI would not extend the deadline for proposals based on a request for extension received the day proposals were due.

Proposal Evaluation

Weir American Hydro and [redacted] both submitted proposals to supply the blades. The proposals were reviewed by an evaluation team consisting of Matt Rondeau from NSPI Technical & Construction Services and Robert Evans from NSPI Procurement. Both suppliers were deemed to have submitted proposals which were acceptable from a technical standpoint and were competitive in price with a similar delivery lead time:

Supplier	Price	Delivery
[redacted]	CAD $[redacted]	35 weeks
Weir American Hydro Corporation	CAD $[redacted]	40 weeks

Based on the proposals submitted, the evaluation team has selected the proposal from Weir American Hydro Corporation as the best value for this procurement. In addition to having the lowest price, NSPI has an existing supply agreement with Weir American Hydro for supply and engineering of complete turbine runner assemblies (of which these blades would be a component). In contrast, while [redacted] is an experienced supplier in the Hydro power industry, NSPI Hydro has no significant experience with them as a supplier.

Conclusion

In addition to having the lowest price, technical compliance and strong experience in hydro turbine runner supply, NSPI's existing relationship and experience with Weir American Hydro in supply of hydro turbine runners provides the best value to NSPI of the proposals received and requests authorization to proceed with the purchase of the replacement runner blades at a total value of CAD $[redacted]

Procurement Recommendation
Replacement Runner Blades - Tusket
December 2012

NOVA SCOTIA POWER
An Emera Company

Prepared By:

Matt Rondeau (Project Manager)
Engineer, Generation Services

Robert Evans
Procurement Lead, Renewables

Reviewed by:

Jonathan Lorette
Engineering Lead, Hydro

Paul Warren
Plant Manager, Hydro & Wind Energy

Craig Sutherland
Director, Procurement & Real Estate

Dave Pickles
Director, Power Production

Approved by:

Mark Sidebottom
VP, Power Generation and Delivery

HYDRO TECH Inc.
www.hydrotech-inc.ca

Job # 1239

PO # 243939

Report for

NOVA SCOTIA POWER
An Emera Company

Tusket #2 Condition Assessment

Hydro Tech Job #1239

HYDRO TECH Inc.
65 Industrial Court B.
Sault Ste. Marie, ON P6B 5Z9
Tel. 705.946.3182 Fax 705.946.8492

June 29, 2012

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3

Visual Inspection Report – AS-Found			
Project #	**1239**	**Project Name**	**Nova Scotia Power _ Tusket-2 Condition Assessment**
Date of Report	**June 26, 2012**	**Completed By**	**Brandon Lyons**

Introduction

Purpose:

Nova Scotia Power contracted Hydro Tech Inc. to perform an Initial Visual Inspection of specific components from Tusket Hydro Station unit #2.

Schedule:

RFP submitted: April 12, 2012

PO issued: June 4, 2012

Inspection executed: June 18 – June 22, 2012

Report worked: June 25 – June 29, 2012

Plan:

Below is the Step-by-Step plan that was required per the contract and outlines the general actions taken during the inspection.

1) PO Issued by NSPI

2) Planning
   a. Review dwgs
   b. Review any available pics
   c. Review any other relevant docs

3) Travel to place where all of the components are disassembled, laid out, cleaned and ready for inspection:

   - Milton Heavy Maintenance Shop
   - 14 River Rd.
   - Milton, Nova Scotia B0T 1P0

4) Safety:
   a. Site Orientation provided by NSPI at Hydro Tech's arrival to inspection area

5) Components receiving the initial AS-FOUND Visual Inspections
   a. Operating Ring
   b. Wicket Gate Bushings
   c. Push/Pull Rods
   d. Quadrant Shaft (Gov Shaft)
   e. Headcover
   f. Throat Ring
   g. Wicket Gates (qty 16)
   h. Wicket Gate Links
   i. Runner Blades
   j. Runner Blade Seals
   k. Kaplan Head

6) Clarifications of inspection
   a. This inspection includes an initial AS-FOUND visual inspection only
   b. This inspection does not include dimensional inspections
   c. This inspection does not include inspections that require the component to be in machines (such as a Vertical Boring Mill or a Lathe)
   d. NDE services is not included as part of this inspection
   e. FARO services is not included as part of this inspection
   f. The engineering/design of the repairs is not included as part of this inspection
   g. This inspection includes only the components listed above - section **"5) Components receiving the initial AS-FOUND Visual Inspections"**
   h. Any additional components needing inspection or inspections at the Tusket Station will be considered "out-of-scope" work.
   i. This "out-of-scope" work will be completed on a T&M basis per the included Hydro Tech rate sheet.
   j. "Out-of-scope" work will not be completed without Hydro Tech formally communicating this "out-of-scope" work on a Hydro Tech supplied Extra Work Authorization (EWA) form and receiving approval through an NSPI signature on the form.

7) Travel from NSPI's Milton Heavy Maintenance Shop to Hydro Tech office

8) Report

a. The report will be completed from the Hydro Tech office approximately (3) business days after completing the shop inspection
b. After NSPI has an opportunity to review the report, Hydro Tech will attend a follow up conference call to discuss any questions and the proposed direction going forward

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3

Visual Inspection Report – AS-Found			
Project #	**1239**	**Project Name**	**Nova Scotia Power _ Tusket-2 Condition Assessment**
Date of Report	**June 26, 2012**	**Completed By**	**Brandon Lyons**

TABLE OF CONTENTS

- **Introduction**
- **Table of Contents**
- **Non-Conforming Quality Control Reports = (NCR)**
  - NCR-001 _ Operating Ring – Surface Condition
  - NCR-002 _ Wicket Gate – Surface Condition
  - NCR-003 _ Wicket Gates – Old Coating
  - NCR-004 _ Wicket Gates – Heights and End Seals
  - NCR-005 _ Wicket Gates – Broken Corners
  - NCR-006 _ Wicket Gate Links
  - NCR-007 _ Wicket Gate #1 – Pin Holes
  - NCR-008 _ Wicket Gate Seals
  - NCR-009 _ Wicket Gate Bushings
  - NCR-010 _ Upper Wicket Gate Stem Bushing Wear
  - NCR-011 _ Push-Pull Rods – General Condition
  - NCR-012 _ Push-Pull Rod – Bushings
  - NCR-013 _ Quadrant Shaft – General Condition
  - NCR-014 _ Runner Blade Seals – Nonexistent
  - NCR-015 _ Runner Blades – Cavitation Damage
  - NCR-016 _ Turbine Guide Bearing Blocks
  - NCR-017 _ Wicket Gate Stems
  - NCR-018 _ Wicket Gate Link Pins
  - NCR-019 _ Operating Ring – Bushings
  - NCR-020 _ Operating Ring – Wear pads
  - NCR-021 _ Operating Ring – Wicket Gate wear
  - NCR-022 _ Throat Ring – Material
  - NCR-023 _ Throat Ring - Measurements
  - NCR-024 _ Headcover – Coating Issues
  - NCR-025 _ Headcover – Broken TGB Fit
  - NCR-026 _ Headcover – Wear Indications
  - NCR-027 _ Headcover – Flange Indications
  - NCR-028 _ Headcover – Hardware & Dimensional Verification
  - NCR-029 _ Kaplan Hub – Dimensional Checks

- NCR-030 _ Kaplan Hub – Bushings
- NCR-031 _ Hub Material in Bushing Grooves
- NCR-032 _ Hub – Pitting & Coating
- NCR-033 _ Hub – Nose-cone, Clamp, Linkage & Hardware
- NCR-034 _ Bottom Plate - Operating Ring running surfaces
- NCR-035 _ Bottom Plate - Wicket Gate Rod holes

- **Corrective Action Recommendations = (CAR)**
  - CAR-001 _ Operating Ring – Surface Condition
  - CAR-002 _ Wicket Gate – Surface Condition
  - CAR-003 _ Wicket Gates – Old Coating
  - CAR-004 _ Wicket Gates – Heights and End Seals
  - CAR-005 _ Wicket Gates – Broken Corners
  - CAR-006 _ Wicket Gate Links
  - CAR-007 _ Wicket Gate #1 – Pin Holes
  - CAR-008 _ Wicket Gate Seals
  - CAR-009 _ Wicket Gate Bushings
  - CAR-010 _ Upper Wicket Gate Stem Bushing Wear
  - CAR-011 _ Push-Pull Rods – General Condition
  - CAR-012 _ Push-Pull Rod – Bushings
  - CAR-013 _ Quadrant Shaft – General Condition
  - CAR-014 _ Runner Blade Seals – Nonexistent
  - CAR-015 _ Runner Blades – Cavitation Damage
  - CAR-016 _ Wicket Gates
  - CAR-017 _ Turbine Guide Bearing Blocks
  - CAR-018 _ Wicket Gate Rods
  - CAR-019 _ Wicket Gate Link Pins
  - CAR-020 _ Operating Ring – Bushings
  - CAR-021 _ Operating Ring – Wear pads
  - CAR-022 _ Operating Ring – Wicket Gate wear
  - CAR-023 _ Throat Ring – Material
  - CAR-024 _ Throat Ring - Measurements
  - CAR-025 _ Headcover – Coating Issues
  - CAR-026 _ Headcover – Broken TGB Fit
  - CAR-027 _ Headcover – Wear Indications
  - CAR-028 _ Headcover – Flange Indications
  - CAR-029 _ Headcover – Hardware & Dimensional Verification

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 3

Visual Inspection Report – AS-Found

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment

- CAR-030 _ Kaplan Hub – Dimensional Checks
- CAR-031 _ Kaplan Hub – Bushings
- CAR-032 _ Hub Material in Bushing Grooves
- CAR-033 _ Hub – Pitting & Coating
- CAR-034 _ Hub – Nose-cone, Clamp, Linkage & Hardware
- CAR-035 _ Bottom Plate - Operating Ring running surfaces
- CAR-036 _ Bottom Plate - Wicket Gate Rod holes

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3	
	NCR #	1239 - 001

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Operating Ring - Surface Condition



Pitting on top surface of Operating Ring (typical of entire surface)
Pit depth range = 1/32” – 1/4” (approximately)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 3	
	NCR #	1239 - 001

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



General Surface Condition – Pic #1



General Surface Condition – Pic #2

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 3	
	NCR #	1239 - 001

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



General Surface Condition – Pic #3



General Surface Condition – Pic #4

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 5	
	NCR #	1239 - 002

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Wicket Gates - Surface Pitting



Pitting on surface of Wicket Gate (typical)
Pit depth range = 1/32" – 1/4" (approximately)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 5	
	NCR #	1239 - 002

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #15 – Pitting _ Up-stream side, Bottom end, Leading Edge



Wicket Gate #12 – Pitting _ Up-stream side, Bottom end, Leading Edge

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 5	
	NCR #	1239 - 002

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #12 – Pitting _ Down-stream side, Top end, Leading Edge



Wicket Gate #11 – Pitting on Up-stream side

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 4 of 5	
	NCR #	1239 - 002

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #11 – Pitting on Down-stream side



Wicket Gate #9 – Pitting _ Up-stream side, Bottom end, Leading Edge

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 5 of 5	
	NCR #	1239 - 002

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment





Wicket Gate #7 – Pitting on Down-stream side



Wicket Gate #16 – Pitting on Up-stream side

The worst pitting is concentrated on this Up-Stream corner towards the Bottom end, Leading Edge (common location of the worst pitting on all 16 Wicket Gates)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	NCR #	1239 - 003

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Wicket Gates – Old Coating



Old Coating was not completely removed after the initial blasting effort

This Visual Inspection was completed with the gates in this partially coated condition.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 7	
	NCR #	1239 - 004

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Wicket Gates – Heights & End Seals



Wicket Gate Heights measured with a tape

Note: Ends were not found to be in good condition on many gates (jagged), so using a set of verniers would not have added any value, and in fact, may have been misleading. As you moved from Leading Edge to Trailing Edge, the heights increased then decreased many times because of the jagged profile that exists.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 7	
	NCR #	1239 - 004

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #3 – General overview Bottom End



Wicket Gate #3 – Top End in good condition (Typical on all gates)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 7	
	NCR #	1239 - 004

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #3 – Bottom End Leading Edge – pic-1



Wicket Gate #3 – Bottom End Leading Edge – pic-2

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 4 of 7	
	NCR #	1239 - 004

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #13 – Bottom End, Leading Edge



Wicket Gate #16 – Bottom End, Leading Edge

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 5 of 7	
	NCR #	1239 - 004

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #15 – Bottom End, Leading Edge



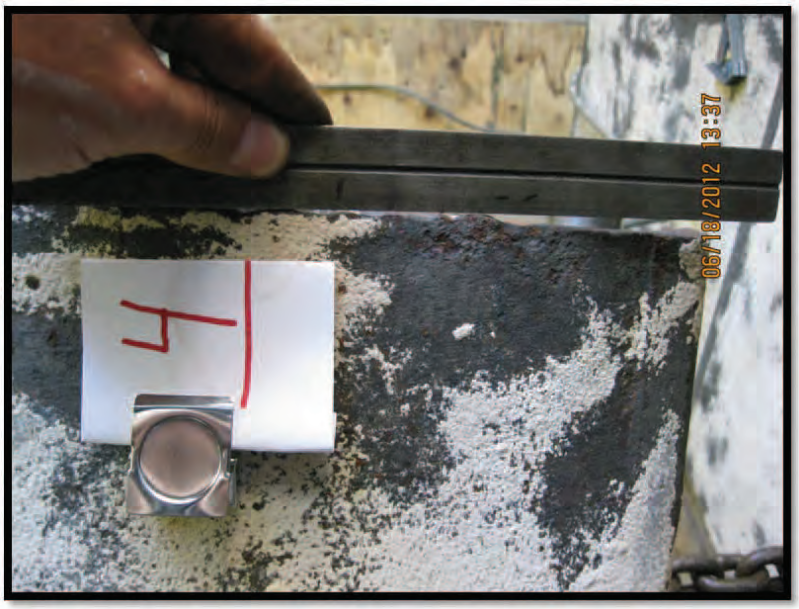
Wicket Gate #2 – Bottom End, Leading Edge

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 6 of 7	
	NCR #	1239 - 004

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #4 – Bottom End, Leading Edge



Wicket Gate #5 – Bottom End, Leading Edge

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 7 of 7	
NCR #	1239 - 004

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment

NSP Tusket-2 - Wicket Gate heights - AS-FOUND

Date: 6/22/2012

Tool used to Measure:	Tape Measure
Measurements taken by:	NSP & HT
Measurements verified by:	HT - Brandon Lyons

Gate Height Spec =	**29-5/32" = 29.156"**	per dwg # H-009W1-9-411-00-019

Wicket Gate #	Leading Edge Height (inches)	Trailing Edge Height (inches)	Delta (spec - smallest)	Notes
1	29-1/32"	29-3/32"	1/8"	>Minor - Bottom Seal Pitted/Jagged/Worn >Pin holes discovered on Dwn-strm side/face
2	28-15/16"	29-1/16"	7/32"	Major - Bottom Seal Pitting/Erosion/Wear
3	28-13/16"	29-1/16"	9/32"	Major - Bottom Seal Pitting/Erosion/Wear
4	28-15/16"	29-1/16"	7/32"	Major - Bottom Seal Pitting/Erosion/Wear
5	29-1/16"	29-3/32"	3/32"	Major - Bottom Seal Pitting/Erosion/Wear
6	29-1/16"	29-1/16"	3/32"	Major - Bottom Seal Pitting/Erosion/Wear
7	29-3/32"	29-1/16"	3/32"	Minor - Bottom Seal Pitting & Wear
8	29-1/16"	29-1/8"	3/32"	Minor - Bottom Seal Pitting & Wear
9	29-1/16"	29-1/16"	3/32"	>Minor - Bottom Seal Pitting & Wear >Broken Corner on Bottom Seal, Dwn-strm side on Leading Edge
10	29-1/16"	29-1/8"	3/32"	>Minor - Bottom Seal Pitting & Wear >Broken Corner on Bottom Seal, Dwn-strm side on Leading Edge
11	29"	29-1/16"	5/35"	Major - Bottom Seal Pitting/Erosion/Wear
12	29-1/16"	29-3/32"	3/32"	Minor - Bottom Seal Pitting & Wear
13	29-1/16"	29-3/32"	3/32"	Major - Bottom Seal Pitting/Erosion/Wear
14	29-1/16"	29-1/16"	3/32"	>Minor - Bottom Seal Pitting & Wear >Broken Corner on Bottom Seal, Dwn-strm side on Leading Edge
15	29-1/32"	29-1/8"	1/8"	Major - Bottom Seal Pitting/Erosion/Wear
16	29-1/16"	29-1/16"	3/32"	Major - Bottom Seal Pitting/Erosion/Wear

NOTE: 1) Gates highlighted yellow recommend the ends to be built up to Spec = 29-5/32"

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3	
	NCR #	1239 - 005

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Wicket Gates – Broken Corners







Wicket Gate #10 – Broken Corner – (typical size & location on gates 9, 10 & 14)

Note: Broken Corners on the Bottom End, Leading Edge, Down-Stream Side likely caused by the Gate contacting the Operating Ring at some point.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 3	
	NCR #	1239 - 005

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #10 – Broken Corner – (close-up)



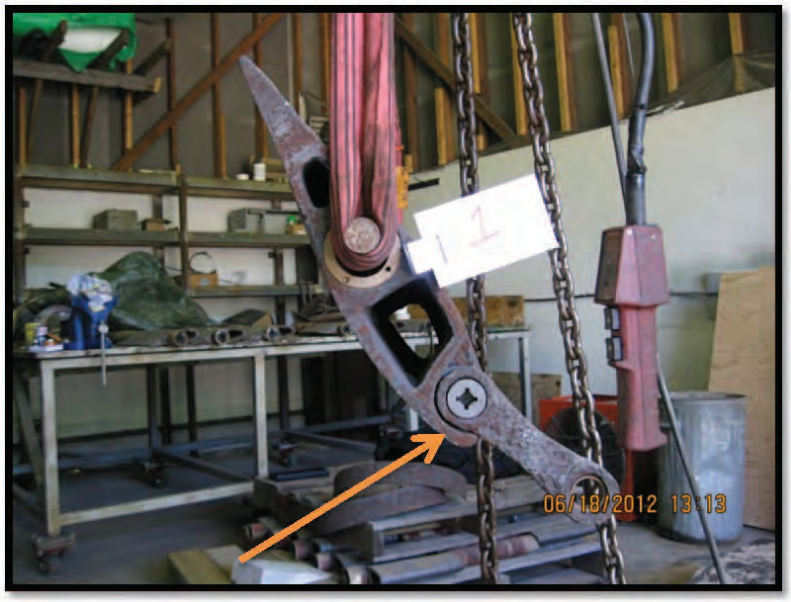
Wicket Gate #9 – Broken Corner

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 3	
	NCR #	1239 - 005

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #1 – Corner NOT broken



Wicket Gate #14 – Broken Corner

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 2	
	NCR #	1239 – 006

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑	Complete CAR Form

Wicket Gates Links



Wicket Gate Link #11 – (typical condition of all links)

Note: All Wicket Gate Links are very pitted and worn likely due to corrosion & erosion.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 2	
	NCR #	1239 – 006

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment





Wicket Gate Link removed from Gate





Wicket Gate Link #6 was the only one found broken during the inspection

Note: This broken link appeared to be a relatively new break.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 2	
	NCR #	1239 - 007

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Wicket Gate #1 – Pin Holes



Wicket Gate #1 – Pin holes discovered on the Down-Stream Face/Side

Note: These Pin holes were discovered prior to a proper abrasive blast. Therefore, these holes could potentially be larger and more of them could be visible after a proper abrasive blast of the Wicket Gates.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 2 of 2	
NCR #	1239 - 007

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #1 – Pin Holes up to ~ 3/32” – 1/8” diameter





Wicket Gate #1 – More Pin Holes to scale

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 5	
	NCR #	1239 – 008

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Wicket Gate Seals



Wicket Gate #11 – Trailing Edge Seal



Wicket Gate #11 – Leading Edge Seal

Notes:

- Pitting & Corrosion: The Wicket Gate Seals are pitted due to corrosion and/or erosion through the many years of operation.
- Coating: The old coating has failed in many locations.
- Sealing: The combination of the pitting and the partial coating along the seals was likely preventing a good seal during shut-down.
- Risks if nothing is done to repair the seals:
  - Operational & Cost Risk -> Erosion rate increases
  - Maintenance Cost Risk -> Higher rehab costs next overhaul
  - Operational & Cost Risk -> Continual loss of water when shut-down
- See pics for general representative condition of all (16) sets of Wicket Gate Seals.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 5	
	NCR #	1239 – 008

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #11 – Leading Edge Seal – Corrosion & Old Coating



Wicket Gate #9 – Trailing Edge Seal

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 5	
	NCR #	1239 – 008

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #9 – Trailing Edge Seal – Old repair failing



Wicket Gate #9 – Leading Edge Seal approx. 1” wide & broke on Bottom End

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 4 of 5	
	NCR #	1239 – 008

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #12 – Leading Edge Seal – Pitting



Wicket Gate #12 – Trailing Edge Seal

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 5 of 5	
	NCR #	1239 – 008

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate #16 – Down-Stream side, Trailing Edge – Pitting

Note: This edge on Wicket Gate #16 in the pic above is not a sealing surface. However, if the trailing edge were to be repaired to fix the seal, this pitting would also be removed during the repair process.



Wicket Gate #14 – Trailing Edge Seal

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3	
	NCR #	1239 – 009

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Wicket Gate Bushings



Wicket Gate Bushings – (2) per Gate

Note:

- There is a bushing located at the top and bottom of each Wicket Gate.
- These bushings appear to show signs of wear.
- Measurements should be taken to record and verify actual wear.
- Thrust Face of bottom bushing show be measured to record how far below gate it is set.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 3	
	NCR #	1239 – 009

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Top Wicket Gate Bushing



Bottom Wicket Gate Bushing

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 3	
	NCR #	1239 – 009

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Top Wicket Gate Bushing



Bottom Wicket Gate Bushing

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3	
	NCR #	1239 – 010

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Upper Wicket Gate Stem Bushing wear or rubbing



Upper Wicket Gate Stem Bronze Bushings
(2-1/2" Bushings – 4 Threads per inch)

Notes:

- (2) issues noted during inspection:
  - Signs of wear or rubbing on ID
  - Thread deformation on Bushing #13

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 3	
	NCR #	1239 – 010

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Upper Wicket Gate Bushing



Appears to be signs of wear or rubbing on the ID of Bushings

NOTE: the Wicket Gate Stem is typically stationary during normal operation

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

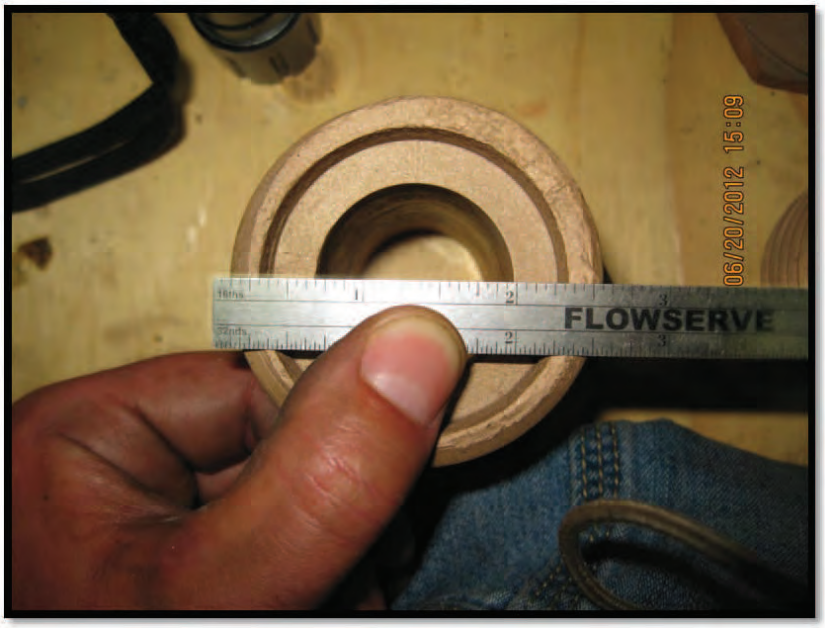
HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 3	
	NCR #	1239 – 010

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Bushing #13 – only one with visual Thread deformation



Upper Wicket Gate Stem Busing – bottom end

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3	
	NCR #	1239 – 011

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Push-Pull Rods – General Condition



(2) Push-Pull Rods – connect the Quadrant Shaft (Gov. Regulating Shaft) to the Operating Ring

Note: These Rods had the old coating on them and the old bushing installed at the time of the visual inspection.

Precise **Push-Pull Rod Condition** is difficult to determine for certain with the heavy coat of paint and corrosion that was on the Push-Pull rods at the time of the inspection.
However, it is likely that these Push-Pull Rods are **near the end-of-life** based on the visual inspection. The coating was not smooth, indicating that it was most likely applied over large pits and divits in the base material. Also the threads appeared to have a lot of old paint and corrosion on them limiting their adjustability.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 3	
	NCR #	1239 – 011

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Push-Pull Rods ends



Heavy coat of paint, corrosion and pitting

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 3	
	NCR #	1239 – 011

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Push-Pull Rods – Heavy coat of paint and corrosion would prevent adjustment



Push-Pull Rod – Overall Lengths differ by approx. ½”

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 2	
	NCR #	1239 – 012

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Push-Pull Rod - Bushings



Push-Pull Rod Bushings – Visible wear noted in bushing bores

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 2	
	NCR #	1239 – 012

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Push-Pull Rod Bushing on end that connects to Operating Ring



Push-Pull Rod Bushing on end that connects to Quadrant Shaft (Gov. Regulating Shaft)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 5	
	NCR #	1239 – 013

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Quadrant Shaft – General Condition





Quadrant Shaft installed – floor penetration from Turbine Level into Scroll Case

Notes:

- The visual inspection was completed on a best effort basis while it was installed at the station
- NSP decided to leave this shaft installed based on their condition assessment
- The Quadrant Shaft appeared to be in good condition overall, however further investigation should be completed in (2) areas
  - 1) Packing area – should be cleaned and thoroughly inspected
  - 2) Bottom end in scroll case – should be cleaned and thoroughly inspected

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

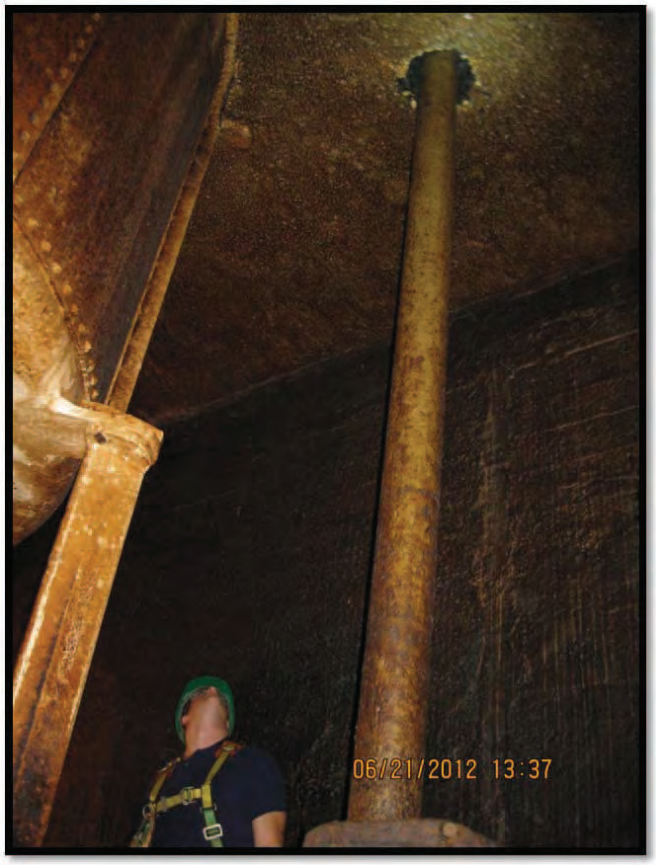
HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 2 of 5

NCR #	1239 – 013

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Quadrant Shaft penetration into Scroll Case



Bottom end of Quadrant Shaft in Scroll Case

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 5	
	NCR #	1239 – 013

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Bottom end of Quadrant shaft



Smooth area identified on Shaft

Note: The coating on the Quadrant Shaft appears to be in good condition, however, the coating on the Clevis and bottom support end does not appear to be in as good condition.



Bottom end of Quadrant shaft where the Push-Pull rods connect – (Clevis)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 4 of 5	
NCR #	1239 – 013

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



OD of Quadrant Shaft is ~5-6 inches



Clevis - location where one of the Push-Pull rods attach to the Quadrant Shaft

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 5 of 5	
	NCR #	1239 – 013

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



(2) Grease fittings 180 degrees apart at the bottom of the installed Quadrant Shaft Assembly

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 4	
	NCR #	1239 - 014

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Runner Blade Seals – Nonexistent



Runner Blade Trunions

Notes:

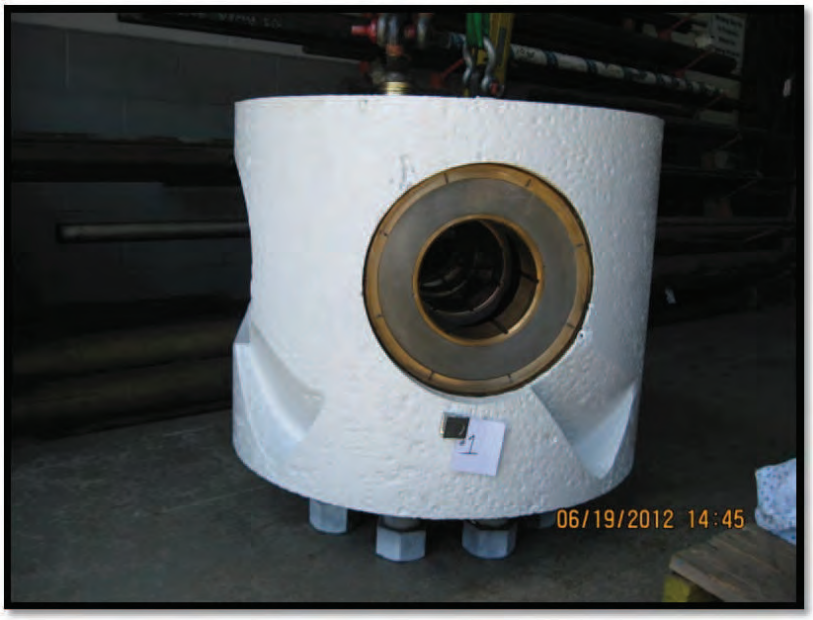
- Runner was found with no Runner Blade Seals
- NSP stopped using Hydraulic Oil and Blade Seals because of leakage issues in the past
- NSP has been using grease in place of the Hydraulic Oil with no seals
- NSP Engineering would like to convert back to using Hydraulic Oil and a new seal design

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 4	
	NCR #	1239 - 014

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Runner Hub



Runner Hub Outer Bushing configuration

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 4	
	NCR #	1239 - 014

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Outer Bushing – signs of wear



Hub – Corrosion & Pitting

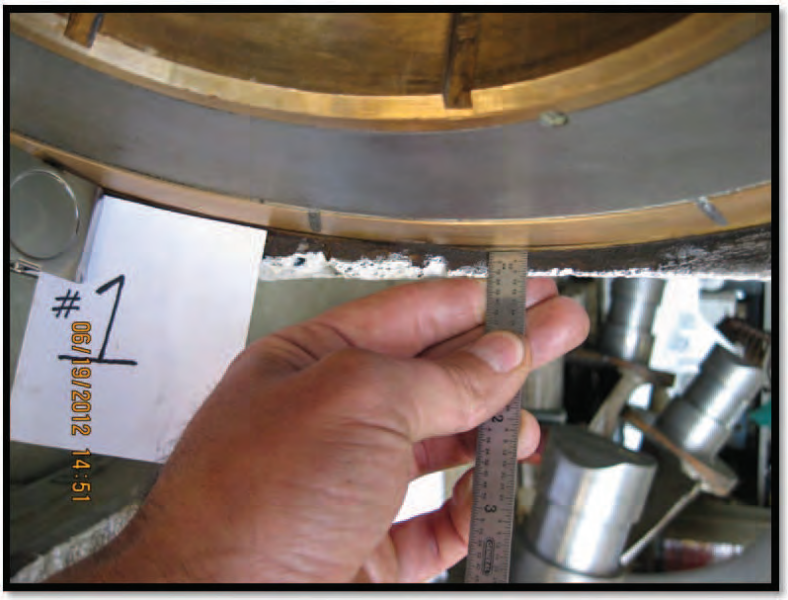
Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 4 of 4	
NCR #	1239 - 014

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Approx ¼" from Flat Bushing to Outer surface of Hub



Grease from Hub – used during operation to stroke Blades

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 9	
	NCR #	1239 - 015

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑	Complete CAR Form

Runner Blades – Cavitation Damage



Blade #1 – Cavitation Damage on down-stream side

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 9	
	NCR #	1239 - 015

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Blade #1 Down-Stream side, Trailing Edge



Blade #1 – Down-Stream side w/ Scale

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

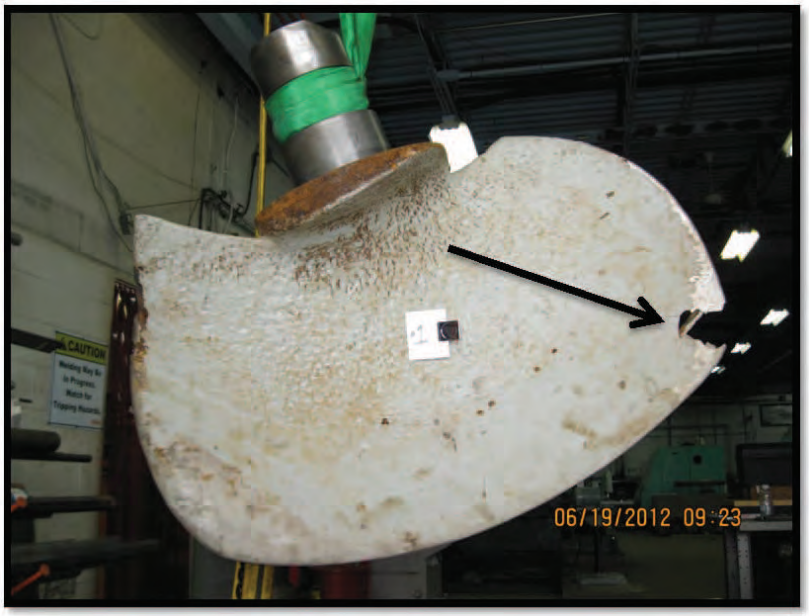
HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 9	
	NCR #	1239 - 015

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Blade #1 – Down-Stream side Cavitation near Trunion



Blade #1 – Up-Stream side – broken piece

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 4 of 9	
	NCR #	1239 - 015

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Blade #2 – Down-Stream side Cavitation & old repair failure



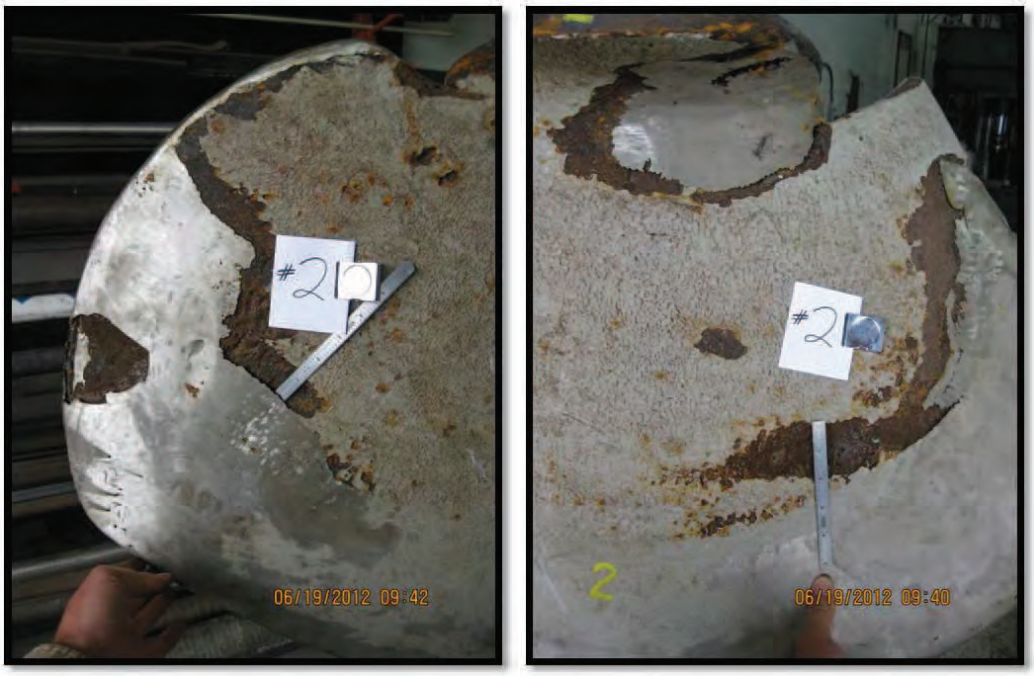
Blade #2 – Cavitation near Trunion (hollow area under old SS repair)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 5 of 9	
	NCR #	1239 - 015

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Blade #2 – Down Stream Side Cavitation & Old SS repair failures



Blade #2 – Up-Stream side

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 6 of 9	
	NCR #	1239 - 015

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Blade #3 Down-Stream side



Blade #3 Down-Stream side Cavitation

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 7 of 9

NCR #	1239 - 015

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Blade #3 – Trailing Edge, DS side



Blade #3 – Leading Edge, US side



Blade #3 – DS side near Trunion

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 8 of 9	
	NCR #	1239 - 015

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Blade #4 – Down-Stream side



Blade #4 Down-Stream Cavitation & old repair failure

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 9 of 9	
NCR #	1239 - 015

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Blade #4 – Cavitation near Trunion



Blade #4 – Up-Stream Side





Blade #4 Trailing Edge

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3	
	NCR #	1239 - 016

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑	Complete CAR Form

Turbine Guide Bearing Blocks



Wooden Turbine Guide Bearing Blocks (most likely Lignum Vitae)

Note: The NSP crew is currently planning to replace these bearing blocks.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 2 of 3

NCR #	1239 - 016

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



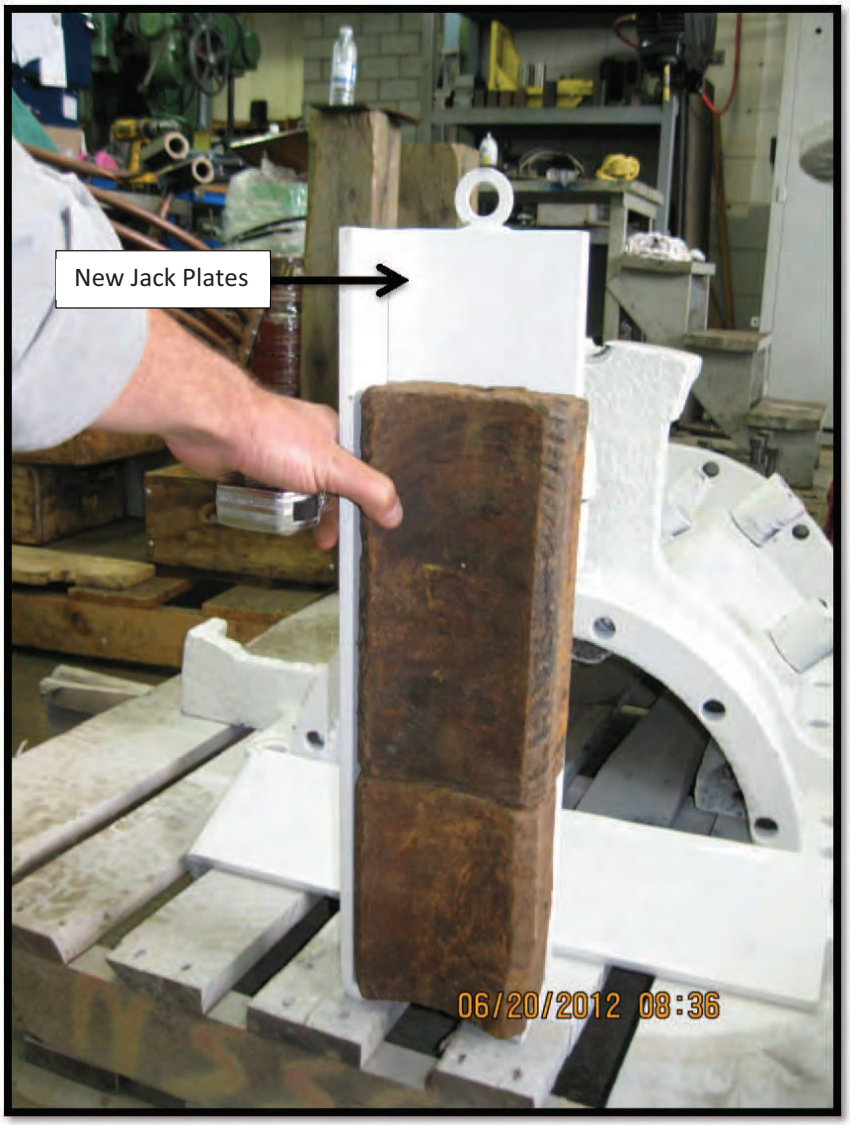
Old Wooden Blocks – broken blocks, short blocks, cracked & worn blocks

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 3	
	NCR #	1239 - 016

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Many sections/pieces stacked would make up a Turbine Bearing "Block"

At least (3) wooden block sections needed in the visual example above

Also note the new jack plates the NSP crew fabricated for the TGB (Turbine Guide Bearing)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3	
	NCR #	1239 - 017

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Wicket Gate – Rods



(16) Wicket Gate Rods w/ SS journals on each end

Note:

- NSP already plans to replace the Wicket Gate Rods with new based on their own assessment

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

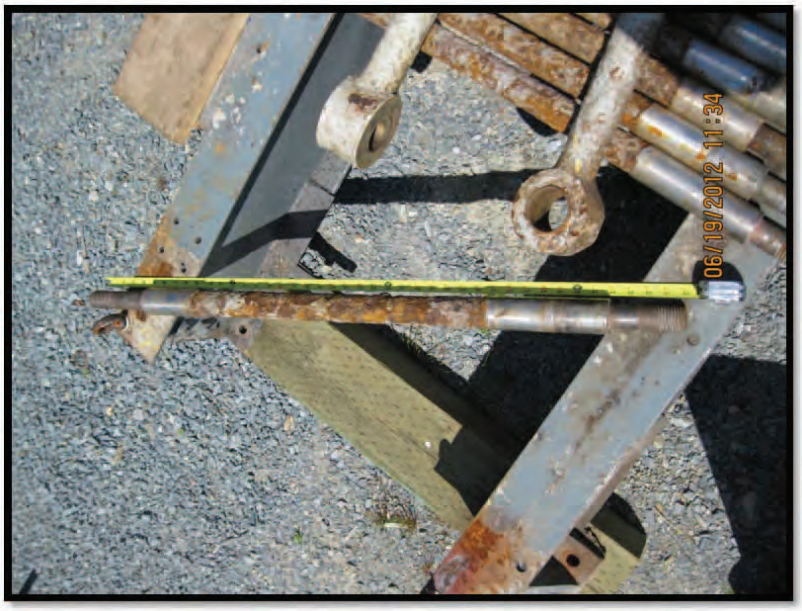
HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 2 of 3

NCR #	1239 - 017

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate Rod



Wicket Gate Rod Journal

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 3	
	NCR #	1239 - 017

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate Rod – Corrosion & Pitting



Wicket Gate Rods – note the different length journals (top and bottom ends)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 2	
	NCR #	1239 - 018

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐		Yes ☑ Complete CAR Form

Wicket Gate Link Pins



Wicket Gate Link Pin – Gate end

Note:

- Wicket Gate Link Pins were not removed for inspection, however one was removed for a quick visual

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 2	
	NCR #	1239 - 018

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wicket Gate Link Pin installed in Gate w/ Link removed



Wicket Gate Link Pin – removed from Gate

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 2	
	NCR #	1239 - 019

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Operating Ring – Bushings



Bottom view



Top view

Operating Ring Bushings

Note:

- NSP is currently planning on replacing these Operating Ring bushings which is always a good idea during a major overhaul
- Bushing visually appeared to be worn

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 2	
	NCR #	1239 - 019

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Operating Ring Bushing – top view



Operating Ring Bushing – w/ scale

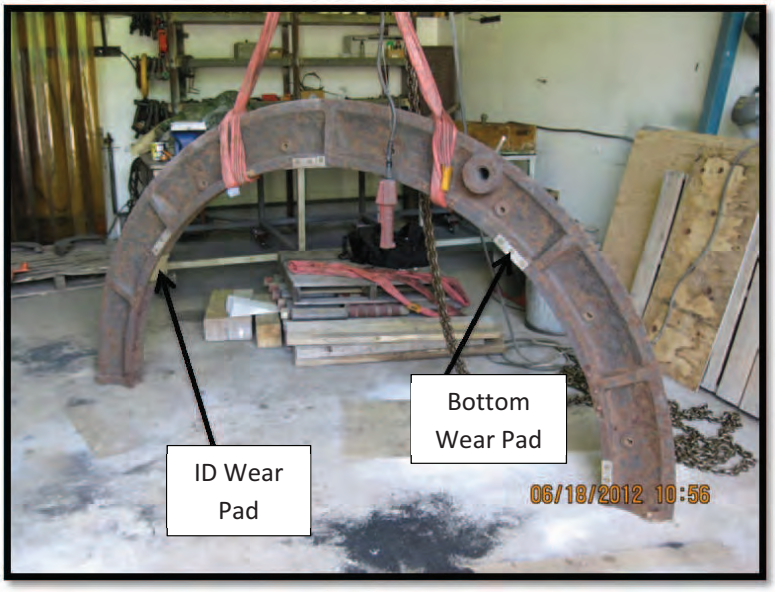
Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 6	
	NCR #	1239 - 020

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Operating Ring – Wear Pads



Notes:

- NSP is currently planning on replacing these Operating Ring wear pads which is always a good idea during a major overhaul
- Some Wear Pads visually worn – others do not look like they have been touched
  - This is the same for each set of wear pads. (ID set & Bottom set)
- Bronze wear pads are located on the ID of the Operating Ring
  - They were installed during a past overhaul and all relocated on the wear pad circle from the original OEM pad locations. This is obvious from seeing part of the old wear pad fasteners still in the bottom of the Operating Ring (see pics below).
- Plastic Wear pads are located on the bottom side of the Operating Ring
  - These were installed during a past overhaul and also all relocated on the wear pad circle. Again note the old fasteners still in the Operating Ring from original OEM.
- Plastic Wear Pads are not OEM material. The OEM dwg calls for “Bronze Wear Plates” in both locations (ID & Bottom).
- Also note the loose & missing fasteners in the currently installed wear pads.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 2 of 6

NCR #	1239 – 020

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Bottom view



Top view

Operating Ring Wear Pads



Loose fastener on Wear Pad

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 6	
	NCR #	1239 – 020

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Missing Fastener – never installed (no threaded hole in Operating Ring)



Fastener head above Wear Pad surface

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 4 of 6	
	NCR #	1239 – 020

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Operating Ring Wear Pads – view of both bottom and ID pads



Uneven Wear on Plastic Pad (bottom of operating ring)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 5 of 6	
	NCR #	1239 – 020

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Uneven Wear on Plastic Pad (bottom of operating ring)
(Close-up of same pad in pic above)



2nd Example of Uneven Wear on Plastic Pads

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 6 of 6	
NCR #	1239 – 020

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Non-OEM plastic Wear Pad



Bronze OEM Wear Pad removed from bottom location – remains of old pad in pic above (bottom location where plastic Wear Pads are currently installed)

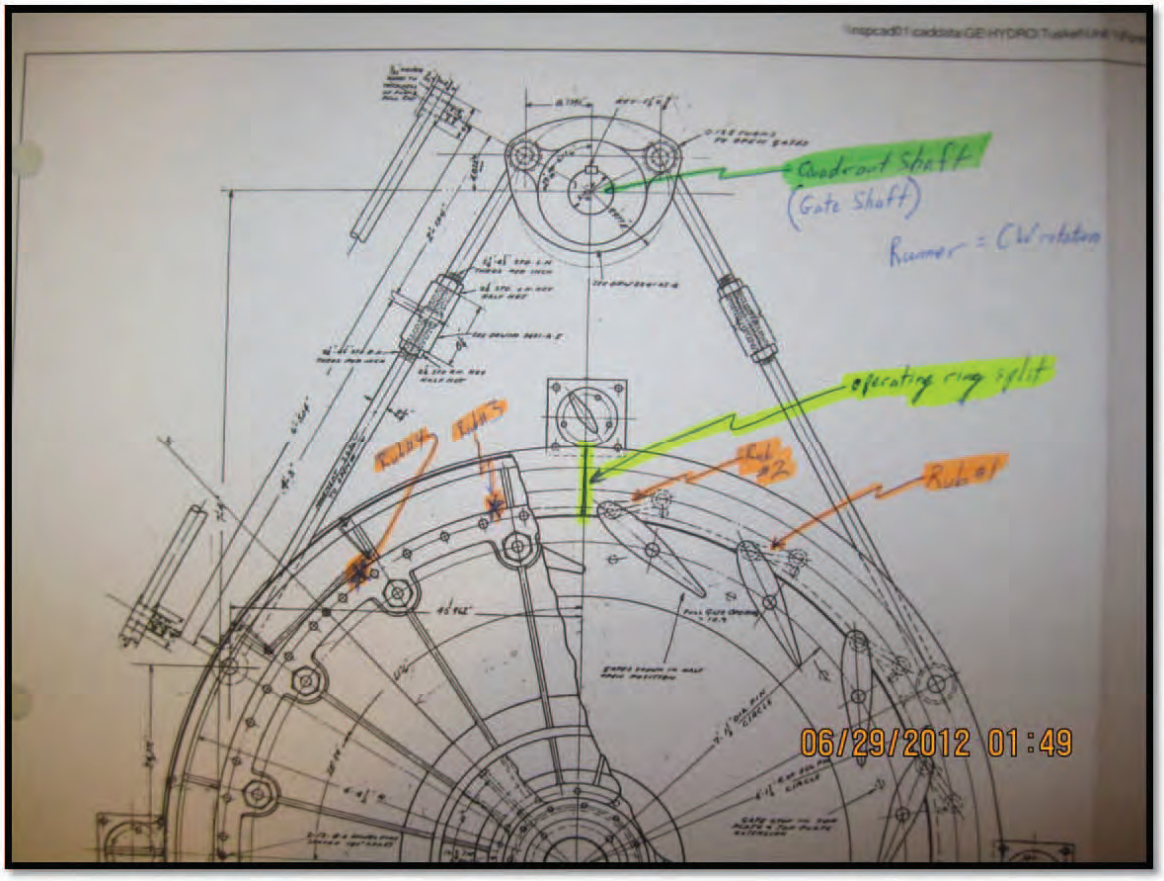
Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 5	
	NCR #	1239 - 021

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Operating Ring – Wicket Gate wear indications



Notes:

- Wear from the Wicket Gates was discovered in (4) locations on the Operating Ring.
- (2) locations per half caused by the (2) Wicket Gates on either side of the Operating Ring Split that is in-line with the Quadrant Shaft. (see pic of dwg above)
- NSP had noted issues at the Operating Ring splits during operation.
- NSP also noted that many of the bottom wear pads were not touching the embedded Bottom Plate running surface.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 5	
	NCR #	1239 – 021

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Upstream Operating Ring half – (2) rub/wear indications near split



Downstream Operating Ring half – (2) rub/wear indications near split

Note: All (4) indications are CW of the Link pin holes in the Operating Ring

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 5	
	NCR #	1239 – 021

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Rub #1 (from pic of dwg above)





Rub #2 (from pic of dwg above)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 4 of 5	
	NCR #	1239 – 021

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Rub #2 (from pic of dwg above) – Approx ¼" deep



Bottom End, Leading Edge of Gate rubbing the Operating Ring

Note: This is the piece/section that is broke on (3) Wicket Gates

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 5 of 5	
	NCR #	1239 – 021

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Rub #3 (from pic of dwg above)



Rub #4 (from pic of dwg above)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	NCR #	1239 - 022

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Throat Ring - Material



Throat Ring appears to be Stainless Steel

Note:

- OEM dwg indicates that this entire Bottom Plate/Throat Ring Assembly (which is one component) is Cast Iron.
- S. Morgan Smith dwg # 3630-CA
- NSP dwg # H-009W1-9-411-00-017

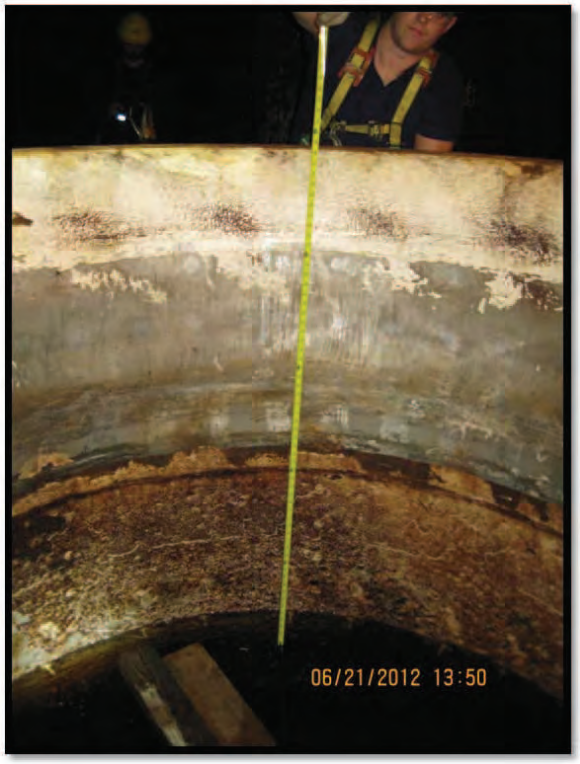
Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 4	
	NCR #	1239 - 023

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Throat Ring - Measurements



Throat Ring

Note:

- There is a 36.125” rad in this Throat Ring – this needs to be verified
- Stationary Survey:
  - Dimensional checks should be performed while all of the rotating components are removed to verify the component is within spec and help determine if any and how maintenance is required.

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 4	
	NCR #	1239 – 023

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Looking down on the Throat Ring



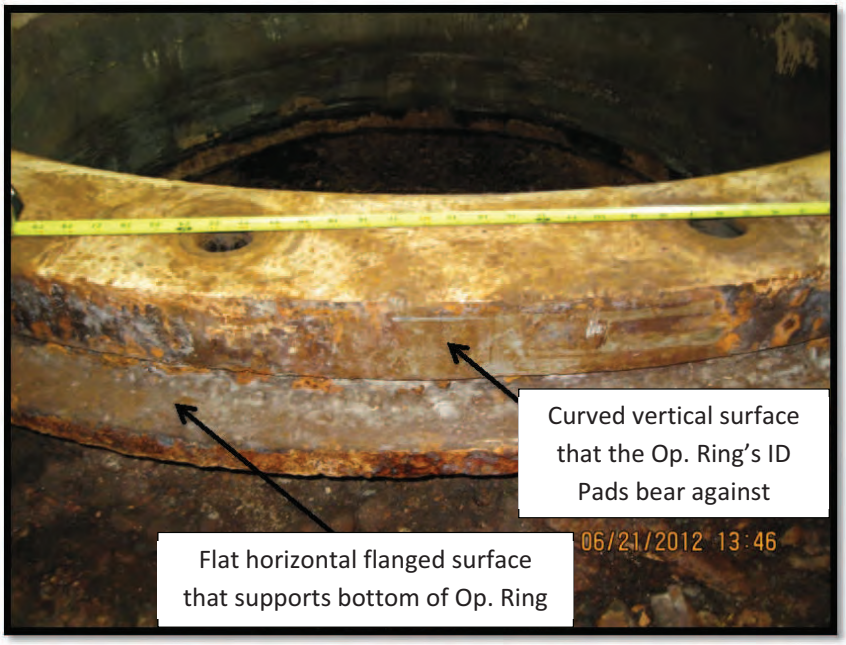
Top of Throat Ring (Bottom Plate)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 4	
	NCR #	1239 – 023

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Bottom Ring surfaces that were in contact with Operating Ring wear pads

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 4 of 4	
	NCR #	1239 – 023

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Appears to be Grinding marks in Throat Ring

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3	
	NCR #	1239 - 024

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐		Yes ☑ Complete CAR Form

Headcover – Coating Issues



Headcover

Note:

- The Headcover was coated prior to the visual inspection
  - Therefore the visual inspection was severely limited
- The coating was applied in areas that should have been taped-off
  - Flange surface
  - Headcover stud holes (along with jack-bolt & dowel holes)
  - Headcover Upper Wicket Gate Bushing threads
  - Etc…
- The current coating does not fill in the pits and create a smooth surface

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 3	
	NCR #	1239 – 024

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Paint on Headcover Flange & in Threads



Paint in Upper Wicket Gate Bushing Threads

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 3	
	NCR #	1239 – 024

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Pitting can be seen through coating



Visual Inspection is severely limited by coating

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 2	
	NCR #	1239 - 025

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Headcover – Broken TGB Fit



Headcover – Broken Piece at Turbine Guide Bearing Fit

Note:

- Upper Fit in the Headcover for the Turbine Guide Bearing consists of (4) locations around the bore where (4) separate TGB Housing Support Arms fit
- One of these (4) fit areas has a broken piece
- The broken piece is at one of the (2) TGB fit locations that has a dowel

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 2	
	NCR #	1239 – 025

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



TGB Fit – Broken Piece



Broken Piece shown with Straight Edge

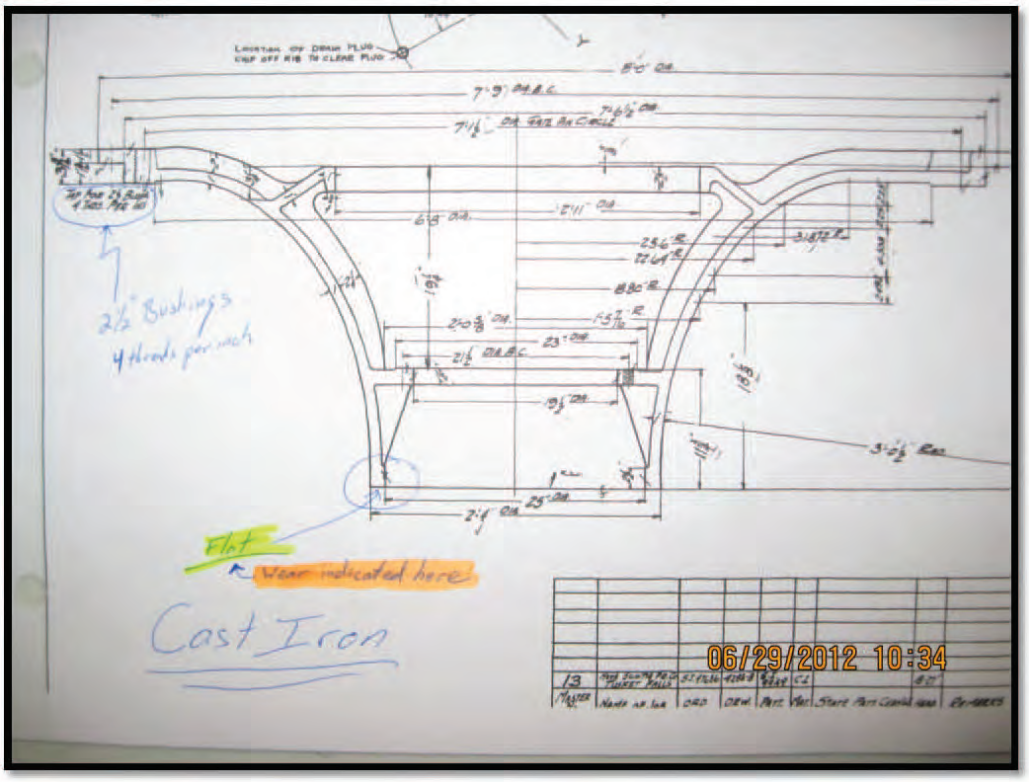
Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 2	
	NCR #	1239 - 026

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Headcover – Wear Indication



Headcover – Wear Indication

Note:

- Wear was identified on the lower flat edge (see highlighted pic above)
- A 1/8" clearance is spec'd in this location between the rotating Runner Hub and the stationary Headcover (per OEM dwg)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 2	
	NCR #	1239 – 026

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Wear on this Surface



Wear Indication on bottom Headcover surface

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 6	
	NCR #	1239 - 027

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐		Yes ☑ Complete CAR Form

Headcover – Flange Indication



Headcover – Top View

Note:

- (6) Flange Indications were discovered
- (5) of the (6) Indications were previously repaired by filling the voids up with a non-magnetic material that appears to be babbitt or lead or something similar.
- Paint limited the inspection
- Depth of Indications is unknown

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 6	
	NCR #	1239 – 027

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Indication #1 – pic-1



Indication #1 – pic-2

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 6	
	NCR #	1239 – 027

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Indication #1 – pic-3



Indication #2 – Only indication discovered with no repair

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 4 of 6

NCR #	1239 – 027

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Indication #3



Indication #4

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 5 of 6	
	NCR #	1239 – 027

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Indication #5



Indication #6

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

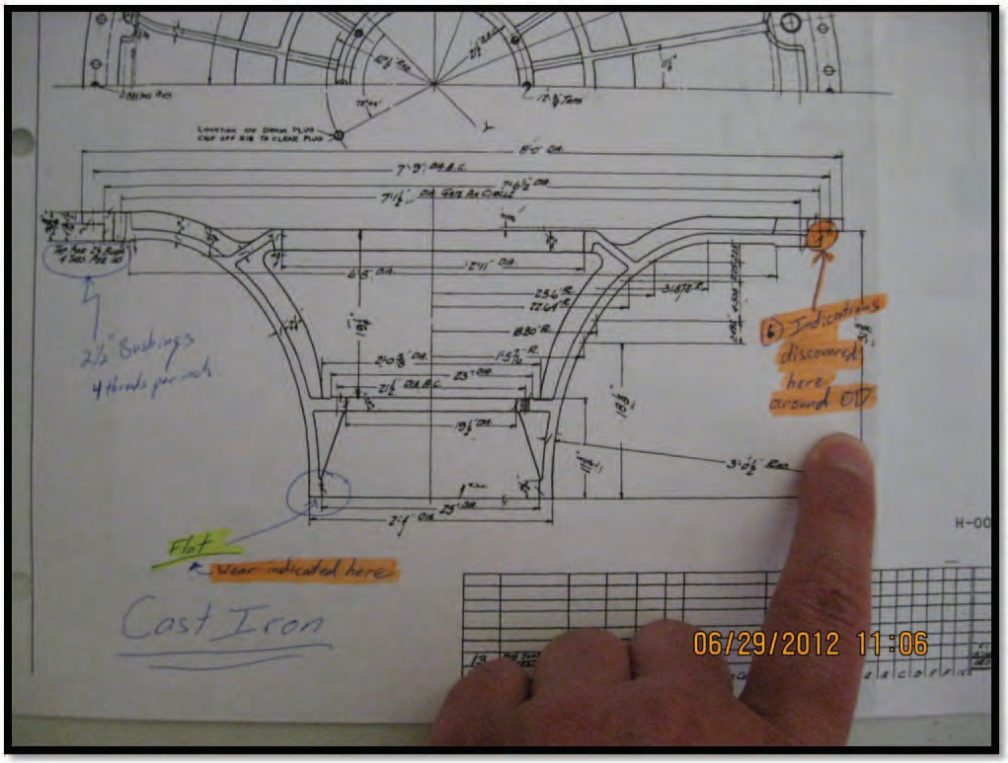
HYDRO TECH Inc. www.hydrotech-inc.ca	Page 6 of 6	
	NCR #	1239 – 027

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Flange measurement to spec with scale



Dwg indicating area of Indications

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 2	
	NCR #	1239 - 028

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Headcover – Hardware & Dimensional Verification



Headcover – Top View

Notes:

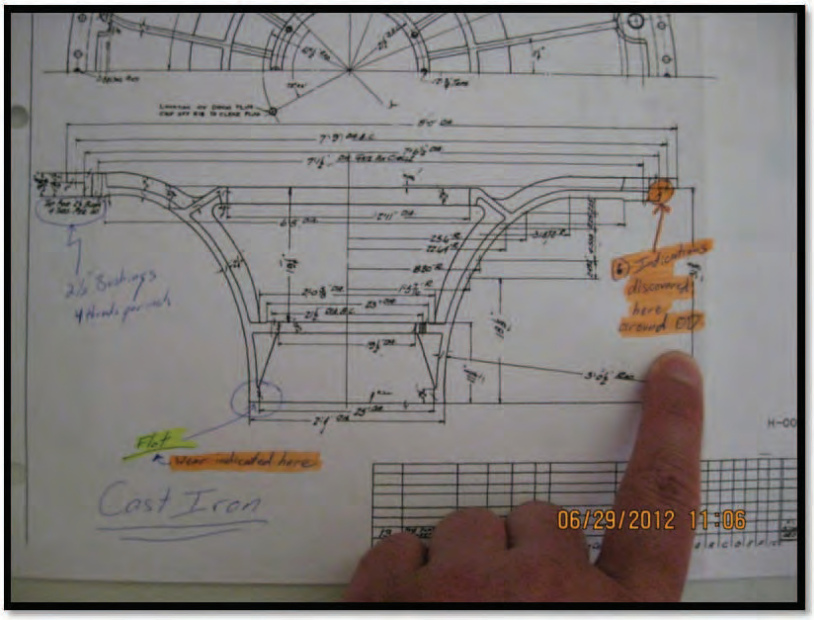
- All hardware should be replaced – Including the Wicket Gate Stops
- Wicket Gate Stops appear to not be in good condition, however it is difficult to determine with the coating of paint
- Dimensional Inspection of Headcover is the next typical step after the visual inspection

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 2	
	NCR #	1239 – 028

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Dwg some of the Dimensions that should be verified in Spec



Wicket Gate Stop

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3	
	NCR #	1239 - 029

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR		No ☐	Yes ☑ Complete CAR Form

Kaplan Hub – Dimensional Checks required



Hub – Bottom side facing up

Notes:

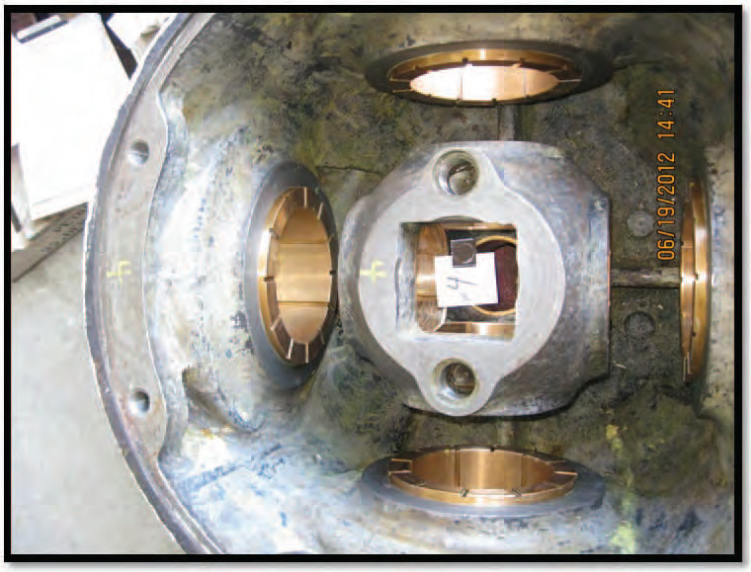
- Dimensional Inspection of Hub is the next typical step after the visual inspection
- Paint limited the visual inspection
- Coating on inside should have some work completed
- Bushings were found to have wear
- Bushings should be dimensionally inspected and recorded
- Top & Bottom Flanges – verified within spec
- Bores – verified in spec and on location
- Overall Height
- …..and other dims verified from OEM specs

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 3	
	NCR #	1239 – 029

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Inside Hub – view from bottom end



Outer Flat Bushing and bore of Flanged Thrust Bushing – view from outside Hub

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

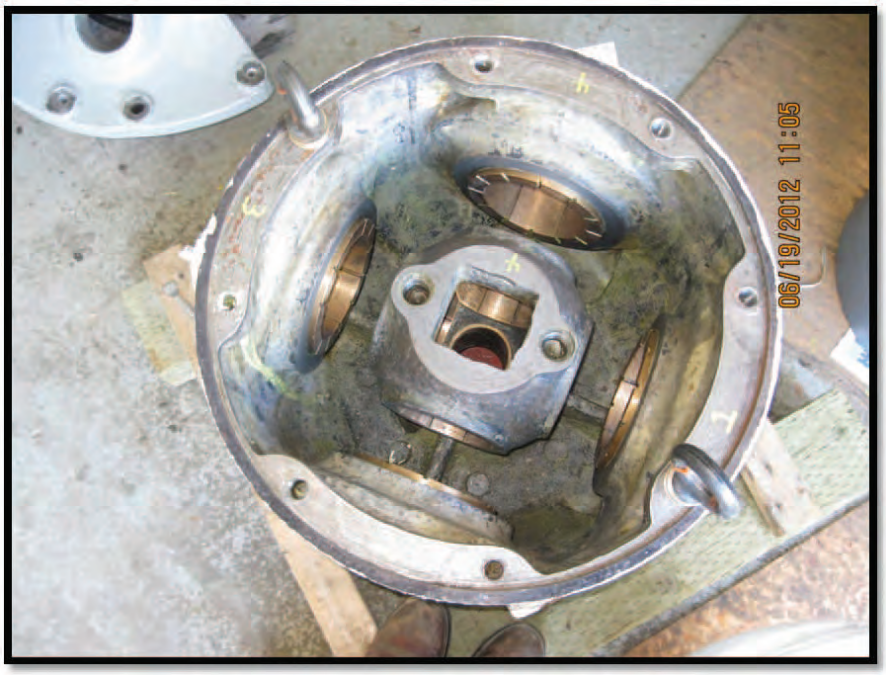
HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 3	
	NCR #	1239 – 029

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Inner Blade Trunion Bushing at location 4



(13) Bushings total in the Hub – dimensionally inspect to determine rehab (repair or replace)

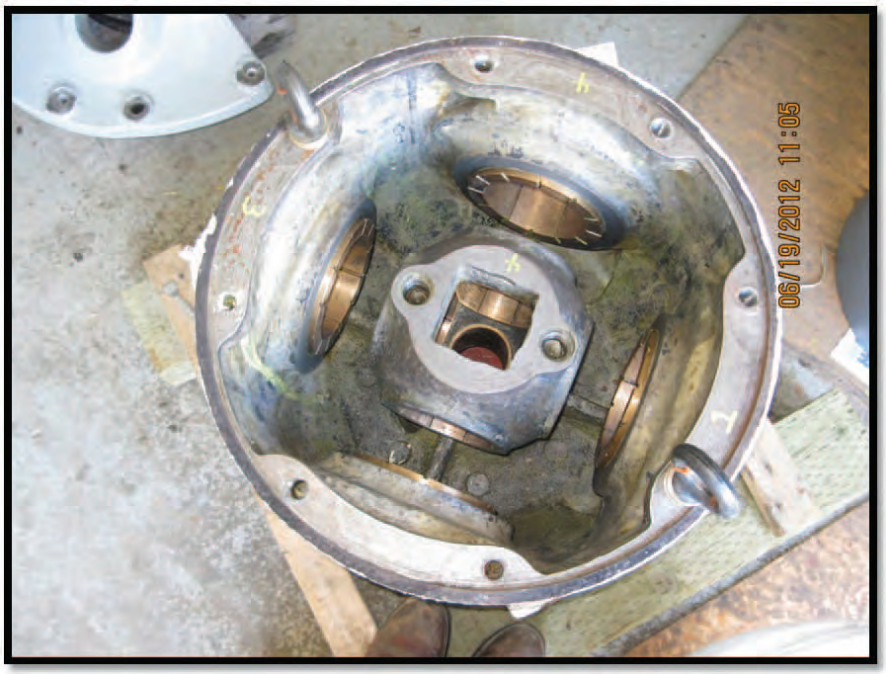
Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 4	
	NCR #	1239 - 030

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Kaplan Hub – Bushings



(13) Bushings total in the Hub – dimensionally inspect to determine rehab (repair or replace)

Notes:

- (13) Bushings total in the Hub
  - (3) per blade
  - (1) in the center for the Shaft that connect to the Cross-Head
- Bushings were found to have wear
- Bushings should be dimensionally inspected and recorded
- Zig-Zag Indications on some of the bushings indicate that there was potentially installation or disassembly issues

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 4	
	NCR #	1239 – 030

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Outer Flat Bushing and bore of Flanged Thrust Bushing – view from outside Hub



Inner Blade Trunion Bushing at location 4

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 4	
	NCR #	1239 – 030

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



(5) Bushings at the Center of Hub



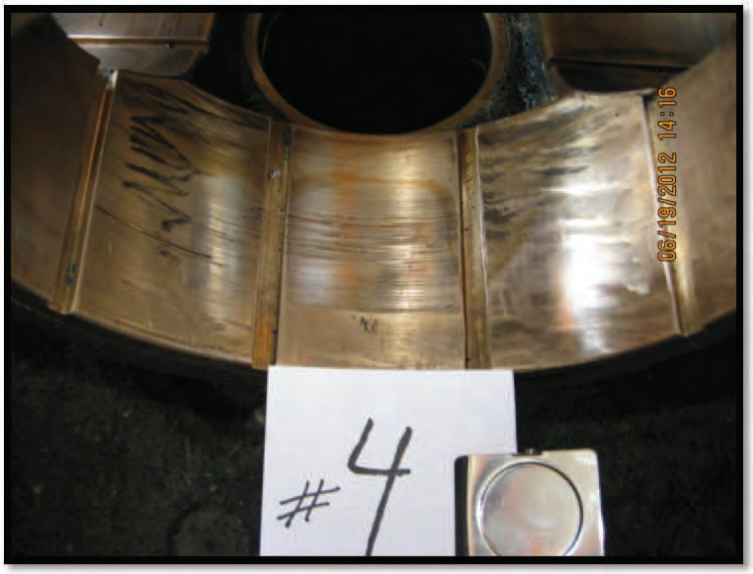
Blade Trunions that are the operating Journals inside the Hub Bushings

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

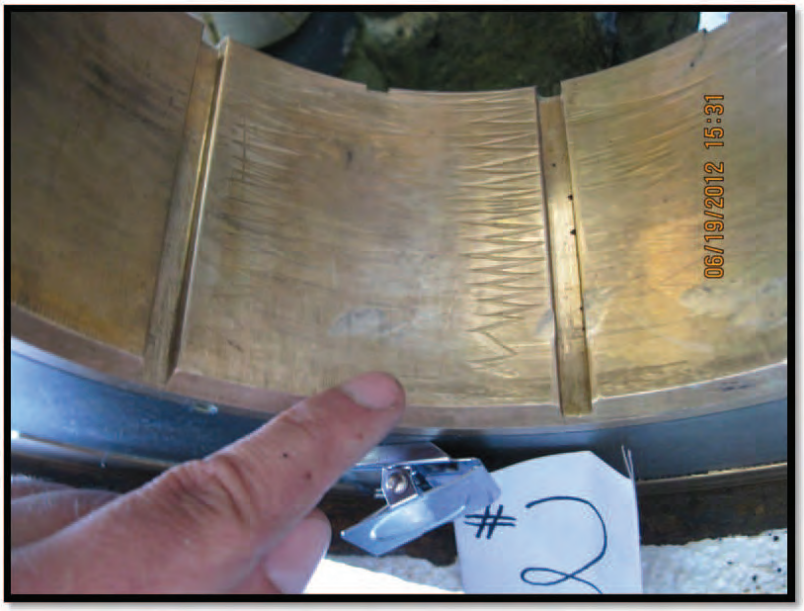
HYDRO TECH Inc. www.hydrotech-inc.ca	Page 4 of 4	
	NCR #	1239 – 030

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Typical Wear on upper half of Bushings



Zig-Zag Indication – most likely occurred during assembly or disassembly
(There are more than one of these type of indications in Hub bushings)

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 4	
	NCR #	1239 - 031

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Kaplan Hub – Material in Bushing Oil Grooves



Outer Flat Bushing Oil Groove filled with metallic material

Notes:

- Material was discovered in the oil grooves of the Outer Flat Bushing
- Dimensions of wear on bushing and Blade Trunion are a match
- Material likely from the Blade Trunions

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 4	
	NCR #	1239 - 031

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Outer Bushing – signs of wear



Outer Flat Bushing grooves filled with what appears to be metal scraped from Blade Trunion

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 4	
	NCR #	1239 - 031

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Blade Trunion wear – typical on all (4) blades

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 4 of 4	
	NCR #	1239 - 031

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Blade Tunion wear dimension matches Flat Bushing

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 4	
	NCR #	1239 - 032

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Hub - Pitting & Coating



Hub – Pitting at postion #1 – (pic-1)

Notes:

- Pitting noted all over outer part of Hub
- Worse Pitting noted near the blade penetrations of Hub (see pic above)
- Coating limited visual inspection

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 4	
	NCR #	1239 - 032

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Pitting at position #1 – pic-2



Pitting at position #1 – pic-3

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 4	
	NCR #	1239 - 032

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Pitting at position #2



Pitting at position #3

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 4 of 4	
	NCR #	1239 - 032

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Pitting at position #4 – best condition of all (4) positions

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 7	
	NCR #	1239 - 033

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Hub – Nose-Cone, Clamp, Linkage & Hardware



Hub – Cross-Head, Linkage & Hardware

Notes:

- All Hardware showed signs of wear
- Clamps showed signs of wear on Thrust Face
- Cold-chisel marks discovered – likely done during maintenance

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 2 of 7	
NCR #	1239 - 033

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Studs on Top side of Hub



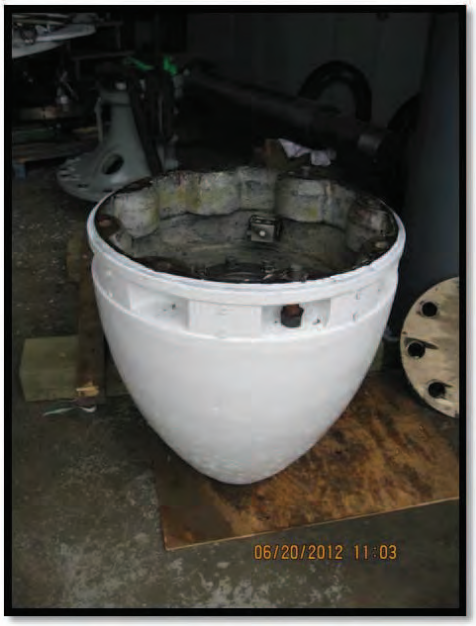
Nose-Cone

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 7	
	NCR #	1239 - 033

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Nose-Cone – Pitting & Coating



Cross-Head & Linkage

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 4 of 7	
	NCR #	1239 - 033

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Clamp, Linkage & Hardware – Blade position #4



Cold Chisel marks – (4) per clamp

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 5 of 7	
	NCR #	1239 - 033

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Thrust Face wear on Clamp – pic-1



Thrust Face wear on Clamp – pic-2

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 6 of 7	
NCR #	1239 - 033

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Thrust Face wear on Clamp – pic-3



Old Thread repair

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 7 of 7	
NCR #	1239 - 033

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



General Pic of Clamp, Linkage and Hardware at position #1

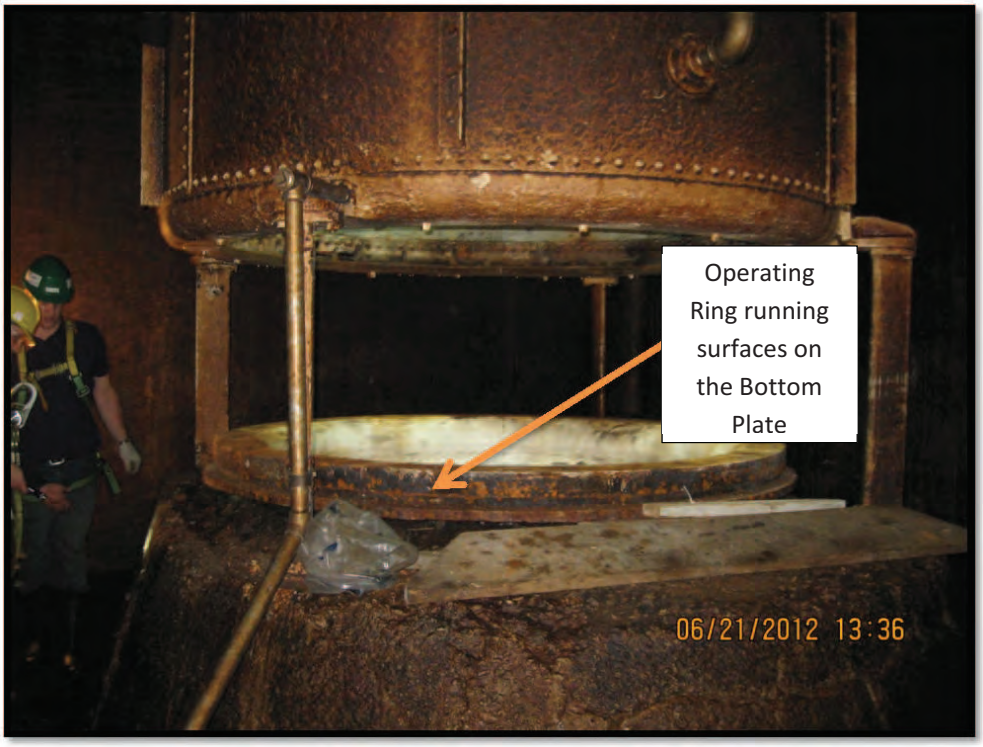
Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3	
	NCR #	1239 - 034

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐	Yes ☑ Complete CAR Form	

Bottom Plate – Operating Ring running surfaces



Distributor Section – Disassembled On-Site

Note:

- OEM dwg indicates that this entire Bottom Plate/Throat Ring Assembly (which is one component) is Cast Iron.
- NSP dwg # H-009W1-9-411-00-017
- Wear was indicated on both of the Bottom Plate's running surfaces (Circumferential & Bottom)
- Flatness of the Bottom running surface is likely not in spec
- Roundness of the Circumferential running surface is likely not in spec
- Surface Finish on both surfaces are not in spec

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc.
www.hydrotech-inc.ca

Page 2 of 3

NCR #	1239 – 034

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Bottom Plate – General top view



Bottom Running Surfaces are in Poor Condition

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 3	
	NCR #	1239 – 034

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Bottom Running Surface - Wear



Circumferential Running Surface - Wear

Note: Wear Noted on what appears to be an old surface repair

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 3	
	NCR #	1239 - 035

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons
Is a Corrective Action Report (CAR) to be completed for this NCR	No ☐		Yes ☑ Complete CAR Form

Bottom Plate – Wicket Gate Rod holes



Wicket Gate Rod holes in the Cast Iron Bottom Plate

Note:

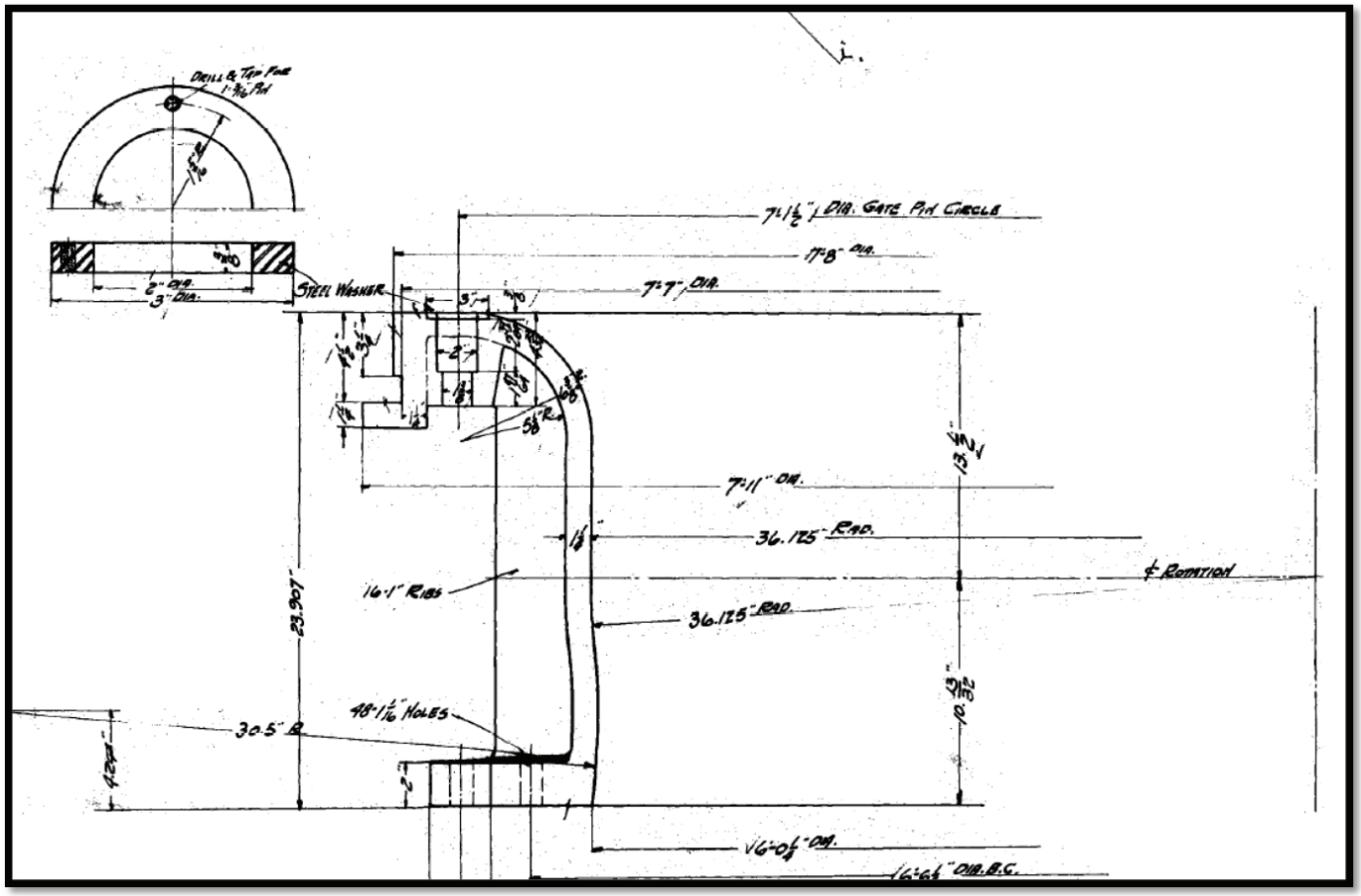
- OEM dwg indicates that this entire Bottom Plate/Throat Ring Assembly (which is one component) is Cast Iron.
- S. Morgan Smith dwg # 3630-CA
- NSP dwg # H-009W1-9-411-00-017
- Due to the area not being cleaned up, it was difficult to tell if there were sleeves installed in the Wicket Gate rod holes that are located in the Bottom Plate or not. It is likely that there are **not** sleeves in this location since the OEM dwg does not indicate any sleeves.
- Also Note that the Rods are completely stationary (per design), so the need for sleeves during the initial installation was not necessary.
- Pitting Noted in bores of Wicket Gate Rod holes in the Bottom Ring

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 3	
	NCR #	1239 – 035

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



OEM Dwg – No Sleeves in Bottom Plate

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 3 of 3	
	NCR #	1239 – 035

NON-CONFORMING QUALITY CONTROL REPORT

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment



Pitting noted in bores of Wicket Gate Rod holes in Bottom Plate

Non-Conformance Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 - 001
	NCR #	1239 - 001

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Operating Ring - Surface Condition

AS-Found Condition:

- The Surface Condition of the Operating Ring is poor.
- There is a lot of pitting all over the surface of the split Operating Ring.

Recommendation:

- **Apply a proper Coating System**

Recommendation Details:

Applying a coat of standard paint over a rough surface (like the current one), will likely not last long and accelerate the end-of-life of this component (requiring replacement).

To extend the life of this component a **proper Coating System** should be applied that will fill in all of the pitting and retain the original smooth profile of the component.

This System should take into account erosion, corrosion and abrasion conditions. Also the preparation of the component prior to application should be a critical part of this documented System.

There are many Coating Systems that could potentially achieve this goal. Hydro Tech has worked with many suppliers and coating specialists in the past to develop the proper Coating System for particular applications and would lead the development of a Coating System for this application as well, if requested.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 - 002
	NCR #	1239 - 002

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Wicket Gates - Surface Condition

AS-Found Condition:

- The Surface Condition of all 16 Wicket Gates is poor.
- There is a lot of pitting over all of the surfaces of the Wicket Gates.

Recommendation:

- **Apply a proper Coating System**

Recommendation Details:

Applying a coat of standard paint over a rough surface (like the current surfaces), will likely not last long and accelerate the end-of-life of this component (requiring replacement).

To extend the life of these components, a **proper Coating System** should be applied that will fill in all of the pits and retain the original smooth profile/surface of the components.

This System should take into account erosion, corrosion and abrasion conditions. Also the preparation of the component prior to application should be a critical part of this documented System.

There are many Coating Systems that could potentially achieve this goal. Hydro Tech has worked with many suppliers and coating specialists in the past to develop the proper Coating System for particular applications and would lead the development of a Coating System for this application as well, if requested.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 2	
	CAR #	1239 - 003
	NCR #	1239 - 003

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Wicket Gates – Old Coating

AS-Found Condition:

- All 16 Wicket Gates were still partially coated with the old coating.

Recommendation:

- **Blast 100% of the coating from the Wicket Gates (preferably to something close to an SP10) and perform a second visual inspection**

Recommendation Details:

There could potentially be indications that are not visible (and potentially were not visible during the inspection) because of the coating that was left on the Wicket Gates. Therefore it is important to remove all of the old coating by abrasive blasting and then perform a second complete visual inspection. Any indications noted during this inspection should be NDE'd.

Please note that an initial visual inspection is typically performed to get an initial condition report of the components prior to them getting blasted. In general, this noted initial condition report is typically used to get a general idea of the condition and begin developing a Scope of Work (SOW) for the rehab of the components. Typically, a little more scope is added to the SOW after the post-blasting inspection.

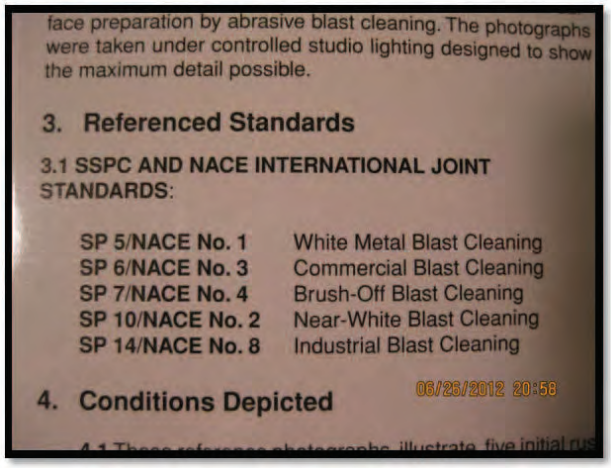
***See the pics below from the SSPC Publication illustrating & describing the SP-10 Dry Abrasive Blast Cleaning Standard.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 2	
	CAR #	1239 - 003
	NCR #	1239 - 003

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment


face preparation by abrasive blast cleaning. The photographs were taken under controlled studio lighting designed to show the maximum detail possible.

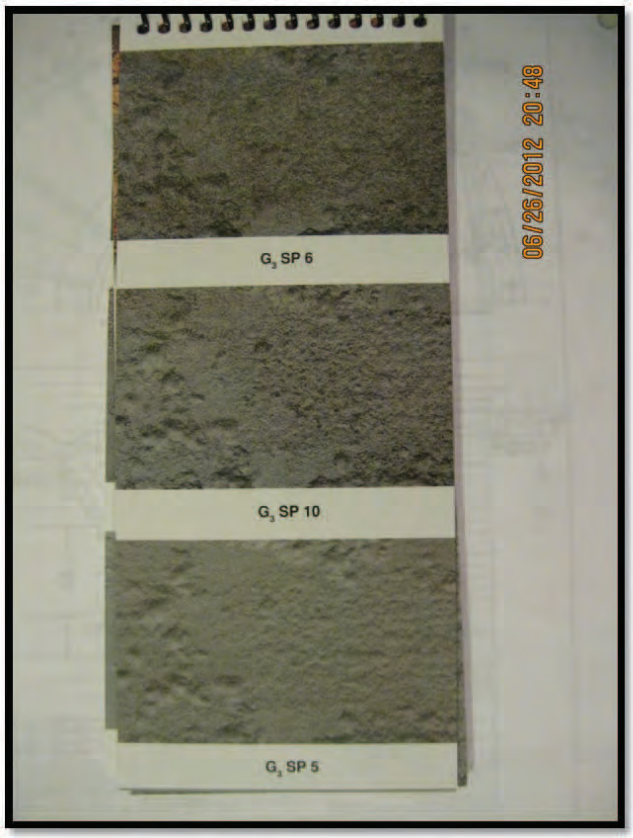
3. Referenced Standards

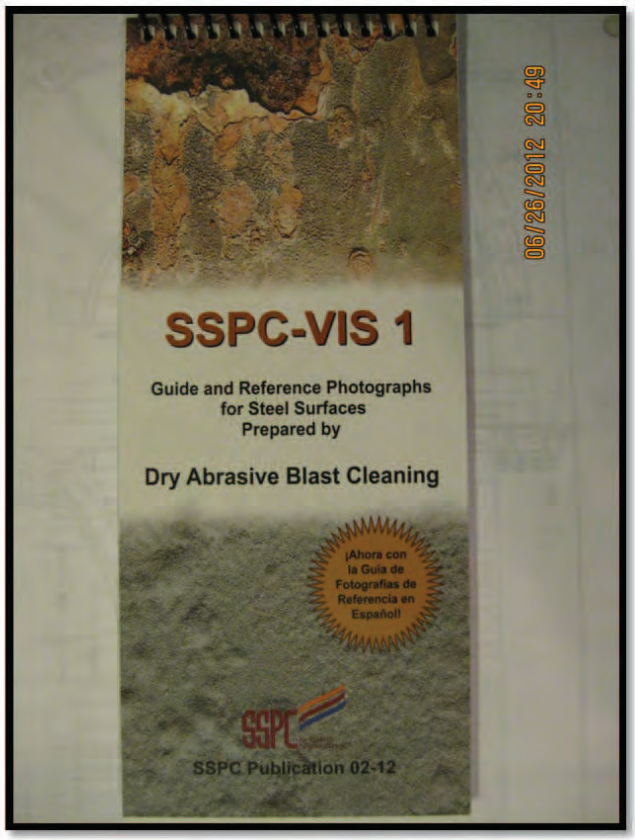
3.1 SSPC AND NACE INTERNATIONAL JOINT STANDARDS:

SP 5/NACE No. 1	White Metal Blast Cleaning
SP 6/NACE No. 3	Commercial Blast Cleaning
SP 7/NACE No. 4	Brush-Off Blast Cleaning
SP 10/NACE No. 2	Near-White Blast Cleaning
SP 14/NACE No. 8	Industrial Blast Cleaning

4. Conditions Depicted

06/26/2012 20:58





Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 - 004
	NCR #	1239 - 004

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Wicket Gate Heights & End Seals

AS-Found Condition:

- All 16 Wicket Gates were short per the S. Morgan Smith Co. Turbine Assembly Dwg specification. (2'-5 5/32")
- All of the Bottom End Seals were not in good condition
  - (9 of the 16) Wicket Gates were identified as being the worst
- All of the Top End Seals appeared to be in decent condition

Recommendation:

- **Material Sample from one of the broken gates taken and sent to a lab for analysis to determine if the Wicket Gates are Cast Steel or Cast Iron**
- **Repair or Replace decision will have to be made after all issues and material analysis are considered**

Recommendation Details:

Once the material is analyzed and confirmed to be Cast Steel or Cast Iron, and the gates have been properly blasted and re-inspected, then a proper repair method can potentially be determined.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 - 005
	NCR #	1239 - 005

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Wicket Gates – Broken Corners

AS-Found Condition:

- (3) Wicket Gates were discovered to have broken corners in a triangular shape approx. 2"tall and 2" long.
- These broken corners were on the Bottom End, Leading Edge, Down-stream side.
- The likely cause was the Gates contacting this Operating Ring at some point during operation or maintenance.

Recommendation:

- **Determine the material of the Wicket Gates by sending a sample to a material analysis lab.**

Recommendation Details:

- All discoveries (in the other NCR's) must be taken into consideration prior to determining the repair or replacement options.
  - If the repairs are substantial then the cost of a new set may not be much more than repairing the old cast Gates.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 - 006
	NCR #	1239 - 006

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Wicket Gates Links

AS-Found Condition:

- All 16 Wicket Gates Links were in poor condition.

Recommendation:

- **Replace all (16) Wicket Gate Links with NEW.**

Recommendation Details:

N/A

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 - 007
	NCR #	1239 - 007

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Wicket Gate #1 – Pin Holes

AS-Found Condition:

- Pin Holes were discovered on the Down-stream side of Wicket Gate #1.

Recommendation:

- **Properly blast all (16) Wicket Gates and visually re-inspect.**
- **NDE as needed during/after this visual inspection**
- **Measure & record depth, size and location of pin holes**
- **Determine the proper method of rehab or replacement**

Recommendation Details:

Without a proper surface prep (abrasive blast) many of these pin holes could potentially be covered up. Therefore, further investigation is recommended prior to making a final recommendation for either a rehab method or replacement.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 - 008
	NCR #	1239 - 008

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Wicket Gate Seals

AS-Found Condition:

- Pitting & Corrosion: The Wicket Gate Seals are pitted due to corrosion and/or erosion through the many years of operation.
- Coating: The old coating has failed in many locations.
- Sealing: The combination of the pitting and the partial coating along the seals likely was preventing a good seal during shut-down.
- Risks if nothing is done to repair the seals:
  - Operational & Cost Risk -> Erosion rate increases
  - Maintenance Cost Risk -> Higher rehab costs next overhaul
  - Operational & Cost Risk -> Continual loss of water when shut-down

Recommendation:

- **Properly blast all (16) Wicket Gates and visually re-inspect.**
- **Material Sample – send a material sample to a lab to determine the actual material of the Wicket Gates (Cast Steel or Cast Iron)**
- **Rehab Seals**
- **Or replace Wicket Gates**

Recommendation Details:

Before a proper repair can be engineered, there is more information that is needed.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 - 009
	NCR #	1239 - 009

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Wicket Gate Bushings

AS-Found Condition:

- Signs of wear was noted in the bushings during the Visual Inspection

Recommendation:

- **Measure & Record all Bushing ID's**
  - **Take a min of (2) measurements per bushing 90 degrees apart**
- **Measure and record the wear on the Thrust Face of the bottom bushings**
- **Measure and record how far below the bottom of the gate the bottom bushing is set**
- **Replace all (32) bushings**

Recommendation Details:

- NSP is in the process of replacing the Wicket Gate Stems, so the mating SS journals will be new
- There are (16) top Wicket Gate Bushings
- There are (16) bottom Wicket Gate Bushings

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 - 010
	NCR #	1239 - 010

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Upper Wicket Gate Stem Bushing wear or rubbing

AS-Found Condition:

- (2) issues noted during inspection:
  - Signs of wear or rubbing on ID
  - Thread deformation on Bushing #13

Recommendation:

- **NDE all (16) Bushings**
  - **Threads**
  - **Bore**
  - **Flange**
  - **The entire bushing should be NDE'd**

- **Mic the ID of all (16) bushings – 90 degrees apart at the top and bottom of the bore (4 measurements per bushing)**

Recommendation Details:

- These bushings should not see any movement as the shafts are designed to be stationary and the wicket gate pivots on the shaft.
- These bushings also act as a seal
  - A Loctite product (or similar) is most likely recommended to prevent the water from traveling along the OD and ID of this bushing and reaching the top side of the headcover.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 - 011
	NCR #	1239 – 011

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Push-Pull Rods – General Condition

AS-Found Condition:

- **Note:** These Rods had the old coating on them and the old bushing installed during the visual inspection.

- **Surface Condition:**
  - The coating was not smooth, indicating that it was most likely applied over large pits and/or divots in the base material.

- **Threads/Adjustability:**
  - Also the threads appeared to have a lot of old paint, corrosion and pitting on them limiting their adjustability. This Adjustability is critical when setting Wicket Gates during assembly and for future maintenance.

- **Summary:**
  - Precise **Push-Pull Rod Condition** is difficult to determine for certain with the heavy coat of paint and corrosion that was on the Push-Pull rods at the time of the inspection.

  - However, it is likely that these Push-Pull Rods are **near the end-of-life** based on the visual inspection.

Recommendation:

- **Option 1: Replace with new 4140 rods.**

- **Option 2: Blast and perform a better inspection to determine the proper rehab or make a final replacement decision**
  - **Option 1 may want to be estimated prior to further investigation (option 2) to determine is further investigation is worth the time and $$$**

Recommendation Details:

- After being in service for 83 years, these rods (and other original components) have had a long life, so replacement may be a logical and easy decision.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 012
	NCR #	1239 – 012

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Push-Pull Rods – Bushings

AS-Found Condition:

- Visible wear noted in bushings.

Recommendation:

- **Option 1:**
  - **Measure bushing bores at 0 & 90 degrees**
  - **Replace bushings with new if found worn**

- **Option 2: if replacing Push-Pull rods with new**
  - **Measure old bushing bores at 0 & 90 degrees (to document only)**
  - **Install new bushings in new Push-Pull Rods**

- **NOTES:**
  - **With either option, the pins should also be measured and recorded because it is likely that they will need to be replaced as well.**
  - **In general, it is good practice to plan on replacing all hardware such as pins, bolts and other fasteners when performing a major overhaul.**

Recommendation Details:

N/A

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 013
	NCR #	1239 – 013

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Quadrant Shaft – General Condition

AS-Found Condition:

- The visual inspection was completed on a best effort basis while it was installed at the station
- NSP decided to leave this shaft installed based on their own condition assessment
- The Quadrant Shaft appeared to be in good general condition considering the age
- Coating on the Quadrant Shaft appeared to be in good condition considering the age
- Coating (if there ever was any) on the Clevis and bottom steel base support (bottom end) did not appear to be in good condition
  - A steel base such as this typically contains a bushing and a thrust bearing at the bottom of the Gate Shaft (Quadrant Shaft)

Recommendation:

- **Further investigation should be completed in (2) areas at a minimum**
  - **1) Packing area – shaft should be cleaned and thoroughly inspected for wear and/or cracks**
  - **2) Bottom end in scroll case – should be cleaned and thoroughly inspected**
    - **This includes the Clevis**
- **Clevis pin holes should be measured, recorded and compared to spec**
- **Firmness of the anchoring should be checked with a hydraulic ram exherting a force equal to approx 50% of that of the servomotor**
  - **Examine the surrounding concrete for cracks before and during the Anchoring Firmness test**
- **Bottom end & Clevis should be properly coated**
- **Grease fittings should be replaced and**
- **Lower bushing area inspected for wear – again this can be done with a hydraulic ram and dial indicators if disassembly is not in the SOW**
- **Wet portion of the Gate Shaft, the Clevis, the steel base and the concrete (3' diam circle) should be blasted, inspected and coated with the appropriate coating system.**
- **Lower Bushing should be re-greased**

Recommendation Details:

N/A

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 014
	NCR #	1239 – 014

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Runner Blade Seals - Nonexistent

AS-Found Condition:

- Runner was found with no Runner Blade Seals
- NSP stopped using Hydraulic Oil and Blade Seals because of leakage issues in the past
- NSP has been using grease in place of the Hydraulic Oil with no seals
- NSP Engineering would like to convert back to using Hydraulic Oil and a new seal design

Recommendation:

- **Design new blade seals & convert back to hydraulic oil**
  - **Hydro Tech can design and supply new seals, if NSP desires**

Recommendation Details:

Designing new blade seal configurations appears to be common with the older Kaplan units. Seals have come a long way since this unit was first installed in 1929, so a conversion to hydraulic oil and new seals is very achievable.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 015
	NCR #	1239 – 015

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Runner Blades - Cavitation

AS-Found Condition:

- Runner Blades are cavitated very badly (Blade #1 is beyond repair)
- Old SS repairs have failed
- These blades have been repaired many times in the past. It appears as though there are repairs over repairs in some cases.
- Cavitation and corrosion is occurring on the original base metal under the SS repair patches in many locations

Recommendation:

- **Hydro Tech is noting that these blades are at end-of-life and recommends replacement**
- **Replacement with a new set of copied blades would most likely take approx. 5-6 months**
- **Replacement with a new design to fix the cavitation issues would most likely take over a year**

- **Copied Blade option:**
  - **Reverse Engineer, design and make a new set of SS blades**
  - **Hydro Tech is very capable of doing this SOW, if NSP desires**
- **New Runner Design option:**
  - **Hydro Tech could recommend a runner mfr to NSP if desired**
  - **Hydro Tech does not design New Runners, but does work with a lot of different Runner manufacturers**

Recommendation Details:

There are (3) identical units at the Tusket Station. All (3) units have the same original 1929 blades installed. Once one set of blades has been reverse engineered, machined and supplied, the rest of them will be much easier and less expensive to replace when the time comes.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/27/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 016
	NCR #	2,3,4,5,7,8,9

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Wicket Gates

AS-Found Condition:

- Reference NCRs: 2,3,4,5,7,8, & 9 along with the associated CARs 2,3,4,5,7,8, & 9.

Recommendation:

- **Replace all (16) Wicket Gates with a set of new Gates**
  - **There is a significant cost and schedule impact to the project when taking all of the issues into account together.**
  - **There is also a quality factor that needs to be considered with rehabbing 83 year old components vs. replacement with new.**
  - **These gates are near their end-of-life based on the complete visual assessment, so serious consideration should be given to the replacement recommendation Hydro Tech has proposed.**
  - **Hydro Tech is very capable of engineering and executing either the rehab or replacement options.**

Recommendation Details:

There are (3) identical units at the Tusket Station. All (3) units have the same original 1929 Wicket Gates installed. Once one set of Wicket Gates have been supplied, future sets could potentially be supplied in advance of the overhaul to reduce down-time. This thought process should be considered with many of the other components as well.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 017
	NCR #	1239 - 016

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Turbine Guide Bearing Blocks

AS-Found Condition:

- TGB currently has Wooden Blocks (most likely Lignum Vitae)
- Old blocks are in small sections – many pieces stacked to make up (1 of the 4) TGB "Blocks"
- New Jack Plates fabricated by NSP crew
- Old blocks are worn, cracked and/or broken

Recommendation:

- **Replace the blocks with (4) new blocks made with a synthetic material such as orkot or CIP**

Recommendation Details:

- Thordon is not recommended in this application due to the material allowing debri and/or sand to embed itself in it and acting as an abrasive pad wearing the shaft instead of the blocks wearing
- Hydro Tech has not had good experiences with Thordon in this type of application

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 018
	NCR #	1239 - 017

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Wicket Gate Rods

AS-Found Condition:

- Wicket Gate Rods were very pitted and corroded (End-of-life)

Recommendation:

- **Replace the Rods with new**

Recommendation Details:

- NSP already plans to replace the Wicket Gate Rods with new based on their own assessment

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 019
	NCR #	1239 – 018

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Wicket Gate Link Pins

AS-Found Condition:

- Wicket Gate Link Pins were not removed for inspection
- However, one was loose enough to remove for a quick visual

Recommendation:

- **Remove all Link Pins**
- **NDE**
- **Mic OD's & record**
- **Replace as needed**

Recommendation Details:

- Typically all fasteners, bushings, wear parts, pins, etc… are replaced during a major overhaul. (Best Practice)

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 020
	NCR #	1239 – 019

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Operating Ring - Bushings

AS-Found Condition:

- NSP is currently planning on replacing these Operating Ring bushings which is always a good idea during a major overhaul
- Bushing visually appeared to be worn

Recommendation:

- **Replace all bushings**

Recommendation Details:

- Typically all fasteners, bushings, wear parts, pins, etc… are replaced during a major overhaul. (Best Practice)

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 2	
	CAR #	1239 – 021
	NCR #	1239 – 020

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Operating Ring – Wear Pads

AS-Found Condition:

- NSP is currently planning on replacing these Operating Ring wear pads which is always a good idea during a major overhaul
- Some Wear Pads visually worn – others do not look like they have been touched
  - This is the same for each set of wear pads. (ID set & Bottom set)
- Bronze wear pads are located on the ID of the Operating Ring
  - They were installed during a past overhaul and all relocated on the wear pad circle from the original OEM pad locations. This is obvious from seeing part of the old wear pad fasteners still in the bottom of the Operating Ring (see pics below).
- Plastic Wear pads are located on the bottom side of the Operating Ring
  - These were installed during a past overhaul and also all relocated on the wear pad circle. Again note the old fasteners still in the Operating Ring from original OEM.
- Plastic Wear Pads are not OEM material. The OEM dwg calls for "Bronze Wear Plates" in both locations (ID & Bottom).
- Also note the loose & missing fasteners in the currently installed wear pads.

Recommendation:

- **Replace all Wear Pad with either new Bronze Wear Pads or continuous Bronze Wear Rings**
  - **Bronze Wear Rings would be the preferred option on both the ID and Bottom**
    - **These rings would be continuous split rings that would add structural integrity to the Operating Ring along with improving the operation of the component.**

- **Dimensionally inspect with FARO**
  - **Recommend doing with the FARO vs. a machine**
  - **There are many components that could be checked with the FARO while on the Tusket project, like all of the other the Embedded parts at the station, stationary components at the station, along with the other components at the shop (headcover, hub, etc…)**
  - **Using the FARO to check & correct the levelness and flatness of the mating running surface on the Bottom Plate in the scroll case is critical to ensuring this operating ring is going to operate properly.**

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 2 of 2	
	CAR #	1239 - 021
	NCR #	1239 - 020

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment

- **Verifying the elevation of the Operating Ring is going to be at the proper relative elevation as the Quadrant Shaft Clevis is critical to the proper operation and life of the components. So this is another item that could be checked with the FARO.**

- **Fitted bolts at splits – assuming there currently are not any**

- **Replace all fasteners with new**

Recommendation Details:

- Typically all fasteners, bushings, wear parts, pins, etc… are replaced during a major overhaul. (Best Practice)
- Plastic Wear Pad note:
  - Anytime a greaseless or plastic wear pad or bushing is being utilized, the mating running surface should be stainless steel.
- FARO note:
  - There are many advantages to using the FARO to dimensionally inspect many of the components during disassembly of an overhaul.
  - If the decision is made to utilize the FARO lazer tracker, then a good plan should be developed prior to mobilizating the FARO so we know exactly what we want to measure and/or align.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/26/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 022
	NCR #	1239 – 021

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Operating Ring – Wicket Gate wear

AS-Found Condition:

- Wear from the Wicket Gates was discovered in (4) locations on the Operating Ring.
- (2) locations per half caused by the (2) Wicket Gates on either side of the Operating Ring Split that is in-line with the Quadrant Shaft. (see pic of dwg above)
- NSP had noted issues at the Operating Ring splits during operation.
- NSP also noted that many of the bottom wear pads were not touching the embedded Bottom Plate running surface.
-

Recommendation:

- **Coating system should be selected to include a filler material that should fill these wear indications.**
- **Operating Ring misalignment is most likely caused this issue, therefore fixing the alignment, placement, and rehab issues of the Operating Ring will prevent this from occurring again.**

Recommendation Details:

- Highly recommend the use of the FARO to assist in this alignment and rehab process.

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 023
	NCR #	1239 – 022

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Throat Ring - material

AS-Found Condition:

- OEM dwg indicates that this entire Bottom Plate/Throat Ring Assembly (which is one component) is Cast Iron.
- It appears to be Stainless Steel or have a Stainless Steel cladding or overlay
- S. Morgan Smith dwg # 3630-CA
- NSP dwg # H-009W1-9-411-00-017

Recommendation:

- **Verify the material**
- **Determine when this was changed to SS (if it indeed is Stainless Steel)**
- **This difference is even more of a reason to verify the dimensions of this Throat Ring and all of the stationary components.**
- **Determine the Thickness of the Throat Ring**

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 024
	NCR #	1239 – 023

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Throat Ring - Measurements

AS-Found Condition:

- S. Morgan Smith dwg # 3630-CA
- NSP dwg # H-009W1-9-411-00-017
- There is a 36.125" rad in this Throat Ring – this needs to be verified

Recommendation:

- **Stationary Survey should be executed:**
  - **Dimensional checks should be performed while all of the rotating components are removed to verify the component is within spec and help determine if any and how maintenance is required.**
  - **The FARO laser tracker would be the perfect tool for this task.**

- **Determine the Thickness of the Throat Ring**

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 025
	NCR #	1239 – 024

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Headcover – Coating issues

AS-Found Condition:

- The Headcover was coated prior to the visual inspection
  - Therefore the visual inspection was severely limited
- The coating was applied in areas that should have been taped-off
  - Flange surface
  - Headcover stud holes (along with jack-bolt & dowel holes)
  - Headcover Upper Wicket Gate Bushing threads
  - Etc…
- The current coating does not fill in the pits and create a smooth surface

Recommendation:

- **Blast Coating off Headcover and perform a complete thorough inspection**
  - **Especially since Indications have been identified on the Headcover Flange**

- **Apply New Coating System**
  - **New Coating System should fill in pits and divots**
  - **Keep in mind that there should be an Immersion Coating System and a non-immersion coating system to consider**

- **Tape all areas that should not get coated prior to applying new coating system**

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 026
	NCR #	1239 – 025

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Headcover – Broken TGB Fit

AS-Found Condition:

- Upper Fit in the Headcover for the Turbine Guide Bearing consists of (4) locations around the bore where (4) separate TGB Housing Support Arms fit
- One of these (4) fit areas has a broken piece
- The broken piece is at one of the (2) TGB fit locations that has a dowel

Recommendation:

- **Per the OEM Dwg the Headcover is Cast Iron**
- **Re-inspect area After Blasting for any additional cracking or indications**
- **After inspection a method to strengthen this area may want to be considered**

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/28/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 027
	NCR #	1239 – 026

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Headcover – Wear Indication

AS-Found Condition:

- Wear was identified on the ID of the lower flat edge of Headcover
- A 1/8” clearance is spec’d in this location between the rotating Runner Hub and the stationary Headcover (per OEM dwg)

Recommendation:

- **Inspect after cleaning up paint in area to ensure there are no crack indications**

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 028
	NCR #	1239 – 027

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Headcover – Flange Indications

AS-Found Condition:

- (6) Flange Indications were discovered
- (5) of the (6) Indications were previously repaired by filling the voids up with a non-magnetic material that appears to be babbitt or lead or something similar
- Paint limited the ability for Hydro Tech to complete a full visual inspection
- Depth of Indications is unknown

Recommendation:

- **Remove paint in this area to perform thorough inspection of Headcover Flange**
- **Determine depth of repairs**
- **Determine Structural Integrity of Headcover**
- **Hydro Tech does not recommend installing the Headcover until the Structural Integrity of the Headcover is properly determined to be appropriate for the application**

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 029
	NCR #	1239 – 028

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Headcover – Hardware & Dimensional Verification

AS-Found Condition:

- All hardware should be replaced – Including the Wicket Gate Stops
- Wicket Gate Stops appear to not be in good condition, however it is difficult to determine with the coating of paint
- Dimensional Inspection of Headcover is the next typical step after the visual inspection

Recommendation:

- **Replace all Hardware, including Stops**
- **Dimensionally inspect Headcover**

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 030
	NCR #	1239 – 029

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Kaplan Hub – Dimensional Checks required

AS-Found Condition:

- Dimensional Inspection of Headcover is the next typical step after the visual inspection
- Paint limited the visual inspections
- Coating on inside should have some work completed
- Bushings were found to have wear
- Bushings should be dimensionally inspected and recorded
- Top & Bottom Flanges – verified within spec
- Bores – verified in spec and on location
- Overall Height

  …..and other dims verified from OEM specs

Recommendation:

- **Remove Paint and perform complete visual inspection**
- **Dimensionally inspect Bushings & record data**
- **Dimensionally inspect the entire Hub**
  - **Again this is a perfect application for the FARO**

Recommendation Details:

Tools that should be considered using for the inspections, but not all are needed:

- Inside & Outside Mics
- Profilometer (surface finish device)
- Vernier Calipers
- FARO
- VBM and/or HBM

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 031
	NCR #	1239 – 030

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Kaplan Hub – Bushings

AS-Found Condition:

- (13) Bushings total in the Hub
  - (3) per blade
  - (1) in the center for the Shaft that connect to the Cross-Head
- Bushings were found to have wear
- Bushings should be dimensionally inspected and recorded
- Zig-Zag Indications on some of the bushings indicate that there was potentially installation or disassembly issues

Recommendation:

- **At a minimum the surface finishes need to be brought in spec**
  - **This was obvious by eye**
- **Dimensionally Inspect and record data**
- **Compare to Blade Trunions & to OEM specs**
- **Determine what rehab is needed**
  - **Repair**
  - **Replacement**

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 032
	NCR #	1239 – 031

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Kaplan Hub – Material in Bushing Oil Grooves

AS-Found Condition:

- Material was discovered in the oil grooves of the Outer Flat Bushing
- Dimensions of wear on bushing and Blade Trunion are a match
- Material likely from the Blade Trunions

Recommendation:

- **Flat Bushings need to be cleaned and inspected**
- **Dimensional checks needed to determine amount of material lost on both the Blade Trunions and Bushings**
- **Clearances should be double checked to ensure everything is per spec**
  - **Under normal operation the Trunions typically should not be contacting the outer flat bushing**

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 033
	NCR #	1239 – 032

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Kaplan Hub – Pitting & Coating

AS-Found Condition:

- Pitting noted all over outer part of Hub
- Worse Pitting noted near the blade penetrations of Hub
- Coating limited visual inspection

Recommendation:

- **Blast and perform thorough Visual Inspection**
- **Determine depth of pitting and repair method**
- **Coating system – a good system is required to fill pits and extend the life of this component**

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 034
	NCR #	1239 – 033

CORRECTIVE ACTION RECOMMENDATION

Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Hub – Nose-Cone, Clamp, Linkage & Hardware

AS-Found Condition:

- All Hardware showed signs of wear
- Clamps showed signs of wear on Thrust Face
- Cold-chisel marks discovered – likely done during maintenance
- Paint on Nose-cone limited inspection

Recommendation:

- **Blast and perform thorough Visual Inspection on Nose-Cone**
- **Coating system – a good system is required to fill pits and extend the life of the Nose-cone**
- **Replace ALL hardware**
- **Any hardware or threaded fastener that is not going to be replaced should be NDE'd to determine if it should be reused**
- **Clean-up any marks, burrs and deformed metal areas (like chisel marks)**
- **Machine face of Thrust face on clamp to proper finish**

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 035
	NCR #	1239 – 034

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Bottom Plate – Operating Ring running surfaces

AS-Found Condition:

- OEM dwg indicates that this entire Bottom Plate/Throat Ring Assembly (which is one component) is Cast Iron.
- NSP dwg # H-009W1-9-411-00-017
- Wear was indicated on both of the Bottom Plate's running surfaces (Circumferential & Bottom)
- Flatness of the Bottom running surface is likely not in spec
- Roundness of the Circumferential running surface is likely not in spec
- Surface Finish on both surfaces are not in spec

Recommendation:

- Dimensionally check bottom plate to determine flatness, roundness, relative position/location, etc…
- Surface Finishes on both running surfaces
  - Develop a plan to achieve specifications
- Flatness & Roundness of the running surfaces
  - after confirming the current condition is out-of-spec, develop a plan to achieve specification
- Relative Position/Location:
  - Ensure the Elevations and Centerlines are within spec of these surfaces
  - Relative positions with all of the other components needs to be verified to ensure proper operation

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

HYDRO TECH Inc. www.hydrotech-inc.ca	Page 1 of 1	
	CAR #	1239 – 036
	NCR #	1239 – 035

CORRECTIVE ACTION RECOMMENDATION			
Project #	1239	Project Name	Nova Scotia Power _ Tusket-2 Condition Assessment
Date of Report	June 26, 2012	Completed By	Brandon Lyons

Bottom Plate – Wicket Gate Rod holes

AS-Found Condition:

- OEM dwg indicates that this entire Bottom Plate/Throat Ring Assembly (which is one component) is Cast Iron.
- S. Morgan Smith dwg # 3630-CA
- NSP dwg # H-009W1-9-411-00-017
- Due to the area not being cleaned up, it was difficult to tell if there were sleeves installed in the Wicket Gate rod holes that are located in the Bottom Plate or not. It is likely that there are **not** sleeves in this location since the OEM dwg does not indicate any sleeves.
- Also Note that the Rods are completely stationary (per design), so the need for sleeves during the initial installation was not necessary.
- Pitting Noted in bores of Wicket Gate Rod holes in the Bottom Ring

Recommendation:

- Clean Bottom Plate for further inspection & work
- Dimensionally inspect bores
- Verify if there are indeed sleeves or not
- Inspect and record the condition of each bore after cleaning
- Determine if sleeving is necessary to achieve a smooth, properly sized & positioned bore
- Steel Washers – that are positioned on the machined surface at the top of each hole
  - These washers set the height of the Wicket Gates
  - They need to be inspected (dimensionally & visually)
  - Likely these are all going to require replacement
  - Hydro Tech Inspection of these washers was not completed nor required per the SOW

Recommendation Details:

Corrective Action Approval and Sign-off		Date Signed
Hydro Tech Representative	Brandon Lyons	6/29/2012
Customer Representative		
Other as Required		

CI Number: 44968

Title: HYD – Wreck Cove Unit 2 Excitation System

Start Date: 2013/10
Final Cost Date: 2015/03
Function: Generation
Forecast Amount: $601,088

DESCRIPTION:

This project is to replace the aging excitation system on unit 2 at the Wreck Cove Hydro Station. The excitation system for a synchronous generator provides the direct current (DC) field current to the generator rotor. The DC field current is derived from rectifying an alternating current (AC) supply. The excitation system includes the thyristor rectifier bridges, Automatic Voltage Regulator (AVR), field circuit breaker, monitoring and control.

Summary of Related CIs +/- 2 years:
2015 CI 45370 HYD – WRC Unit 1 Excitation System $590K (est)

JUSTIFICATION:

Justification Criteria: Hydro

Sub Criteria: Equipment Replacement

Why do this project?

The excitation systems on both units at Wreck Cove are original to the plant and were installed in 1978. The excitation system on Unit 1 experienced a failure and was damaged in May 2013. The original manufacturer was unable to supply replacement parts or provide advice on how to proceed as they no longer supported the system. A temporary repair was implemented and the unit was returned to service. In addition, since July 2013, the excitation system on Unit 2 has been operating unreliably. At least ten unit trips in recent months are attributed to failure of the excitation system.

The system on Unit 2 is required to be replaced as soon as possible to mitigate the risk of an irreparable failure of the wiring, transformers, brushes and/or rotor due to protection failure.

Why do this project now?

Should the excitation system on Unit 2 fail, it is not likely NS Power will be able to repair it adequately and reliably, and therefore a new system will have to be procured. Lead time for delivery for a new system is typically five to six months. This amount of downtime cannot be tolerated at the Wreck Cove facility as it is a key generation unit, critical for use during peak grid demands and integral to meeting NS Power's renewable energy requirements. The planned outage in 2014 is of sufficient duration to allow for the replacement of the excitation system.

Why do this project this way?

By proactively replacing the excitation system, the risk of an unplanned outage due to an excitation system failure will be mitigated. Upgrade or refurbishment of the existing system is no longer possible. Recent excitation system replacements have been completed at a number of NS Power thermal plants. The system to be installed on Wreck Cove Unit 2 is identical to that installed successfully at the Lingan Generating Station.

CI Number : 44968-H697 - HYD-Wreck Cove Unit 2 Excitation System **Project Number** H697

Parent CI Number : -

Cost Centre : 480 - 480-Wreck Cove Hydro System **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		15,050	0	15,050
095		095-Thermal & Hydro Contracts AO		38,562	0	38,562
095		095-Hydro Term Labour AO		8,021	0	8,021
095		095-Hydro Regular Labour AO		11,014	0	11,014
001	023	001 - HYDRO Regular Labour	023 - HGP - Power Equip.-Station S	39,012	0	39,012
001	023	001 - HYDRO Regular Labour	023 - GTG - Power Equip.-Station S	9,185	0	9,185
004	023	004 - HYDRO Term Labour	023 - GTG - Power Equip.-Station S	8,636	0	8,636
004	023	004 - HYDRO Term Labour	023 - HGP - Power Equip.-Station S	25,908	0	25,908
011	023	011 - Travel Expense	023 - HGP - Power Equip.-Station S	3,000	0	3,000
012	023	012 - Materials	023 - HGP - Power Equip.-Station S	45,000	0	45,000
013	023	013 - POWER PRODUCTION Contracts	023 - HGP - Power Equip.-Station S	394,700	0	394,700
041	023	041 - Meals & Entertainment	023 - HGP - Power Equip.-Station S	3,000	0	3,000
			Total Cost:	601,088	0	601,088
			Original Cost:	122,408		

Wreck Cove Unit 2 Exciter Replacement
Summary of Alternatives

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Hydro	**CI Number:**	44968
Originator :		**Project No. :**	H697

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Replace Exciter	6.49%	-37,422,460	31,202,385	1	161.87%	0.8 years
B	Refurbish Exciter	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Based on posistive economic results including < 1 year payback, replace excitation system with a standardized model.

Notes/Comments :

Replace Exciter

Due to recent issues, assumed a 20% probability of failure of the excitation system in year 1. A failure would result in a 27 week outage. Because equipment would be irreparable, replacement would be required and lead time is anticipated to be 24 weeks. 3 additional weeks would be required for removal of the existing, and installation of the new excitation system. Due to the unplanned nature of the failure, there may also be increases in the cost of procuring and installing the new system which are not captured here.

Refurbish Exciter

The Original Equipment Manufacturer (OEM) has been unable to spply replacementparts or advise how to deal with issues on this system as it is no longer supported. Therefore, this option is not technically feasible and was not explored further.

Test 3

Test 4

Wreck Cove Unit 2 Exciter Replacement
Summary of Sensitivities

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Hydro	**CI Number:**	44968
Originator :		**Project No. :**	H697

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Exciter	6.49%	-37,422,460	31,202,385	1	161.87%	0.8 years
B	Refurbish Exciter	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Exciter	10%	-37,373,145	31,160,090	1	148.95%	0.9 years
B	Refurbish Exciter	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
Change:	**A**		49,315	-42,295	0	-12.92%	0.1 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Exciter	-10%	-33,630,899	28,039,851	1	147.66%	0.9 years
B	Refurbish Exciter	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
Change:	**A**		3,791,561	-3,162,534	0	-14.21%	0.1 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement		PV of Revenue Requirement	PV of Revenue Requirement	PV of Revenue Requirement	Delay?
	Yrs Delay:	1	2	3	
	A	916,591	1,943,366	3,084,122	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

**Formulas have been altered to reflect the end of year recognition of avoided ex*

Wreck Cove Unit 2 Exciter Replacement
Avoided Cost Calculations

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Hydro	**CI Number:**	44968
Originator :		**Project No. :**	H697

Replace Exciter

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	1	0	1		
Probability of Occurance (%)	0%	25%	0%	25%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	[redacted]					
Duration (Hours)	0	4536				
Totals	$0	$1,088,092	$0	$0	$0	$1,088,092
Total Capital Cost of Alternative						$601,088

Refurbish Exciter

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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)	[redacted]					
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

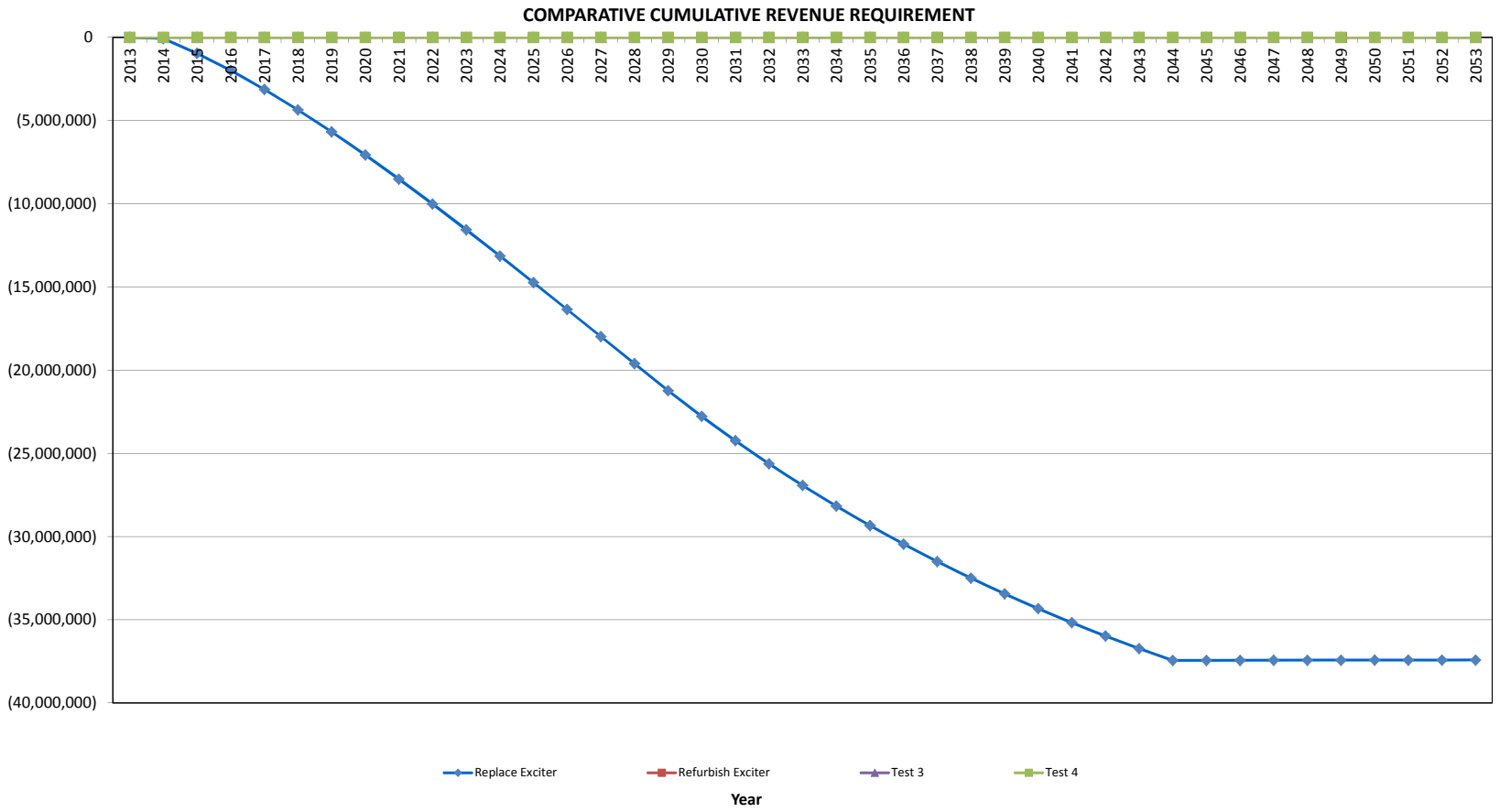
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	[redacted]					
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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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)	[redacted]					
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Wreck Cove Unit 2 Exciter Replacement
Replace Exciter

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	-	(543,490.9)	21,137.6	523,199.8	(543,490.9)	6,552.7	(536,938.2)	(504,214.7)	0.94	(504,214.7)
2015	-	-	1,088,092.3	-	40,584.2	479,961.5	1,088,092.3	(324,727.5)	763,364.8	673,154.1	0.88	168,939.3
2016	-	-	1,331,824.9	-	37,337.5	440,182.2	1,331,824.9	(401,291.1)	930,533.8	770,558.6	0.83	939,498.0
2017	-	-	1,584,871.7	-	34,350.5	403,585.3	1,584,871.7	(480,661.6)	1,104,210.1	858,650.5	0.78	1,798,148.5
2018	-	-	1,847,507.6	-	31,602.5	369,916.2	1,847,507.6	(562,930.6)	1,284,577.0	938,028.4	0.73	2,736,176.9
2019	-	-	2,120,014.9	-	29,074.3	338,940.6	2,120,014.9	(648,191.6)	1,471,823.3	1,009,259.2	0.69	3,745,436.1
2020	-	-	2,402,683.6	-	26,748.3	310,443.0	2,402,683.6	(736,539.9)	1,666,143.7	1,072,878.8	0.64	4,818,314.9
2021	-	-	2,695,811.0	-	24,608.5	284,225.2	2,695,811.0	(828,072.8)	1,867,738.2	1,129,393.8	0.60	5,947,708.6
2022	-	-	2,999,702.4	-	22,639.8	260,104.9	2,999,702.4	(922,889.4)	2,076,813.0	1,179,282.8	0.57	7,126,991.4
2023	-	-	3,314,671.2	-	20,828.6	237,914.2	3,314,671.2	(1,021,091.2)	2,293,580.0	1,222,997.6	0.53	8,349,989.0
2024	-	-	3,641,038.8	-	19,162.3	217,498.7	3,641,038.8	(1,122,781.7)	2,518,257.1	1,260,964.8	0.50	9,610,953.8
2025	-	-	3,979,135.2	-	17,629.3	198,716.5	3,979,135.2	(1,228,066.8)	2,751,068.4	1,293,586.5	0.47	10,904,540.3
2026	-	-	4,329,299.1	-	16,219.0	181,436.8	4,329,299.1	(1,337,054.9)	2,992,244.3	1,321,241.8	0.44	12,225,782.1
2027	-	-	4,691,878.0	-	14,921.5	165,539.6	4,691,878.0	(1,449,856.5)	3,242,021.4	1,344,287.9	0.41	13,570,070.0
2028	-	-	5,067,228.2	-	13,727.7	150,914.1	5,067,228.2	(1,566,585.1)	3,500,643.1	1,363,061.4	0.39	14,933,131.4
2029	-	-	5,455,715.7	-	12,629.5	137,458.6	5,455,715.7	(1,687,356.7)	3,768,359.0	1,377,878.9	0.37	16,311,010.3
2030	-	-	5,564,830.0	-	11,619.2	125,079.6	5,564,830.0	(1,721,495.4)	3,843,334.6	1,319,648.1	0.34	17,630,658.4
2031	-	-	5,676,126.6	-	10,689.6	113,690.9	5,676,126.6	(1,756,285.5)	3,919,841.1	1,263,890.9	0.32	18,894,549.3
2032	-	-	5,789,649.1	-	9,834.5	103,213.3	5,789,649.1	(1,791,742.5)	3,997,906.6	1,210,500.4	0.30	20,105,049.7
2033	-	-	5,905,442.1	-	9,047.7	93,573.9	5,905,442.1	(1,827,882.3)	4,077,559.8	1,159,374.7	0.28	21,264,424.3
2034	-	-	6,023,551.0	-	8,323.9	84,705.7	6,023,551.0	(1,864,720.4)	4,158,830.6	1,110,416.4	0.27	22,374,840.7
2035	-	-	6,144,022.0	-	7,658.0	76,546.9	6,144,022.0	(1,902,272.8)	4,241,749.1	1,063,532.5	0.25	23,438,373.2
2036	-	-	6,266,902.4	-	7,045.3	69,040.8	6,266,902.4	(1,940,555.7)	4,326,346.7	1,018,634.3	0.24	24,457,007.6
2037	-	-	6,392,240.5	-	6,481.7	62,135.3	6,392,240.5	(1,979,585.2)	4,412,655.2	975,636.7	0.22	25,432,644.3
2038	-	-	6,520,085.3	-	5,963.2	55,782.1	6,520,085.3	(2,019,377.8)	4,500,707.4	934,458.7	0.21	26,367,103.0
2039	-	-	6,650,487.0	-	5,486.1	49,937.2	6,650,487.0	(2,059,950.3)	4,590,536.7	895,022.5	0.19	27,262,125.5
2040	-	-	6,783,496.7	-	5,047.2	44,559.9	6,783,496.7	(2,101,319.3)	4,682,177.4	857,254.0	0.18	28,119,379.5
2041	-	-	6,919,166.6	-	4,643.5	39,612.8	6,919,166.6	(2,143,502.2)	4,775,664.5	821,082.2	0.17	28,940,461.7
2042	-	-	7,057,550.0	-	4,272.0	35,061.5	7,057,550.0	(2,186,516.2)	4,871,033.8	786,439.2	0.16	29,726,901.0
2043	-	-	7,198,701.0	-	3,930.2	30,874.2	7,198,701.0	(2,230,378.9)	4,968,322.0	753,260.0	0.15	30,480,161.0
2044	-	-	7,342,675.0	-	3,615.8	27,022.0	7,342,675.0	(2,275,108.4)	5,067,566.6	721,482.5	0.14	31,201,643.5
2045	-	-	-	-	3,326.5	23,477.9	-	1,031.2	1,031.2	137.9	0.13	31,201,781.4
2046	-	-	-	-	3,060.4	20,217.3	-	948.7	948.7	119.1	0.13	31,201,900.5
2047	-	-	-	-	2,815.6	17,217.6	-	872.8	872.8	102.9	0.12	31,202,003.4
2048	-	-	-	-	2,590.3	14,457.9	-	803.0	803.0	88.9	0.11	31,202,092.3
2049	-	-	-	-	2,383.1	11,918.9	-	738.8	738.8	76.8	0.10	31,202,169.1
2050	-	-	-	-	2,192.5	9,583.1	-	679.7	679.7	66.4	0.10	31,202,235.5
2051	-	-	-	-	2,017.1	7,434.1	-	625.3	625.3	57.3	0.09	31,202,292.8
2052	-	-	-	-	1,855.7	5,457.1	-	575.3	575.3	49.5	0.09	31,202,342.3
2053	-	-	-	-	1,707.2	3,638.2	-	529.2	529.2	42.8	0.08	31,202,385.1
Total	**-**	**-**	**142,784,399.8**	**(543,490.9)**	**508,807.4**		**142,240,908.8**	**(44,105,433.6)**	**98,135,475.2**	**31,202,385.1**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(5,000,000)
(10,000,000)
(15,000,000)
(20,000,000)
(25,000,000)
(30,000,000)
(35,000,000)
(40,000,000)
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
2053
Replace Exciter
Refurbish Exciter
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: HYDRO
CI# / FP#: 44968
Title: HYD-Wreck Cove Unit 2 Excitation System
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Hydro River Staff - Construction	pd	50.0	$ 345	$ 17,272		
1.2	Engineering Staff	pd	31.1	$ 439	$ 13,653		
1.5	Hydro River Staff - Removal	pd	50.0	$ 345	$ 17,272		
				Sub-Total	$ 48,197		
2	**012 Materials**						
2.1	Misc electrical supplies	lot	1	$ 30,000.00	$ 30,000		
2.2	Material Order payment	lot	1	$ 15,000.00	$ 15,000		
2.3					$ -		
				Sub-Total	$ 45,000		
3	**013 Power Production Contracts**						
3.1	Excitation System Purchase	lot	1	[redacted]		Cost Support 1 (same system as used at LIN3)	
3.2	Power Potential Transformer Purchase	lot	1				
3.3	OEM Commissioning Support	lot	1	$ 40,000.00	$ 40,000		
3.4	Power System Stabilizer Tuning	lot	1	$ 15,000.00	$ 15,000		
3.5	CSA Special Recognition	lot	1	$ 8,500.00	$ 8,500		
3.6							
				Sub-Total	$ 394,700		
5	**004 Term Labour**						
5.1	Hydro River Staff - Construction	pd	50.0	345	$ 17,272		
5.2	Hydro River Staff - Removal	pd	50.0	345	$ 17,272		
5.3							
				Sub-Total	$ 34,544		
6	**011 Travel Expenses**						
6.1	Travel	lot	1	$ 3,000.00	$ 3,000		
6.2					$ -		
				Sub-Total	$ 3,000		
8	**041 Meals and Entertainment**						
8.1	Meals	lot	1	$ 3,000.00	$ 3,000		
8.2					$ -		
				Sub-Total	$ 3,000		
9	**094 Interest Capitalized**						
9.1	AFUDC	1	lot	$ 15,050	$ 15,050		
9.2					$ -		
				Sub-Total	$ 15,050		
10	**095 Administrative Overhead**						
10.1	Hydro Regular Labour AO	1	lot	$ 11,014	$ 11,014		
10.4	Hydro Term Labour AO	1	lot	$ 8,021	$ 8,021		
10.5	Thermal & Hydro Contracts AO	1	lot	$ 38,562	$ 38,562		
				Sub-Total	$ 57,597		
				Sub-Total (without AO/AFUDC):	$ 528,441		
				Total Cost Estimate:	$ 601,088		
11	**Original Cost**						
11.1					$ 122,408		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.



Basler Electric

A PROPOSAL FOR

Nova Scotia Power Incorporated

Multi unit bid

ECS2100 Static Excitation System
Sales Quotation Number: SQ715301
August 5, 2011

12570 State Route 143 • Highland IL 62249-1074 U.S.A. • Phone 618/654-2341 • Fax: 618/654-2351 • www.basler.com

August 5, 2011

Dartmouth, Nova Scotia

Dear Ms Janice Trenholm:

We are pleased to present our proposal for an **ECS2100** Digital Static Excitation system for the Tufts Cove, Lingan, and Point Aconi Multi unit bid. This proposal is based on *your request Project Exciter Replacement Request for Proposal*. The ECS2100 is a fully tested and customer accepted modern all-digital excitation control system intended for application on the full range of utility power generation applications, well-proven for reliable operation and high performance in the electric utility industry.

The digital static excitation system in our proposal the Tufts Cove, Lingan, and Point Aconi Multi unit bid are furnished with a **dual-control channel**. The term "dual-control channel" is defined as two (2) independent logic schemes with each scheme having both an automatic regulator (terminal voltage regulation) and a manual regulator (field current regulation). Both the main and redundant channels are configured with identical sets of printed circuit modules. Each channel continuously monitors the system and each has the capability of performing the voltage regulation, limiter, protection, sequence control, and firing functions. All limiter and protection functions are available in both automatic and manual modes of operation.

The ECS2100 **static excitation system** implements static excitation system control matching the IEEE Type ST4B excitation system model structure, as defined in *IEEE Recommended Practice for Excitation System Models for Power System Stability Studies, IEEE Standard 421.5-2005*. This design is widely accepted as a standard within North America.

The ECS2100 **Power System Stabilizer** (PSS) implements a dual-input accelerating power stabilizer matching the IEEE PSS2B structure, as defined in *IEEE Recommended Practice for Excitation System Models for Power System Stability Studies, IEEE Standard 421.5-2005*. This design is the accepted standard within North America and requires only PT and CT inputs to derive the input signals to the stabilizer.

The proposed logic scheme includes standard limiters and protection features to match those specified. Please see the attached product bulletin *ECA* for a detailed description of the many technical and software features of the proposed systems.

The digital static excitation system in our proposal *is* furnished with (N+1) draw-out power converters (*i.e.,* power drawers). The systems are forced-air cooled with redundant forced-draft fans/blowers. Our draw-out thyristor bridge assemblies, more commonly referred to as *power drawers,* with N+1 redundancy, make this a superior system design, in that the one of the bridges can be withdrawn under load without affecting the generator output. Therefore, bridge maintenance and repairs can be performed on-line with no loss of revenue. Power circuits also include voltage suppression; de-excitation controls with discharge resistor; and field-flashing for build-up support. Power will be supplied from the power potential transformer (PPT) offered as a separate item.

A draw-out power circuit breaker is included as the main disconnect device (41A). It is fully rated and also meets the most stringent operational safety "rack-out/tag-out" requirements.

SQ Nº. 715301

We are pleased to present our proposal for ECS2100 Digital Automatic Voltage Regulator (AVR) systems for Point Tupper. This proposal is based on *your request Project Exciter Replacement Request for Proposal*. The ECS2100 is a fully tested and customer accepted modern all-digital excitation control system intended for application on the full range of utility power generation applications, well-proven for reliable operation and high performance in the electric utility industry.

The voltage regulator portion of these digital static excitation system in our proposal are furnished with a **dual-control channel**. The term "dual-control channel" is defined as two (2) independent logic schemes with each scheme having both an automatic regulator (terminal voltage regulation) and a manual regulator (field current regulation). Both the main and redundant channels are configured with identical sets of printed circuit modules. Each channel continuously monitors the system **and each has the capability of performing the voltage regulation, limiter, protection, sequence control, and firing functions.** All limiter and protection functions are available in both automatic **and manual** modes of operation.

The ECS2100 **Power System Stabilizer** (PSS) implements a dual-input accelerating power stabilizer matching the IEEE PSS2B structure, as defined in *IEEE Recommended Practice for Excitation System Models for Power System Stability Studies, IEEE Standard 421.5-2005*. This design is the accepted standard within North America and requires only PT and CT inputs to derive the input signals to the stabilizer.

The proposed logic scheme includes limiters and protection features to match those *specified.* Please see the attached product bulletin *ECA* for a detailed description of the many technical and software features of the proposed systems.

The digital AVR systems in our proposal are furnished with dual (N+1) fixed power converters. The systems are cooled with natural convection of air, without the need of any fans/blowers. Power circuits also include voltage suppression and de-excitation controls.

Power will be supplied from the power potential transformer included in our proposal as a separate item. A three-phase contactor is included as the main disconnect device (41A).

As requested per Nova Scotia document "Excitation Supplier Addendum" Basler has included base pricing for all units requested, with a multi unit discount pricing table presented on the following page, outlining our multiyear proposal for purchase of all quoted units as your single source supplier.

Please do not hesitate to contact Roger Labbé, your Basler Electric representative, or Gene Asbury should you have any questions. We look forward to your purchase order and to working with you on this project. Thank you for considering Basler Electric Company as your supplier for excitation control equipment.

Sincerely,

John Roane

Proposal Engineer
Excitation Systems Engineering
Power Systems Group
Basler Electric Company

SINGLE SOURCE SUPPLIER DISCOUNT TABLE

Generator	System Type	Base price (Single System)	Year of Delivery	Reduced Price (Multiple Unit Supply, per stated delivery schedule*)
Tufts Cove #3	3 pwr drwr	[redacted]	2012	[redacted]
TC PPT			2012	
Lingan #3	4 pwr drwr		2012	
Lg PPT			2012	
Pt. Tupper G2	2 fxd bridges		2012	
PT PPT			2012	
Tufts Cove #2	3 pwr drwr		2012	
TC PPT			2012	
Lingan #4	4 pwr drwr		2013	
Lg PPT			2013	
Point Aconi #1	3 pwr drwr		2013	
PA PPT			2013	

Total Base Price	Total Discount Price
[redacted]	[redacted]

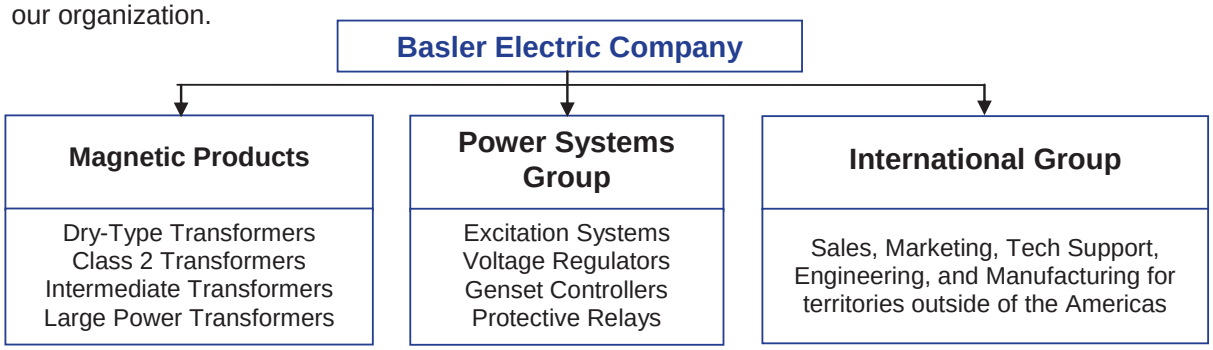
Introduction

Corporate

From a modest beginning in 1942, Basler Electric has built a worldwide reputation for advanced product development and precision manufacturing of products to utilize and control the power of electricity.

A privately held corporation, Basler is under second and third generation ownership, with corporate headquarters in Highland, Illinois, and other facilities located in Taylor, Texas; Piedras Negras, Mexico; Wasselonne, France; Suzhou, China; and Singapore. Basler Electric has a global workforce that can concentrate on customer needs and develop products to meet those needs. A below diagram illustrates the basic product offerings and corporate overview of our organization.





Quality

Basler Electric has received certification to ISO 9001-2008 for its facilities in Highland, Illinois; Wasselonne, France; Taylor, Texas; and Suzhou, China. Basler's Quality Policy applies to all of its manufacturing facilities and uses the Quality System designed to comply with the requirements of the ISO certification.

ISO 9001-2008
Highland, IL USA Wasselonne, France
Taylor, TX USA Suzhou, China

The system stresses problem prevention, continuous process improvement, and compliance to well-documented procedures that involve all employees, suppliers, and associates. It encompasses all phases of quality planning, audit methods, quality records, work instructions, and test and inspection procedures. It establishes controls throughout the entire organization to ensure conformance to requirements in all departments of the company. It also ensures meeting quality objectives and minimizes the possibility of compromises that could affect product quality and reliability.

The management of Basler Electric is committed to providing the resources necessary to maintain the Quality System and processes associated with ISO Certification and to strive for continuous improvement through quality management.

ECS2100 General System Information

The fully static exciter, consisting of digital excitation control and rectifier bridge assemblies cooled with redundant fans, complete with accessories listed below, mounted and wired and tested in a NEMA 1 Control/Rectifying cubicle.

The ECS2100 is a multi-microprocessor excitation control system that provides advanced technology to precisely control, protect, and monitor synchronous generators, including new and existing applications that are driven by all types of prime movers, such as steam, gas, hydro, and diesel. Its multifunctional design allows the ECS2100 to operate as a voltage regulator or as a static exciter, providing excitation currents up to 10,000 Adc and field forcing levels up to 1500 Vdc.

Example System Designs



Figure 1- ECS2100 System Rated 1000A, N+1 Power Drawers



Figure 2- ECS2100 System Rated 2000A, N+1 Power Drawers



Figure 3- ECS2100 System Rated 2000A, Fixed Bridges



Figure 4- ECS2100 System Rated 3000A, Fixed Bridges

Basler Electric
ROUTE 143, BOX 269
HIGHLAND, ILLINOIS 62249, U.S.A.
http://www.basler.com, info@basler.com
PHONE 618/654-2341Operator-assisted Fax 618/654-2341, ext 248 FAX 618/654-2351

Power System Control and Protection for the Electric Power Industry

QUOTATION

TO: **Nova Scotia Power Inc.**
315 Windmill Road
Dartmouth, Nova Scotia
Canada B3A 1H3

QUOTATION (SQ) No.: 715301

DATE of QUOTE: August 5, 2011

ATTN: Ms. Janice Trenholm, 902-428-7697 **janice.trenholm@nspower.ca**

REF: RFP for Tufts Cove, Lingan, Point Aconi, & Point Tupper Exciter Replacement

Item	Qty	Description	Price Each

SEE PAGE 3 FOR DISCOUNT PRICING ON SINGLE SOURCE SUPPLIER OPTON FOR ALL UNITS.

Tufts Cove Units 2 & 3 Static Exciter **(Base Price)**

1 **2** **ECS2100 (for 2012 Shipment)** **US$** [redacted]

Supply of a Fully Static Exciter – to be installed by *others.* The fully static exciter, consisting of digital excitation control and rectifier bridge assemblies cooled with redundant fans, complete with accessories listed below, mounted and wired and tested in a NEMA 2 Control/Rectifying cubicle – for use with a brush-type synchronous generator with main field requirements of 1200 **Amperes at** 250 **Volts** at rated load and power factor. **The static exciter includes a multi-bridge design that provides a minimum of N+1 bridge redundancy,** with

Continuous capacity of 1380 Amperes,

with a 30-second forcing rating of 1920 Amperes (160% of 1200) for operation in 40°C ambient, at up to 3300 feet above sea level

High Initial Response, with ceiling voltage at 724 Volts, based on source voltage at rated level and connection to the PPT (offered as a separate item) with a secondary at 600 Volts -

The quoted system includes:

NEMA-250 Type 2, indoor drip-tight, Excitation Control/Rectifying Enclosure

Cubicle with roof extensions to protect against dripping water
Exterior ANSI Gray #61 (light gray)

Dimensions of ECS2100 Control/Rectifying Enclosure – 144”W x 90”/102”H x 60½”D, weighing approximately 3½ tons

Dual-Control Channel

With automatic voltage regulator (AVR), automatic control, manual control, excitation limiters, integrated protection systems, Integrated Digital AVR set point adjuster

Item	Qty	Description	Price Each

ECS2100 Excitation Equipment - continued

Regulation

Paralleling Compensation
Reactive Current Compensation (*REAC_COMP*)
Line Drop Compensation *(LINE_DROP)*
Adjuster Follower Circuits for Bumpless Transfer (auto-manual)
Bus Voltage Matching – during off-line operation to support synchronizing
Transient Gain Reduction transfer function (*TGR*)
Manual control
available as field *current* regulator (*FCR*)
or field *voltage* regulator (*FVR*)
Auto-Manual Control Transfer – operator action

Limiting Functions including:

Under Excitation Limiter (*UEL*)
Scalable from H_2 pressure value (*PRESSURE_RECAL*)
Over (Maximum) Excitation Limiter (*OEL*)
Scalable from H_2 pressure value (*PRESSURE_RECAL*)
Instantaneous Field Current Limiter (*INST_CUR*)
separate on-line and off-line pickups
Volts/Hertz Limiter (*HXL*)
separate on-line and off-line timing curves
Generator Overvoltage Limiter (*OVL*)

Protective Functions including:

Under Excitation Protection (*UEP*)
Loss of Field (40Q) /Minimum Excitation Protection (*MEP*)
Loss of Field (*40Q*), Alarm/Transfer/Trip with delay
Over Excitation Protection (*OEP*)
Scalable from H_2 pressure value (*PRESSURE_RECAL*)
Instantaneous Field Over-Current Protection (*INST_CUR*)
Separate on-line and off-line pick-ups
Volts/Hertz Protection (*HXP*)
(24), Separate on-line and off-line timing curves
Generator Over voltage Protection (*OVP*)
Loss of PT sensing (*LOS_SENS*)
with Transfer to Metering PTs and/or to Field Current Regulation
Generator Field Ground Detector (*FLDGND / 64F*)

Monitoring Function

Conduction of Current into Power Converter
Rotor (field winding) Temperature Monitoring

Item	Qty	Description	Price Each

ECS2100 Excitation Equipment - continued

Power System Stabilizer (PSS),

Type: Two input; utilizing compensated frequency and power
(IEEE 421.5 Model PSS-2B)
(two or more line CTs –SUPPLIED BY OTHERS – required)

Current Transformers for Control of AVR and PSS: Basler Electric has not included the CTs for the generator bus in the quoted scope of supply. This proposal has been made with the assumption that these CTs and associated cables will be supplied and installed by Others. Please remember that these instrument transformers are required for proper operation of the AVR and the PSS.

On-line Bode Analysis for PSS Tuning

Frequency vs. Gain/Phase: This block creates a range of sinusoidal signals and uses those signals to obtain the frequency response of the chosen regulator/exciter control loop.

Self-diagnostic documentation function

Self-diagnostic documentation function
Event and Alarm Recorder
Configured with Four (4) Event Recorders, each with eight (8) channels
Data Logger

Basler Electric IDP-1200, Interactive Display Panel

12.1 inch (diagonal), high-resolution TFT color LCD touchscreen, operator's interface to monitor status of ECS2100, to control operation, to adjust setpoints, etc.
Ethernet, USB and CompactFlash™ interface ports
Please see *Bulletin SVU*

Three (3) Analog I/O Modules per channel
Four (4) Digital I/O Modules per channel

Redundant Power Inputs,

each logic/control module accepts two sources of power, for enhanced fault tolerance

Redundant Power Supplies,

a paralleled set of dual sourced, power supplies, to feed the logic/control modules
plus a second set of single-sourced, power supplies to feed the other power inputs of the logic/control modules

Power Supplies Dual Sources,

Inputs contribute power to the "auctioneering circuit" that provides an interface to accept both AC and DC sources,
both the PPT's secondary and the **125**-V station battery.

Three (3) Power Converters (N+1), drawout, *power drawers*

cooled by forced air – redundant fans
On-line maintenance
One Rectifier reparable or replaceable with the excitation system energized
patented active Temperature balancing among parallel bridges

Incoming AC Line surge suppression

Item	Qty	Description	Price Each

ECS2100 Excitation Equipment - continued

De-Excitation module – for field discharge for shutdown
Crowbar module – for protection during pole slip
Field Discharge Resistor (FDR)
Shaft Voltage Suppression Network
Field Build-Up Circuit, flashing from 125-VDC source
Field Build-Up Circuit, flashing from 600-Volt AC source

AC Field Breaker – '41-A' Device

Drawout Air Circuit Breaker – EATON Magnum DS

DC Field Disconnect – isolating switch

Test Transformer & Switch –

means of testing when generator is not available

Cabinet space heater

Thermostat for controlling space heater
Two (2) AC receptacles, for 120 V station-fed power
Shorting current transformer (CT) blocks, for CT secondaries

Standard Factory Tests

Witness Testing – at workshop, three consecutive workdays
Special Excitation SystemTests:
Heat Run – 48 Hours
Six (6) Sets O&M Instruction Books, Hardcopy & CD-ROM copies
Six (6) Sets *ccTool*™ Software Level 3 – compatible with Windows™
High-Level Logic for the Digitally-Processed Excitation Controller
Control functions diagrammed in the form of blocks
Inputs and Outputs shown with corresponding variable assignments
Labels and Terms with nomenclature consistent with synchronous machine excitation control

Power Potential Transformer **(Base Price)**

1a **2** **NEMA 1 PPT Enclosure (for 2012 Shipment)** **US$** [redacted]

containing:

PPT, rated 1.17 MVA, 3 phase, 60 Hz
Type AA, 220°C Insulation, 115°C Rise
Primary: 14400 Volts, 95 kV BIL, with fuses
Secondary: 600 Volts, 10 kV BIL

Option - CSA Special Recognition

1b **Lot** **CSA Special Recognition for Exciter quoted as Item 1** **US$** [redacted]

Pricing for CSA "Special Recognition" is based upon 1 site visit by CSA personnel for final system CSA approvals. Pricing is dependent on final schedule (TBD), and Basler reserves the right to adjust pricing for additional scheduling requirements needed, or additional CSA visits being required by CSA.

QUOTATION (SQ) No.: 715301 Page 11 August 5, 2011

Item	Qty	Description	Price Each
		Lingan Units Static Exciter	**(Base Price)**
2	**2**	**ECS2100 (for 2012 Shipment)** Supply of a Fully Static Exciter – to be installed by *others.* The fully static exciter, consisting of digital excitation control and rectifier bridge assemblies cooled with redundant fans, complete with accessories listed below, mounted and wired and tested in a NEMA 2 Control/Rectifying cubicle – for use with a brush-type synchronous generator with main field requirements of 2200 **Amperes at** 350 **Volts** at rated load and power factor. **The static exciter includes a multi-bridge design that provides a minimum of N+1 bridge redundancy,** with **Continuous capacity of 2530 Amperes,** **with a 30-second forcing rating of 3520 Amperes (160% of 2200) for operation in 40°C ambient, at up to 3300 feet above sea level** **High Initial Response, with ceiling voltage at 724 Volts,** based on source voltage at rated level and connection to the PPT (offered as a separate item) with a secondary at 600 Volts - **Dimensions of ECS2100 Control/Rectifying Enclosure – 144"W x 90"/102"H x 60½"D, weighing approximately 3½ tons** **Four (4) Power Converters (N+1), drawout, *power drawers*** **With the same features as quoted in Item 1 but sized for higher continuous ratings.**	**US$** [redacted]
		Power Potential Transformer	**(Base Price)**
2a	**2**	**NEMA 1 PPT Enclosure (for 2012 Shipment)**	**US$** [redacted]
	2	**NEMA 1 PPT Enclosure (for 2013 Shipment)** containing: PPT, rated 2.15 MVA, 3 phase, 60 Hz Type AA, 220°C Insulation, 115°C Rise Primary: 14400 Volts, 95 kV BIL, with fuses Secondary: 600 Volts, 10 kV BIL	**US$** [redacted]

QUOTATION (SQ) No.: 715301 Page 12 August 5, 2011

Item	Qty	Description	Price Each
		Point Aconi Unit 1 Static Exciter	**(Base Price)**
3	**1**	**ECS2100 (for 2012 Shipment)** Supply of a Fully Static Exciter – to be installed by *others.* The fully static exciter, consisting of digital excitation control and rectifier bridge assemblies cooled with redundant fans, complete with accessories listed below, mounted and wired and tested in a NEMA 2 Control/Rectifying cubicle – for use with a brush-type synchronous generator with main field requirements of 1660 **Amperes at** 420 **Volts** at rated load and power factor. **The static exciter includes a multi-bridge design that provides a minimum of N+1 bridge redundancy,** with **Continuous capacity of 1909 Amperes,** **with a 30-second forcing rating of 2656 Amperes (160% of 1660) for operation in 40°C ambient, at up to 3300 feet above sea level** **High Initial Response, with ceiling voltage at 724 Volts,** based on source voltage at rated level and connection to the PPT (offered as a separate item) with a secondary at 600 Volts - **Dimensions of ECS2100 Control/Rectifying Enclosure – 144"W x 90"/102"H x 60½"D, weighing approximately 3½ tons** **Four (4) Power Converters (N+1), drawout, *power drawers*** **With the same features as quoted in Item 1.**	**US$** [redacted]
		Power Potential Transformer	**(Base Price)**
3a	**2**	**NEMA 1 PPT Enclosure (for 2012 Shipment)** containing: PPT, rated 1.62 MVA, 3 phase, 60 Hz Type AA, 220°C Insulation, 115°C Rise Primary: 14400 Volts, 95 kV BIL, with fuses Secondary: 600 Volts, 10 kV BIL	**US$** [redacted]

QUOTATION (SQ) No.: 715301 Page 13 August 5, 2011

Item	Qty	Description	Price Each
		Point Tupper Unit AVR	**(Base Price)**
4	**1**	**ECS2100 AVR (for 2012 Shipment)**	**US$** [redacted]

The voltage regulator shall be designed with two fully redundant voltage regulator channels such that a single failure of the voltage regulator will not cause a loss of proper excitation control to the exciter. The redundant channels shall function in a primary/backup mode. Each channel shall contain all equipment needed for generator voltage regulation including, but not limited to: transducers, power supplies and associated disconnects and breaker/contactors, control and protection circuits, firing circuits, and thyristor power bridges. The voltage regulator shall be designed with redundant logic power supplies, firing circuits and thyristor power bridges. **On line replacement/maintenance of the failed device of the channel not in control shall be provided.** Redundant firing circuits shall operate in parallel. An alarm contact shall be provided to identify a failed firing circuit. **The thyristor power bridge shall be sized so only convection cooling is required.**

Continuous capacity of 40 Amperes,

with a 30-second forcing rating of 64 Amperes (160% of 40) for operation in 40°C ambient, at up to 3300 feet above sea level

High Initial Response, with ceiling voltage at 288 Volts, based on source voltage at rated level and connection to the PPT (offered as a separate item) with a secondary at 240 Volts -

NEMA-250 Type 2, indoor drip-tight, Excitation Control/Rectifying Enclosure

Dimensions of approximately – 72”W x 90”H x 30”D, weighing approximately 1½ tons

Dual-Control Channel

With automatic voltage regulator (AVR), automatic control, manual control, excitation limiters, integrated protection systems, Integrated Digital AVR set point adjuster

Regulation

Paralleling Compensation
- Reactive Current Compensation (*REAC_COMP*)
- Line Drop Compensation *(LINE_DROP)*

Adjuster Follower Circuits for Bumpless Transfer (auto-manual)
Bus Voltage Matching – during off-line operation to support synchronizing
Transient Gain Reduction transfer function (*TGR*)
Manual control
- available as field *current* regulator (*FCR*)
- or field *voltage* regulator (*FVR*)

Auto-Manual Control Transfer – operator action

Item	Qty	Description	Price Each

ECS2100 Excitation Equipment - continued

Limiting Functions including:

Under Excitation Limiter (*UEL*)
Scalable from H_2 pressure value (*PRESSURE_RECAL*)
Over (Maximum) Excitation Limiter (*OEL*)
Scalable from H_2 pressure value (*PRESSURE_RECAL*)
Instantaneous Field Current Limiter (*INST_CUR*)
separate on-line and off-line pickups
Volts/Hertz Limiter (*HXL*)
separate on-line and off-line timing curves
Generator Overvoltage Limiter (*OVL*)

Protective Functions including:

Under Excitation Protection (*UEP*)
Loss of Field (40Q) /Minimum Excitation Protection (*MEP*)
Loss of Field (*40Q*), Alarm/Transfer/Trip with delay
Over Excitation Protection (*OEP*)
Scalable from H_2 pressure value (*PRESSURE_RECAL*)
Instantaneous Field Over-Current Protection (*INST_CUR*)
Separate on-line and off-line pick-ups
Volts/Hertz Protection (*HXP*)
(24), Separate on-line and off-line timing curves
Generator Over voltage Protection (*OVP*)
Loss of PT sensing (*LOS_SENS*)
with Transfer to Metering PTs and/or to Field Current Regulation
Generator Field Ground Detector (*FLDGND / 64F*)

Monitoring Function

Conduction of Current into Power Converter
Rotor (field winding) Temperature Monitoring

Power System Stabilizer (PSS),

Type: Two input; utilizing compensated frequency and power
(IEEE 421.5 Model PSS-2B)
(two or more line CTs –SUPPLIED BY OTHERS – required)

Current Transformers for Control of AVR and PSS: Basler Electric has not included the CTs for the generator bus in the quoted scope of supply. This proposal has been made with the assumption that these CTs and associated cables will be supplied and installed by Others. Please remember that these instrument transformers are required for proper operation of the AVR and the PSS.

On-line Bode Analysis for PSS Tuning

Frequency vs. Gain/Phase: This block creates a range of sinusoidal signals and uses those signals to obtain the frequency response of the chosen regulator/exciter control loop.

Self-diagnostic documentation function

Self-diagnostic documentation function
Event and Alarm Recorder
Configured with Four (4) Event Recorders, each with eight (8) channels
Data Logger

Item	Qty	Description	Price Each

ECS2100 Excitation Equipment - continued

Basler Electric IDP-1200, Interactive Display Panel
12.1 inch (diagonal), high-resolution TFT color LCD touchscreen, operator's interface to monitor status of ECS2100, to control operation, to adjust setpoints, etc.
Ethernet, USB and CompactFlash™ interface ports
Please see *Bulletin SVU*
Three (3) Analog I/O Modules per channel
Four (4) Digital I/O Modules per channel
Redundant Power Inputs,
each logic/control module accepts two sources of power, for enhanced fault tolerance
Redundant Power Supplies,
a paralleled set of dual sourced, power supplies, to feed the logic/control modules
plus a second set of single-sourced, power supplies to feed the other power inputs of the logic/control modules
Power Supplies Dual Sources,
Inputs contribute power to the "auctioneering circuit" that provides an interface to accept both AC and DC sources, both the PPT's secondary and the **125**-V station battery.
Fixed Power Converters (N+1)
cooled by naturally convected air – no fans
Disconnect switches-to allow online maintenance
Blown Fuse Detection
Shaft Voltage Suppression Network
AC Exciter Field Contactor – '41-A' Device
In circuit between PPT and rectifiers
CT/PT test switch and shorting terminal block
Cabinet space heater
Thermostat for controlling space heater
Two (2) AC receptacles, for 120 V station-fed power
Spare Terminals, 15%
Standard Factory Tests
Witness Testing – at factory in Highland, Illinois – two workdays
Six (6) Sets O&M Instruction Books, Hardcopy & CD-ROM copies with "As-Built" Drawings
Six (6) Sets *ccTool*™ Software Level 3 – compatible with Windows™
High-Level Logic for the Digitally-Processed Excitation Controller
Control functions diagrammed in the form of blocks
Inputs and Outputs shown with corresponding variable assignments
Labels and Terms with nomenclature consistent with synchronous machine excitation control

Power Potential Transformer **(Base Price)**

4a **2** **NEMA 1 PPT Enclosure (for 2012 Shipment)** **US$** [redacted]
PPT, rated 13 KVA, 3 phase, 60 Hz
Type AA, 220°C Insulation, 115°C Rise
Primary: 480 Volts, 10 kV BIL
Secondary: 240 Volts, 10 kV BIL

Item	Qty	Description	Price Each

Optional Remote Interface Display Panel

5 Ea. Assembly for Remote IDP-1200, with Accessories, **US$** [redacted]
includes
programming the device to control the ECS2100 system from remote panel
Power supply assembly
Ethernet Switch
Basler Electric IDP-1200, Interactive Display Panel
12.1 inch (diagonal), high-resolution color touchscreen operator's interface to monitor status of ECS2100, to control operation, to adjust setpoints, etc.

Basler Electric Field Service Engineering

6 Ea Basler Electric Field Service Engineering **US$** [redacted]
NOT A FIRM PRICE **NOT A FIRM PRICE**
Estimated – BASED ON THE FOLLOWING
Single mobilization, one engineer
Five (5) consecutive non-holiday weekdays on-site with no overtime
One full week-end day of travel outbound and one full week-end day of travel for return
Estimated Daily Living Expenses
Estimated Air Fare for Travel from St. Louis to *Halifax (YHZ)* and back

ECS2100 Field Service Commissioning Estimate			
	DAYS ON SITE (INPUT):	5	
Qty	Description	Rate	Extended
5	Normal, Standby & Travel Days	[redacted]	
0	Overtime, Weekday Hours		
16	**Weekend**/Holiday Hours		
7	**Estimated** Daily Living Expenses		
1	**Estimated** Air Fare (variable by site)		
0	Other:		
	TOTAL ESTIMATE:		

All estimates for support services are based on present-day rates and on general experience of the durations for such service. This estimate is an example, provided as a courtesy to assist the client in budgeting future service work. This estimate must not be regarded as a firm price offer for such services.

QUOTATION (SQ) No.: 715301 Page 17 August 5, 2011

Item	Qty	Description	Price Each

POWER SYSTEM STABILITY ENGINEERING SERVICES

7 **Ea.** **Power System Stabilizer (PSS) Tuning Support** **US$**[redacted]

Mathematical Simulation Modeling of PSS and digital excitation controller
Stabilizer Settings (Tuning)
Report of
IEEE Model of Excitation System and
Power System Stabilizer

Not Included in Fee for Tuning Support: *Item 7* does NOT include the following:

- On-site technical work of measuring generator characteristics
- On-site technical verification of the performance of the stabilizer

These on-site tasks are discussed elsewhere – *Item 6*, in this proposal - as field engineering services. Mobilization, for tuning a PSS will require the above-described mathematical study as well as 2-3 days on site for field service engineer to perform measurement tests and testing to verify performance.

Machine Data: Tufs Cove: 150MW, 14400V, 60Hz Excitation: 250VDC at 1200ADC
Lingan: 150MW, 14400V, 60Hz Excitation: 350VDC at 2200ADC
Point Aconi: 150MW, 14400V, 60Hz Excitation: 420VDC at 1660ADC
Point Tupper: 150MW, 14400V, 60Hz Excitation: NA VDC at <40ADC

QUOTATION (SQ) No.: 715301 Page 18 August 5, 2011

Item Qty Description Price Each

Schedule Notes

Project Milestone	Weeks	Explanation
Engineering Drawing Creation	4	Approval drawings for submittal can be created in approximately 4 weeks ARO, and will consist of system interconnection diagram, excitation cubicle outline, and transformer enclosure outline (if ordered) drawings.
Customer Drawing Review & Approval	2	The quoted lead-time anticipates customer approval notification within 2 weeks of drawing submittal. System design and/or manufacturing will remain on hold until customer approval is received. If the approval process extends beyond 2 weeks, Basler Electric reserves the right to re-evaluate quoted shipping schedule based on manufacturing backlog.
System Manufacturing Process	18	Based on current production backlogs and material procurement lead times, systems can typically be manufactured in 18 weeks after engineering designs are released to the factory.
Total Time ARO (After Receipt of Order) Estimate	**24**	**This total 24-week time covers the Drawing Creation, Customer Review/Approval, Procurement, and Manufacturing Processes. Please contact Basler if shorter lead times are required.**

Delivery: Delivery will be made FOB Seller's manufacturing plant, title and risk of loss shall pass to Buyer at that point, freight collect.

PSS Tuning: In accordance with Section 9.3 of the Field Service Terms, Conditions, and Rates **Form No. FF100051**, if this quotation includes Power System Stabilizer (PSS) tuning, the attached PSS data collection form must be completed and submitted to Basler Electric Company 30 days prior to the requirement of such tuning.

Field Service: Attached you will find Basler Electric's current Field Service Terms, Conditions, and Rates **Form No. FF100051**, for on-site technical support pertaining to startup and/or training. These terms, conditions and rates are subject to change, and may vary from the time your service work on-site is actually required. Please contact Basler for the most current published rates. Any on-site technical support will be invoiced at the rates published at the time the service work is completed.

Client's Observation of FAT: Basler Electric's project coordinator will notify customer's contact with at least two weeks' notice of the schedule for final factory acceptance testing (FAT). Prior to the testing, Basler Electric's project coordinator will submit the factory acceptance testing plan for review and acceptance. The customer will notify Basler Electric's project coordinator of who will be visiting the factory and when.

Witness Testing: Base scope of work includes support to arrange for customer/designate to witness factory acceptance tests. Basler will support witness test – for three consecutive working days - at no additional charge to NSPI. Additional time of witness testing can be supported for a charge of $[redacted] per day.

Item	Qty	Description	Price Each

Terms and Conditions: Basler Terms and Conditions **Form No. FA100001** apply to this quotation. All prices are quoted in United States Dollars (US$). Quoted price is based on current costs of raw material and purchased parts. Due to the present state of unprecedented instability of these costs, adjustments to the selling price may be required on production releases. The unit price for equipment included in this quotation is valid for 60 days from the date of issuance. If this quotation includes an ESTIMATE for field service work, please note that the ESTIMATED price is not fixed, and those rates are subject to change dependent upon the date the service is actually required.

This quote has been provided based on Basler Electric terms and conditions form FA100001 however Basler is willing to negotiate a mutually agreeable set of terms and conditions at the time of order.

Progress payment invoices against the equipment portion of this quotation will be issued, upon credit approval at time of order placement, at the following project milestones:

1. Drawings sent out for customer approval - 20% of equipment pricing (net thirty days).
2. Drawings returned approved and final engineering design completed and released to manufacture - 30% of equipment pricing (net thirty days).
3. Equipment shipped-remainder of equipment pricing - 50% of equipment pricing (net thirty days).

Invoices for services will be issued at the time the indicated service is completed.

Your Basler Sales Rep is:

Mr. Roger Labbé

Henery & Sons, Inc.
87, Aurora
Pointe-Claire, Québec
Canada H9R 3G5

Phone: (514) 697-4197
FAX: (514) 697-0411
E-Mail: RLabbe@Henery.ca
WWW: http://www.henery.ca/

Quote Prepared by:
BASLER ELECTRIC CO.

John Roane

Proposal Engineer

618-654-2341
618-654-2351

cc: Jeremy Loemker, Product Line Specialist – Excitation Systems, Basler Electric, Highland, x 715
Gene Asbury, Applications Specialist, Basler Electric, Highland, x 747
Karen Henderson, Project Coordinator – ECS2100 Excitation Systems, Basler Electric, Highland, x 755
Steve Etherton, Engineering Manager - Excitation Systems Engineering, Highland, x 327

NSPI Excitation/AVR System Replacements
Recommendation
Oct 2011

NOVA SCOTIA POWER
An Emera Company

Submitted to:

- Mark Sidebottom — General Manager Power Production
- Mark Savory — VP Technical & Construction

The recommendation for excitation system replacements is presented on behalf of the engineering and procurement personnel, which was made up of:

- Willard Cameron — Engineer Specialist
- Chuck Hooper — Engineer Specialist
- Karl Nowlan — Senior Electrical Engineer, Tufts Cove Generating Plant
- Janice Trenholm — Procurement Team Lead, Tufts Cove Generating Plant

Dan Brennan was consulted on the recommendation and had no issues or concerns with either [redacted] or Basler.

This initiative was under taken to enter into a preferred supplier arrangement for replacement of NSPI's aging and obsolete excitation systems. It is anticipated that at least six excitation systems will be replaced over the next few years.

NSPI's objective is to select a supplier who is competitive from a quality and cost perspective, has the ability to meet the required schedules, meets or exceeds the required technical specifications, has a well proven excitation system with significant installed base, can immediately respond and provide exceptional customer service to NSPI, if and when required.

NSPI Excitation/AVR System Replacements
Recommendation
Oct 2011

NOVA SCOTIA POWER An Emera Company

Recommendation:

It is recommended that NSPI award the supply of excitation system replacements to Basler Electric, located in Highland, Illinois.

Upon approval of this recommendation, NSPI will negotiate the Terms and Conditions and issue a Purchase Order to Basler for Tufts Cove G3 and Lingan G3 for installation in 2012.

Total expenditures for each system.

- Tufts Cove G3 $[redacted] + [redacted] (spares)=$[redacted]
- Lingan G3 $[redacted] + [redacted] (Spares)=$[redacted]

Background:

The excitation systems on NSPI's large thermal generators are original. Many of the excitation systems have become obsolete, are no longer supported and spare parts are not available. These include Tufts Cove, Lingan, Pt. Tupper and Pt. Aconi. Toshiba have officially advised Lingan and Pt. Aconi that some excitation system parts are no longer manufactured for the existing systems. Tufts Cove G2 and G3 were the first static excitation systems manufactured by Reyrolle Parsons, which has not existed for many years. There is no OEM support for the excitation systems on Tufts Cove G2 and G3.

Overview:

In February 2011, a Request for Proposal (RFP) for supply of a replacement excitation system for Tufts Cove G3 was issued. Four proposals were received from [redacted] Basler, [redacted] and [redacted] did not submit any proposal. [redacted] proposal was more than twice the price of the next highest proposal.

Karl Nowlan, Dan Brennan, Chuck Hooper and Willard Cameron visited all three potential suppliers, [redacted] ([redacted] Basler (Highland, Illinois) and [redacted] to review plant capability, assess their excitation systems and discuss their proposals for Tufts Cove G3. In general, all three suppliers had very good excitation systems from a technical perspective. [redacted] and Basler were well prepared for our visit [redacted]

An initial evaluation of the proposals was independently conducted by the technical team above and focused on the following key selection criteria:

- Cost/Commercial Arrangements
- Quality/Technical Approach
- Service
- Generation and Release of Hardware
- Ease of repair
- Footprint Requirements
- Control Panel/HMI
- References

- Schedule (Delivery of Exciter/AVR)
- Performance G/W

The initial evaluation scored each selection criteria from 1-5 (low to high rating), with each criteria having an appropriate weighting, [redacted] scored the highest, followed secondly by Basler and [redacted] was evaluated with the lowest rating.

The price quotes were as follows:

	Tufts Cove G3 Excitation System Replacement		
Equipment	[redacted]	Basler	[redacted]
Excitation System/AVR		244,100	
Commissioning		20,760	
HMI Panel		Inc	
PSS Study		14,400	
Field Contactor (Pos Leg)			
Total	[redacted]	279,260	[redacted]
Manufactured	[redacted]	Illinois	[redacted]
Delivery		[redacted]	

During the visits to [redacted] and Basler, NSPI indicated an excitation system replacement at Lingan was also being planned for 2012 and requested budget estimates from each supplier. Surprisingly, [redacted] was significantly higher ($[redacted] than Basler. Since it was NSPI's goal to have an excitation system supplier agreement with a single or preferred supplier, this dilemma was discussed with NSPI executive and procurement management.

It was decided to issue an Addendum to the original RFP and request each supplier to re-submit revised bids for each planned excitation system replacement over the next 2-3 years. [redacted] re-submission was not significantly different than Basler and [redacted] was not further considered. NSPI then focused on [redacted] and Basler.

The bids were as follows:

NSPI Excitation/AVR System Replacements
Recommendation
Oct 2011

NOVA SCOTIA POWER
An Emera Company

Excitation System Replacement		
Equipment	[redacted]	Basler ($US)
TC3		Note:Basler offered a new price on TC3 ($[redacted] when re-submitting their bids based on a multiple unit supply, but the intent was not to change the original RFP pricing for TC3. However, even with Basler's original quote for Tufts Cove G3 of $[redacted].US, they were still significantly lower in total cost than [redacted]
TC2		
LG3		
LG4		
POA1		
TUP2		
CSA Approval		
Commissioning Estimate		
HMI Panel		
PSS Study Estimate		Estimates based on PSS studies for four units. [redacted] Basler=[redacted] prices quoted for a single unit in original RFP mult by number of units.
Floor Modifications to accommodate cabinet footprint		Tufts Cove G2 floor needs to be modified to accommodate larger (wider) Basler footprint.
Shipping Costs		For Basler, shipping estimated at [redacted] per system [redacted]
Total		
Difference		
Manufactured		
Technical Support		
Delivery		
Multi Year Contracts for all excitation systems		

Technical Evaluation:

The technical team made a second visit to [redacted] and Basler for a further detailed review of their capability, excitation systems and proposals.

A second technical evaluation was conducted by the technical team above and focused on an extensive list of technical criteria as attached in Fig. 2.

In summary, both companies were technically evaluated very evenly for all practical purposes, with no clear decisive winner from a technical perspective and each has its own strengths. This was also confirmed by Kestrel Power Engineering who has knowledge and works with both excitation systems. In their opinion, [redacted] and Basler were the two top suppliers of excitation systems. Both systems will have a lot of redundancy and single failures would not normally result in either system being unavailable for an extended time. Ontario Power Generation also has both systems installed and indicated both are equally as good from a technical perspective.

NSPI Excitation/AVR System Replacements
Recommendation
Oct 2011

NOVA SCOTIA POWER
An Emera Company

Hydro Quebec, [redacted] excitation systems have a smaller footprint than Basler and no floor modifications would be required for any of the proposed six systems. The [redacted] excitation systems are designed and manufactured in [redacted] Spare parts would come from [redacted] although spare parts would normally be available from similar systems being assembled [redacted] references were checked and overall, responses were very positive. Their system has performed well with very few issues. A few references did comment that the [redacted] For normal operation, understanding the software in detail would not be anticipated or required, [redacted] proposal for Tufts Cove G3 and G2 has slightly different controllers than their proposal for the higher current ratings required for Lingan and Pt. Aconi, although the rectifier bridges would identical for all units, [redacted]

Basler does not have any service based out of Canada, although they service systems all over North America, largely in the US and includes such companies as Florida Light and Power, Georgia Electric, Southern California Edison, Sask Power and Ontario Power Generation. Basler offer 24 hr technical support via dedicated personnel with cell phone access. Basler designs and builds their excitation systems in Highland, Illinois. Spare parts would not normally be stocked but can easily be manufactured in their facility. Basler excitation systems have a larger footprint (i.e. wider) as compared to [redacted] As a result some floor modifications would be required only for Tufts Cove G2 at an approximate cost of $[redacted] The costs were included in the cost comparison. Basler's proposal offered the identical excitation system and control for all six units, the only difference being the number of rectifier bridges. Basler references were checked and overall, responses were very positive. Their system has performed well with very few issues.

Summary

[redacted] and Basler both offer excellent excitation systems. Several references have confirmed that both systems are technically very good. [redacted] is approximately [redacted] than Basler. They do appear to be better positioned for customer service support to NSPI, however, the requirement for customer service support after initial commissioning should be low and the extra cost is not justified.

In addition, NSPI have many smaller Basler excitation systems that work well. Basler's DECS-200 excitation systems are quite often applied on small hydro generators and on rotating exciter system upgrades in NSPI.

Recommendation:

It is recommended that NSPI award the excitation system replacements to Basler.

Upon approval of this recommendation, NSPI will re-negotiate the Terms and Conditions and issue a separate Purchase Order to Basler for Tufts Cove G3 and Lingan G3.

Prepared by:

Janice Trenholm,
Procurement

Willard Cameron,
Engineering Specialist

Chuck Hooper
Engineering Specialist

Karl Nowlan
Senior Electrical Engineer

Page 6 of 6

NSPI Excitation/AVR System Replacements
Recommendation
Oct 2011

NOVA SCOTIA POWER
An Emera Company

Reviewed by:

Phil Zinc
Manager, Generation Engineering Services

Approved by:

Dave Pickles, Senior Plant Manager – Tufts Cove Generating Station

Brad George, Senior Plant Manager – Lingan Generating Station

Mark Sidebottom,
General Manager of Power Production

Mark Savory,
Vice President & COO NSPI

Nova Scotia POWER An Emera Company

PO Box 910 ● Halifax, Nova Scotia ● Canada ● B3J 2W5

25 September 2013

Wreck Cove Excitation System Technical Justification

The current excitation system at Wreck Cove is original and was installed in 1978. Spare parts in stock at the plant are almost depleted. The OEM has indicated that the few spare parts it can still offer are extremely high in cost. They also no longer offer technical support for the system. The excitation systems have begun to fail. One part of the excitation system is three redundant thyristor boards. Two of the three boards are need to be in service for operation. One board has already failed on Unit 1. Should a second board fail, and it could not be repaired, the unit would not be able to be returned to service unless a new board or board component could be sourced.

Negative pressure in the cabinets caused by the cooling fans results in the carbon dust being drawn in from the exciter brushes. The carbon dust has been settling on the electronic components housed in the cabinets since they were installed 35 years ago. The carbon dust is electrically conductive and has the potential to cause undetectable faults. This is the case for both Unit 1 and 2.

Since July 2013 the excitation system on Unit 2 has been operating unreliably. The unit has tripped at least ten times as a result of excitation system failing between July and September 2013. The frequency of the unit trips has been sporadic and follows no pattern. Control voltage fuses have consistently blown without explanation, but seem to have no impact on operation. Following weeks of extensive troubleshooting, it is believed that a false thyristor failure signal is being produced thereby tripping the unit. The thyristor failure signals cannot be disabled as not acting on a true thyristor failure would result in permanent damage to the entire excitation system.

Recent excitation system replacements in Thermal Production:

Thermal Unit	Replaced System's Original Year of Installation
Lingan #3	1983
Lingan #4	1983
Point Aconi	1994
Point Tupper #2	1973
Tufts Cove #2	1971
Tufts Cove #3	1976

Adam Lusk, P.Eng.
Electrical Engineer
Hydro and Wind Energy

energy everywhere.

CI Number: 44887

Title: HYD – Sissiboo Pipeline Replacement

Start Date: 2013/07
Final Cost Date: 2015/02
Function: Generation
Forecast Amount: $475,082

DESCRIPTION:

This project is for the replacement of the original woodstave pipeline at the Sissiboo Falls Generating Station with a fibre reinforced plastic (FRP) pipeline. The original pipeline, installed in 1961, has deteriorated overtime from exposure to the elements. In addition, the use of creosote for preservation is now prohibited by environmental regulations.

Summary of Related Cls +/- 2 years:
2012 CI 23125 HYD Sissiboo Falls Electrical Equipment Replacement $894K
2012 CI 41140 HYD Sissiboo Falls Tailrace Concrete Refurbishment $324K
2012 CI 41141 HYD Sissiboo Grand Lake Spillway Refurbishment $320K

JUSTIFICATION:

Justification Criteria: Hydro

Sub Criteria: Equipment Replacement

Why do this project?

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 these stresses in the wood fibres are greatly increased. This pipeline has experienced localized failures due to banding failure, and due to the deteriorated and rotted condition of the wood. The life of the pipe can no longer be extended by patching and the addition of bands. The deterioration causes head losses, leaks, as well as stability concerns for this hydroelectric development.

Why do this project now?

The condition of the pipeline continues to deteriorate and it has had many steel plates added for reinforcement over the years. It was recently discovered that the woodstaves have dropped significantly where the pipeline reaches the steel thimble at the entrance to the hydro plant, weakening the main connection to the turbine/generator. A loss of the pipeline may result in an extended outage of the plant.

Sissiboo Hydroelectric Development is a critical part of the power system in Western Nova Scotia. With electrical upgrades (CI 23125) and tailrace deck replacement work (CI 41140) also planned for 2014, there is a window to replace this woodstave pipeline with a more efficient product while the plant is shut down.

Why do this project this way?

Due to the condition of the pipe, it is no longer feasible to patch leaks along the length of the pipeline, or complete a temporary repair where the pipeline meets the entrance to the plant. Replacement of the woodstave pipe with FRP pipe is the most cost efficient solution.

CI Number : 44887-H694 - HYD - Siss boo Pipeline Replacement **Project Number** H694

Parent CI Number : -

Cost Centre : 411 - 411-Siss boo/Weymouth System **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		8,984	0	8,984
095		095-Hydro Regular Labour AO		3,923	0	3,923
095		095-Thermal & Hydro Contracts AO		25,402	0	25,402
041	023	041 - Meals & Entertainment	023 - HGP - Power Equip.-Station S	15	0	15
001	027	001 - HYDRO Regular Labour	027 - HGP - Waterways	17,258	0	17,258
011	027	011 - Travel Expense	027 - HGP - Waterways	3,500	0	3,500
012	027	012 - Materials	027 - HGP - Waterways	99,000	0	99,000
013	027	013 - POWER PRODUCTION Contracts	027 - HGP - Waterways	260,000	0	260,000
028	027	028 - Consulting	027 - HGP - Waterways	57,000	0	57,000
			Total Cost:	475,082	0	475,082
			Original Cost:	50,337		

Sissiboo Falls Pipeline Replacement
Summary of Alternatives

Division :	Power Production	**Date :**	**17-Nov-13**
Department :	Hydro	**CI Number:**	44887
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Replace Pipeline with FRP	6.49%	-11,321,026	10,140,352	1	60.68%	2.5 years
B	Replace Pipeline with Steel	6.49%	0	0	2	#NUM!	0.0 years
C	Replace Pipeline with HDPE	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Recommend replacing pipeline with new FRP pipe.

Notes/Comments :

Replace Pipeline with FRP

Pipeline replaced with new FRP pipe

Replace Pipeline with Steel

Steel pipeline installation is estimated to be at least 30% more expensive than FRP. This option would have the same benefits. Therefore, because it is known to have a higher capital cost, it is not evaluated further.

Replace Pipeline with HDPE

HDPE is not a viable option as it cannot withstand the required pressure that a pipe of this size produces. Therefore, this option is not evaluated further.

Test 4

Sissiboo Falls Pipeline Replacement
Summary of Sensitivities

Division :	Power Production	**Date :**	**17-Nov-13**
Department :	Hydro	**CI Number:**	44887
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Pipeline with FRP	6.49%	-11,321,026	10,140,352	1	60.68%	2.5 years
B	Replace Pipeline with Steel	6.49%	0	0	2	#NUM!	0.0 years
C	Replace Pipeline with HDPE	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Pipeline with FRP	10%	-11,285,926	10,110,112	1	56.14%	2.7 years
B	Replace Pipeline with Steel	10%	0	0	2	#NUM!	0.0 years
C	Replace Pipeline with HDPE	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
Change:	**A**		35,100	-30,240	0	-4.55%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Pipeline with FRP	-10%	-10,153,823	9,096,077	1	55.69%	2.7 years
B	Replace Pipeline with Steel	-10%	0	0	2	#NUM!	0.0 years
C	Replace Pipeline with HDPE	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
Change:	**A**		1,167,203	-1,044,275	0	-5.00%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement		PV of Revenue Requirement	PV of Revenue Requirement	PV of Revenue Requirement	Delay?
	Yrs Delay:	1	2	3	
	A	97,837	217,976	360,491	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

Sissiboo Falls Pipeline Replacement
Avoided Cost Calculations

Division :	Power Production	**Date :**	**17-Nov-13**
Department :	Hydro	**CI Number:**	44887
Originator :		**Project No. :**	

Replace Pipeline with FRP

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			91,453	93,282		
Events/Outages (#)	1	1.5	1	1.5		
Probability of Occurance (%)	25%	25%	25%	25%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	[redacted]					
Duration (Hours)	1008	1008				
Totals	$82,585	$122,948	$22,863	$34,981	$105,449	$157,929
Total Capital Cost of Alternative						$475,082

Replace Pipeline with Steel

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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)	[redacted]					
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Replace Pipeline with HDPE

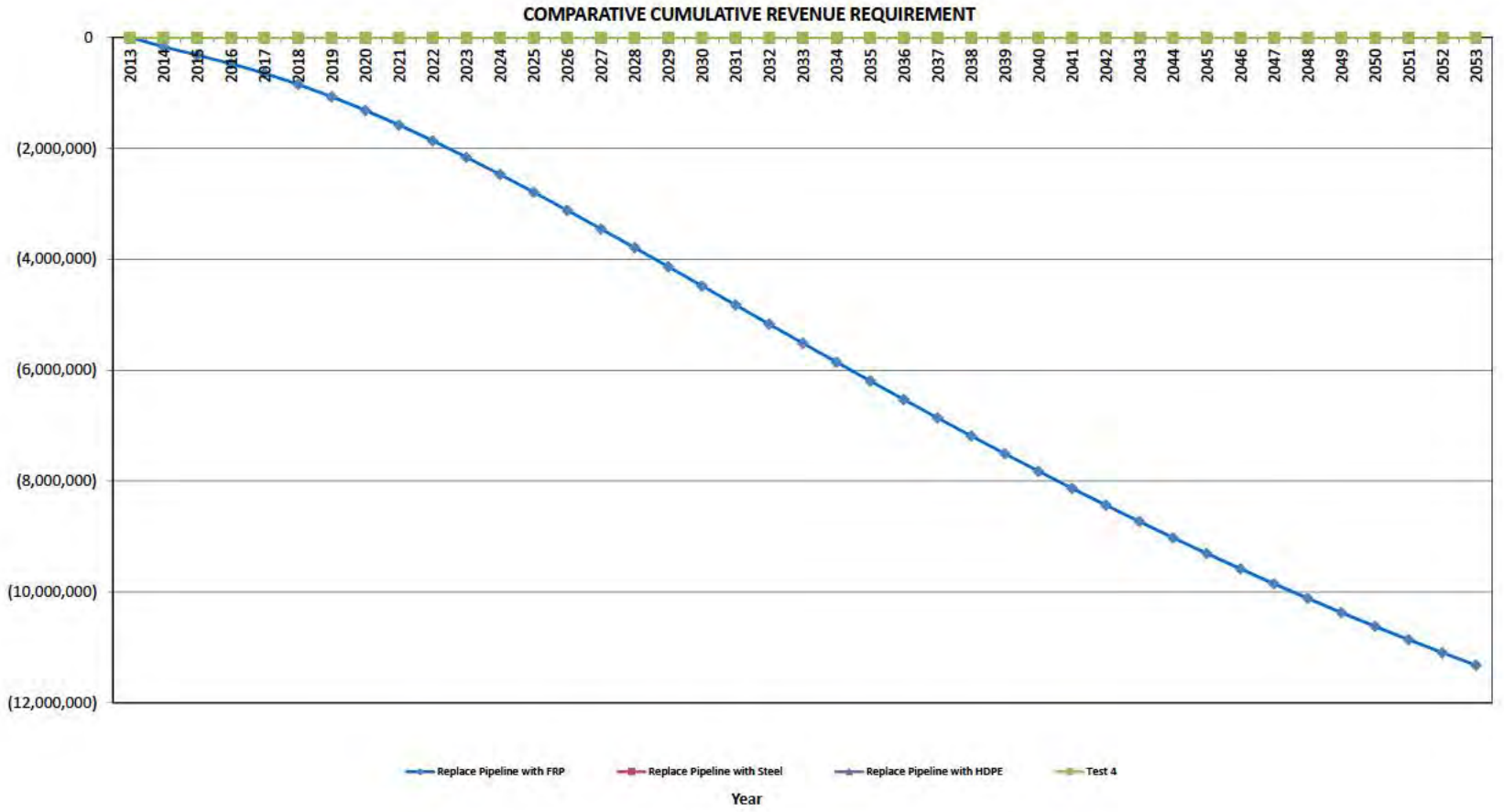
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	[redacted]					
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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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)	[redacted]					
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Sissiboo Falls Pipeline Replacement
Replace Pipeline with FRP

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	105,448.6	(445,757.1)	109,193 2	331,978.3	(340,308 5)	1,160.8	(339,147.7)	(318,478.4)	0.94	(318,478.4)
2015	-	-	157,929.0	-	163,789 8	161,590.4	157,929 0	1,816.9	159,745 8	140,867.8	0.88	(177,610.6)
2016	-	-	214,783.4	-	81,894 9	76,396 5	214,783.4	(41,195.4)	173,588 0	143,745.1	0.83	(33,865.4)
2017	-	-	273,848.8	-	40,947.4	33,799.6	273,848 8	(72,199.4)	201,649.4	156,805.6	0.78	122,940 2
2018	-	-	335,191.0	-	20,473.7	12,501.1	335,191 0	(97,562.4)	237,628.6	173,522.0	0.73	296,462 2
2019	-	-	398,877.3	-	10,236 9	1,851 9	398,877 3	(120,478.5)	278,398.7	190,903.7	0.69	487,365 9
2020	-	-	464,976.9	-	5,118.4	(3,472.8)	464,976 9	(142,556.1)	322,420 8	207,616.2	0.64	694,982.1
2021	-	-	533,561.0	-	2,559 2	(6,135.1)	533,561 0	(164,610.6)	368,950 5	223,098.9	0.60	918,081 0
2022	-	-	604,702.5	-	1,279.6	(7,466.2)	604,702 5	(187,061.1)	417,641.4	237,150.5	0.57	1,155,231.6
2023	-	-	678,476.2	-	639 8	(8,131.8)	678,476 2	(210,129.3)	468,346 9	249,735.0	0.53	1,404,966.6
2024	-	-	754,959.0	-	319 9	(8,464.6)	754,959 0	(233,938.1)	521,020 9	260,890.4	0 50	1,665,856 9
2025	-	-	834,229.7	-	160 0	(8,631 0)	834,229.7	(258,561.6)	575,668.1	270,686.3	0.47	1,936,543 2
2026	-	-	916,369.2	-	80 0	(8,714 2)	916,369 2	(284,049.7)	632,319 5	279,204.1	0.44	2,215,747 3
2027	-	-	1,001,460.6	-	40 0	(8,755.8)	1,001,460.6	(310,440.4)	691,020 2	286,528.1	0.41	2,502,275.4
2028	-	-	1,089,589.2	-	20 0	(8,776.6)	1,089,589 2	(337,766.4)	751,822.7	292,740.7	0.39	2,795,016.1
2029	-	-	1,180,842.3	-	10 0	(8,787 0)	1,180,842 3	(366,058.0)	814,784 3	297,921.2	0 37	3,092,937 2
2030	-	-	1,275,309.7	-	5 0	(8,792 2)	1,275,309.7	(395,344.4)	879,965 2	302,145.0	0 34	3,395,082 3
2031	-	-	1,373,083.4	-	2 5	(8,794.8)	1,373,083.4	(425,655.1)	947,428 3	305,483.3	0.32	3,700,565.6
2032	-	-	1,474,258.0	-	1 2	(8,796.1)	1,474,258 0	(457,019.6)	1,017,238.4	308,003.1	0.30	4,008,568.6
2033	-	-	1,578,930.3	-	0.6	(8,796.7)	1,578,930 3	(489,468.2)	1,089,462.1	309,767.3	0 28	4,318,335 9
2034	-	-	1,687,199.8	-	0 3	(8,797.1)	1,687,199 8	(523,031.8)	1,164,167 9	310,835.3	0 27	4,629,171 2
2035	-	-	1,799,168.5	-	0 2	(8,797 2)	1,799,168 5	(557,742.2)	1,241,426 3	311,262.5	0 25	4,940,433.6
2036	-	-	1,914,941.1	-	0.1	(8,797.3)	1,914,941.1	(593,631.7)	1,321,309.4	311,101.1	0.24	5,251,534.7
2037	-	-	2,034,624.9	-	0 0	(8,797.3)	2,034,624 9	(630,733.7)	1,403,891 2	310,399.9	0.22	5,561,934.6
2038	-	-	2,158,330.1	-	0 0	(8,797.4)	2,158,330.1	(669,082.3)	1,489,247 8	309,204.8	0 21	5,871,139 5
2039	-	-	2,286,169.6	-	0 0	(8,797.4)	2,286,169.6	(708,712.6)	1,577,457 0	307,558.7	0.19	6,178,698 2
2040	-	-	2,418,259.4	-	0 0	(8,797.4)	2,418,259.4	(749,660.4)	1,668,599 0	305,501.7	0.18	6,484,199.9
2041	-	-	2,554,718.4	-	0 0	(8,797.4)	2,554,718.4	(791,962.7)	1,762,755.7	303,071.4	0.17	6,787,271 3
2042	-	-	2,695,668.3	-	0 0	(8,797.4)	2,695,668 3	(835,657.2)	1,860,011 2	300,302.9	0.16	7,087,574 2
2043	-	-	2,841,234.4	-	0 0	(8,797.4)	2,841,234.4	(880,782.7)	1,960,451 8	297,229.1	0.15	7,384,803 3
2044	-	-	2,991,544.9	-	0 0	(8,797.4)	2,991,544 9	(927,378.9)	2,064,166 0	293,880.6	0.14	7,678,684.0
2045	-	-	3,146,731.3	-	0 0	(8,797.4)	3,146,731 3	(975,486.7)	2,171,244.6	290,286.1	0.13	7,968,970.1
2046	-	-	3,306,928.5	-	0 0	(8,797.4)	3,306,928 5	(1,025,147.8)	2,281,780.7	286,472.3	0.13	8,255,442.4
2047	-	-	3,472,274.9	-	0 0	(8,797.4)	3,472,274 9	(1,076,405.2)	2,395,869.7	282,464.0	0.12	8,537,906.4
2048	-	-	3,642,912.4	-	0 0	(8,797.4)	3,642,912.4	(1,129,302.9)	2,513,609.6	278,284.4	0.11	8,816,190 8
2049	-	-	3,818,986.5	-	0 0	(8,797.4)	3,818,986 5	(1,183,885.8)	2,635,100.7	273,955.1	0.10	9,090,145.9
2050	-	-	4,000,646.4	-	0 0	(8,797.4)	4,000,646.4	(1,240,200.4)	2,760,446.1	269,496.2	0.10	9,359,642.1
2051	-	-	4,188,045.2	-	0 0	(8,797.4)	4,188,045 2	(1,298,294.0)	2,889,751 2	264,926.3	0.09	9,624,568.4
2052	-	-	4,381,339.5	-	0 0	(8,797.4)	4,381,339 5	(1,358,215.3)	3,023,124 3	260,262.6	0.09	9,884,831 0
2053	-	-	4,580,690.5	-	0 0	(8,797.4)	4,580,690 5	(1,420,014.1)	3,160,676.4	255,521.2	0.08	10,140,352.2
Total	**-**	**-**	**75,167,240.8**	**(445,757.1)**	**436,772.8**		**74,721,483.6**	**(23,166,445.1)**	**51,555,038.6**	**10,140,352.2**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(2,000,000)
(4,000,000)
(6,000,000)
(8,000,000)
(10,000,000)
(12,000,000)
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
2053
Replace Pipeline with FRP
Replace Pipeline with Steel
Replace Pipeline with HDPE
Test 4
Year

Capital Project Detailed Estimate

Location: Hydro
CI# / FP#: 44887
Title: HYD Sissiboo Falls Pipeline Replacement
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Hydro River Staff - Construction	pd	7.5	345	$ 2,591		
1.2	Engineering Staff	pd	33.7	384	$ 12,940		
1.3	Hydro River Staff - Removal	pd	5.0	345	$ 1,727		
				Sub-Total	$ 17,258		
2	**012 Materials**						
2.1	Pipeline	lot	1	$ 99,000.00	$ 99,000		40308
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 99,000		
3	**013 Power Production Contracts**						
3.1	Pipeline removal	lot	1	$ 60,000.00	$ 60,000		40308
3.2	Pipeline placement	lot	1	$ 200,000.00	$ 200,000		40308
3.3					$ -		
				Sub-Total	$ 260,000		
4	**011 Travel Expenses**						
4.1	Travel Expenses	lot	1	$ 3,500.00	$ 3,500.0		
4.2					$ -		
				Sub-Total	$ 3,500.0		
5	**028 Consulting**						
5.1	Design Drawings	lot	1	$ 40,000.00	$ 40,000		
5.2	Inspection	lot	1	$ 7,000.00	$ 7,000		
5.3	Geotechnical Report	lot	1	$ 10,000.00	$ 10,000		
5.4					$ -		
				Sub-Total	$ 57,000		
6	**041 Meals and Entertainment**						
6.4	Meals	lot	1	$ 14 91	$ 14.91		
				Sub-Total	$ 14.91		
7	**094 Interest Capitalized**						
7.1	AFUDC	lot	1	$ 8,984.33	$ 8,984		
7.2					$ -		
				Sub-Total	$ 8,984		
8	**095 Administrative Overhead**						
8.1	Hydro Regular Labour AO	lot	1	$ 3,922.63	$ 3,923		
8.2	Thermal & Hydro Contracts AO	lot	1	$ 25,402.00	$ 25,402		
				Sub-Total	$ 29,325		
				SUB-TOTAL (no AO, AFUDC)	$ 436,773		
				TOTAL (AO, AFUDC included)	$ 475,082		
11	**Original Cost**						
11.1					$ 50,337		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

Nova Scotia Power Inc.
Sissiboo Falls Hydro Station



External Penstock Inspection August 2013

Submitted by
RAT International Inc.

PID 5545

Executive Summary

Upon the request of Aileen Woodman of Hydro and Wind Energy at Nova Scotia Power Inc., Remote Access Technology completed a visual inspection of the external penstock at the Sissiboo Falls Generation Station. The inspection was completed on August 19th, 2013. The following is a summary of the completed inspection.

Inspection Procedure

The penstock was inspected looking up stream and was broken into 12 sections with 12 being the top of the penstock and 6 being the bottom counting clockwise. Support cradles were lettered starting at the powerhouse with A and ending at the intake with I. Refer to Appendix A drawing for details.

Penstock Access

The external inspection of the wood stave penstock at Sissiboo Falls was completed using Industrial Rope Access Techniques in accordance to the IRATA Code of Practice and the RAT MSP-015 Rope Access Procedure.

Inspection Summary

The external wood stave penstock at Sissiboo Falls was visually inspected and found in poor condition with multiple cracks, holes and failed joints. The following is a itemized list of the noted deficiencies.

Number	Orientation	Location	Description	Photo Reference
1	9 o'clock	6ft from powerhouse	6in long leak	1
2	9 o'clock	1ft south of cradle A	Pin hole leak	2
3	10 o'clock	8ft south of cradle A	Water leaking around knot	3
4	9 o'clock	9ft south of cradle A	Pin hole leak	4
5	9 o'clock	9ft 10in south of cradle B	Pin hole leak	5
6	9 o'clock	5ft south of cradle C	Pin hole leak	6
7	10 o'clock	7ft south of cradle C	Pin hole leak	7
8	9 o'clock	3ft south of cradle D	1/4in hole	8
9	7 o'clock	2ft south of cradle D	2 pin hole leaks	9
10	10 o'clock	8ft south of cradle F	Pin hole leak	10
11	9 o'clock	At cradle F	cluster of 6 pin holes, 3/4in crack	11
12	9 o'clock	9ft 6in south of cradle E	2 pin hole leaks	12
13	9 o'clock	3ft south of cradle F	Cluster of pin holes	13
14	4 o'clock	3ft south of cradle A	Crack were planks meet	14
15	4 o'clock	4ft south of cradle A	4 pin holes 3in x 3in	15
16	6 o'clock	6ft south from cradle B	Pin hole leak	16

Number	Orientation	Location	Description	Photo Reference
17	1 o'clock	9ft south of cradle B	Pin hole leak	17
18	2 o'clock	10in south of cradle B	Cluster of pin holes	18
19	3 o'clock	2ft south of cradle C	Pin hole leak	19
20	3 o'clock	9ft south of cradle D	Crack in wood	20
21	3 o'clock	9ftb south of cradle D	Pin hole leak	21
22	3 o'clock	9ftb south of cradle D	Pin hole leak	22
23	3 o'clock	3ft south of cradle D	Pin hole leak	23
24	3 o'clock	2ft south of cradle G	Pin hole leak	24
25	3 o'clock	Intake	Gap between the penstock and concrete	25
26	N/A	Intake 7ft south of cradle 1	Exposed rebar and leak	26
27	N/A	Intake 7ft south of cradle 1	Exposed rebar	27 through 29
28	N/A	Inside Pump house	Leak between concrete and thimble	30

Refer to Photo's 1 through 38 for details

Recommendations:

1: Repair all noted deficiencies or replace.
2: Replace Penstock completely.

Photo Record

Photo Number 1

Location: External Sissiboo Penstock

Description:
6in leak 6ft from the powerhouse
at 9 o'clock



Photo Number 2

Location: External Sissiboo Penstock

Description:
Pin hole leak 1ft south of Cradle
A at 9 o'clock



Photo Record

Photo Number 3

Location: External Sissiboo Penstock

Description:
Leak around knot 8ft south of Cradle A at 10 o'clock



Photo Number 4

Location: External Sissiboo Penstock

Description:
Pin hole leak 9ft south of Cradle A at 9 o'clock



Photo Record

Photo Number 5

Location: External Sissiboo Penstock

Description:
Pin hole leak 9ft 10in south of Cradle B at 9 o'clock



Photo Number 6

Location: External Sissiboo Penstock

Description:
Pin hole leak 5ft south of Cradle C at 9 o'clock



Photo Record

Photo Number 7

Location: External Sissiboo Penstock

Description:
Pin hole leak 7ft south of Cradle C at 10 o'clock



Photo Number 8

Location: External Sissiboo Penstock

Description:
1/4in hole 3ft south of Cradle D at 9 o'clock



#NAME?
RAT

Photo Record

Photo Number 9

Location: External Sissiboo Penstock

Description:
Pin holes 2ft south of cradle D at 7 o'clock



Photo Number 10

Location: External Sissiboo Penstock

Description:
Pin hole leak 8ft south of Cradle E at 10 o'clock



Photo Record

Photo Number 11

Location: External Sissiboo Penstock

Description:
Multiple pin holes at cradle F at 9 o'clock



Photo Number 12

Location: External Sissiboo Penstock

Description:
2 pin holes 9ft 6in south from Cradle E at 9 o'clock



Photo Record

Photo Number 13

Location: External Sissiboo Penstock

Description:
Multiple pin holes 3ft south of Cradle F at 9 o'clock



Photo Number 14

Location: External Sissiboo Penstock

Description:
Crack were planks meet 3ft south of Cradle A at 4 o'clock



Photo Record

Photo Number 15

Location: External Sissiboo Penstock

Description:
Multiple pin holes 4ft south from cradle A at 4 o'clock

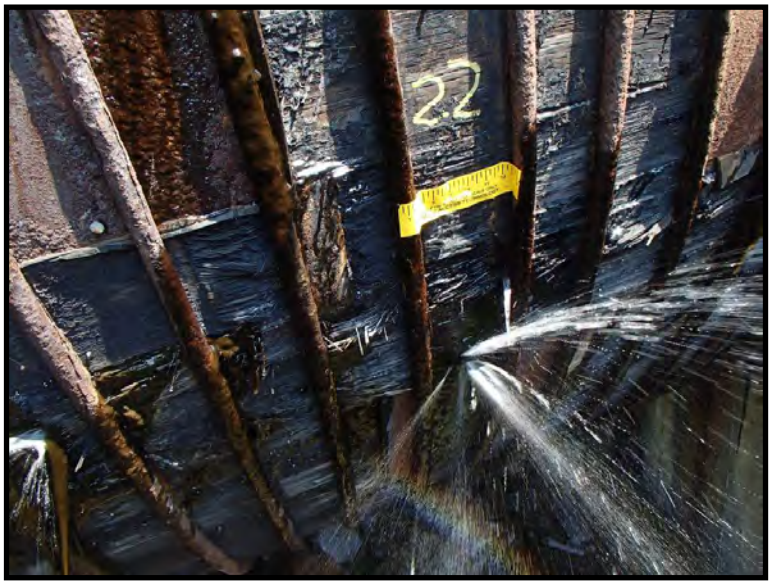


Photo Number 16

Location: External Sissiboo Penstock

Description:
Pin hole 6ft south from Cradle B at 6 o'clock



Photo Record

Photo Number 17

Location: External Sissiboo Penstock

Description:
Pin hole 9ft south of Cradle B at 1 o'clock



Photo Number 18

Location: External Sissiboo Penstock

Description:
Cluster of pin holes 10in south of Cradle C at 2 o'clock



Photo Record

Photo Number 19

Location: External Sissiboo Penstock

Description:
Pin hole 2ft South of cradle C at 3 o'clock



Photo Number 20

Location: External Sissiboo Penstock

Description:
Crack in wood joint 9ft south from Cradle D at 3 o'clock

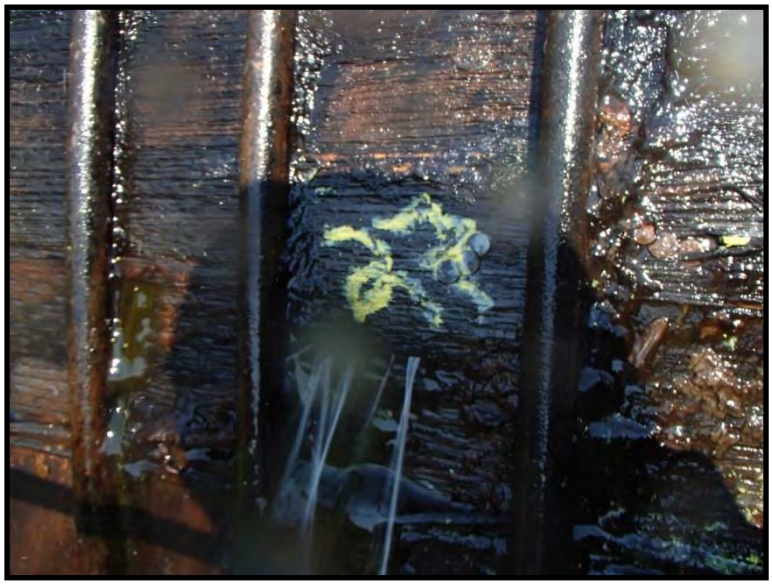


Photo Record

Photo Number 21

Location: External Sissiboo Penstock

Description:
Pin hole 9ft south of Cradle D at
3 o'clock



Photo Number 22

Location: External Sissiboo Penstock

Description:
Pin hole 9ft south of Cradle D at
3 o'clock



Photo Record

Photo Number 23

Location: External Sissiboo Penstock

Description:
Pin hole 3ft south of cradle E at 3 o'clock



Photo Number 24

Location: External Sissiboo Penstock

Description:
Pin hole 2ft south from Cradle G at 3 o'clock



Photo Record

Photo Number 25

Location: External Sissiboo Penstock

Description:
Separation between the concrete and the penstock.



Photo Number 26

Location: External Sissiboo Penstock

Description:
Exposed Rebar and water leakage 7ft south of cradle I.



Photo Record

Photo Number 27

Location: External Sissiboo Penstock

Description:
Exposed Rebar and water leakage
7ft south of cradle I.



Photo Number 28

Location: External Sissiboo Penstock

Description:
2 pin holes 9ft 6in south from
Cradle E at 9 o'clock



Photo Record

Photo Number 29

Location: External Sissiboo Penstock

Description:
Exposed Rebar and water leakage 7ft south of cradle I.



Photo Number 30

Location: External Sissiboo Penstock

Description:
Top of Penstock inside the pump house with a leak between the concrete and the thimble.



Photo Record

Photo Number 31

Location: External Sissiboo Penstock

Description:
General Cradle A West side



Photo Number 32

Location: External Sissiboo Penstock

Description:
General Cradle C East side



Photo Record

Photo Number 33

Location: External Sissiboo Penstock

Description:
General Cradle D East side



Photo Number 34

Location: External Sissiboo Penstock

Description:
General Cradle E East side



Photo Record

Photo Number 35

Location: External Sissiboo Penstock

Description:
General Cradle F West side



Photo Number 36

Location: External Sissiboo Penstock

Description:
General Cradle G East side



Photo Record

Photo Number 37

Location: External Sissiboo Penstock

Description:
General Cradle H East side



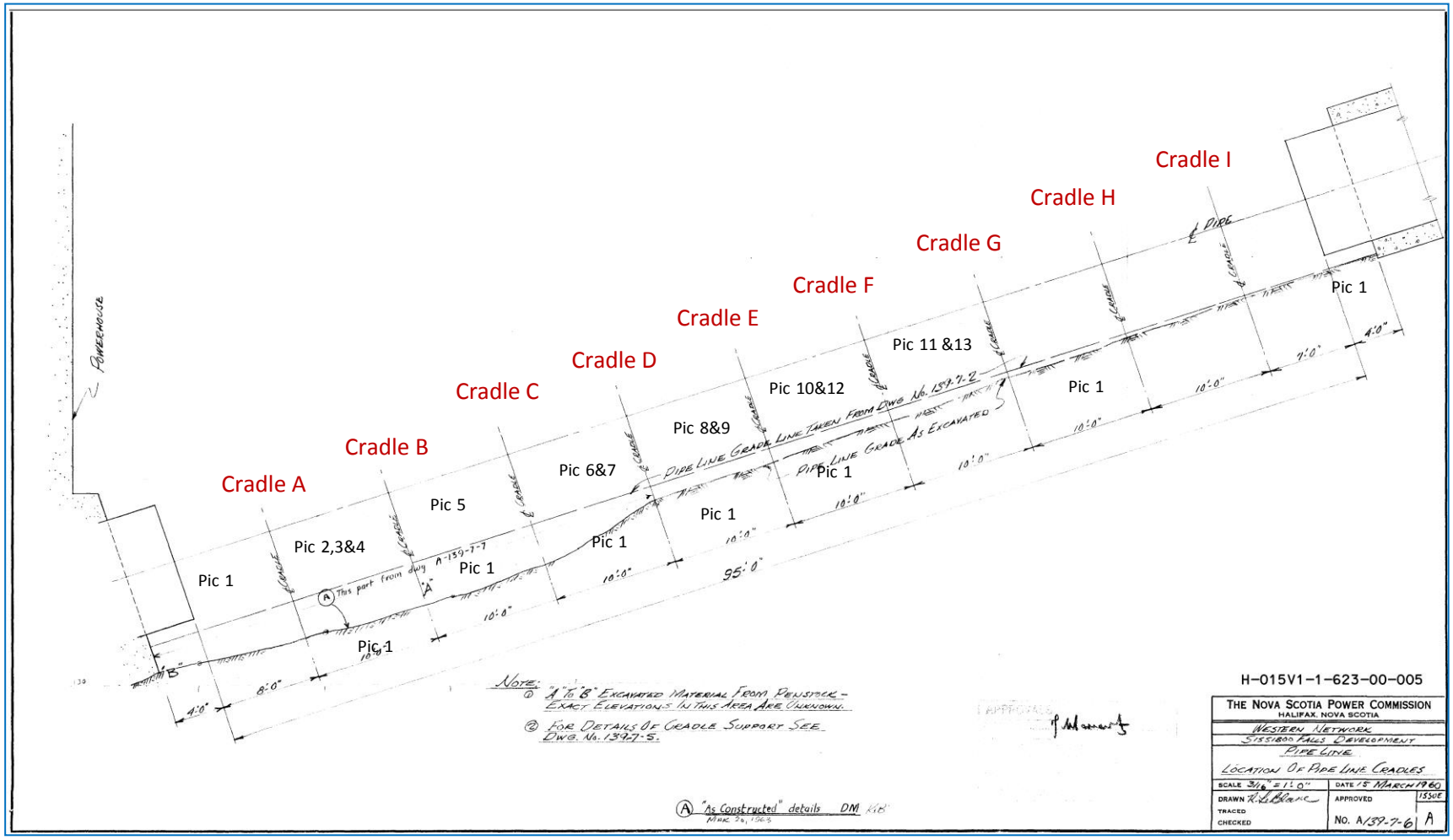
Photo Number 38

Location: External Sissiboo Penstock

Description:
General Cradle I East side



Appendix A


Cradle A
Cradle B
Cradle C
Cradle D
Cradle E
Cradle F
Cradle G
Cradle H
Cradle I
Pic 1
Pic 2,3&4
Pic 5
Pic 6&7
Pic 8&9
Pic 10&12
Pic 11 &13
Pic 1
Pic 1
Pic 1
Pic 1
Pic 1
Pic 1
Pic 1
Pic 1
Powerhouse
Pipe Line Grade Line Taken From Dwg No. 1597-2
Pipe Line Grade As Excavated
This part from dwg A-159-7-7
95'-0"
Note:
1. "A" to "B" Excavated Material From Penstock - Exact Elevations In This Area Are Unknown.
2. For Details Of Cradle Support See Dwg. No. 1597-5.
"As Constructed" details DM
H-015V1-1-623-00-005
THE NOVA SCOTIA POWER COMMISSION
HALIFAX, NOVA SCOTIA
WESTERN NETWORK
SISSIBOO FALLS DEVELOPMENT
PIPE LINE
LOCATION OF PIPE LINE CRADLES
SCALE 3/16" = 1'-0"
DATE 15 MARCH 1960
DRAWN
TRACED
CHECKED
APPROVED
No. A/159-7-6
A

CI Number: 45189

Title: HYD - Upper Lake Falls #2 Overhaul

Start Date: 2014/01
Final Cost Date: 2015/01
Function: Generation
Forecast Amount: $441,716

DESCRIPTION:

Upper Lake Falls #2 is experiencing delays when shutting the unit down due to excessive wear in the turbine wicket gate links and bushings. These are critical parts of the machine as they control the power output and regulation, as well as stop the unit if the generator trips off line. Due to the bushing wear, water leakage when the wicket gates are closed is sufficient to compromise the ability of the unit to come to a full stop when the unit is shut down. Effective unit shut down performance is critical to safe unit operation.

Summary of Related CIs +/- 2 years: None

JUSTIFICATION:

Justification Criteria: Hydro

Sub Criteria: Maintenance

Why do this project?

This project is being conducted to improve the ability of the turbine-generator to come to a full stop when it is shut down in either a planned, or unplanned manner. Additionally, this work will serve to extend life, reduce water leakage through the turbine when the unit is shut down, and enhance the operational capability of the unit into the future.

Why do this project now?

Upper Lake Falls #2 was last overhauled in 1999 which included replacement of the wicket gate stem bushings, and re-alignment of the turbine/generator. The bushings and linkage assemblies which were not replaced at that time have worn such that they now require replacement to support the safe operation of the unit.

Why do this project this way?

This project is intended to correct mechanical deficiencies, which are the result of operational wear, to mitigate the risk of a failure. The bushings, linkage assemblies and associated components will be brought back to within acceptable tolerances to increase reliability and operational efficiency. This work must be undertaken as part of a full unit disassembly and overhaul.

CI Number : 45189 - HYD - Upper Lake Falls #2 Overhaul **Project Number**

Parent CI Number : -

Cost Centre : 470 - 470-Mersey Hydro System **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		4,057	0	4,057
095		095-Thermal & Hydro Contracts AO		7,328	0	7,328
095		095-Hydro Term Labour AO		16,042	0	16,042
095		095-Hydro Regular Labour AO		26,839	0	26,839
095		095-Hydro Overtime Labour AO		2,005	0	2,005
001	024	001 - HYDRO Regular Labour	024 - HGP - Turbine (Hydro)	115,585	0	115,585
002	024	002 - HYDRO Overtime Labour	024 - HGP - Turbine (Hydro)	17,272	0	17,272
004	024	004 - HYDRO Term Labour	024 - HGP - Turbine (Hydro)	69,088	0	69,088
011	024	011 - Travel Expense	024 - HGP - Turbine (Hydro)	2,500	0	2,500
012	024	012 - Materials	024 - HGP - Turbine (Hydro)	75,000	0	75,000
013	024	013 - POWER PRODUCTION Contracts	024 - HGP - Turbine (Hydro)	75,000	0	75,000
014	024	014 - Overtime Meals	024 - HGP - Turbine (Hydro)	0	0	0
015	024	015 - Frt, Post & Delivery	024 - HGP - Turbine (Hydro)	0	0	0
021	024	021 - Telephones	024 - HGP - Turbine (Hydro)	0	0	0
028	024	028 - Consulting	024 - HGP - Turbine (Hydro)	30,000	0	30,000
041	024	041 - Meals & Entertainment	024 - HGP - Turbine (Hydro)	1,000	0	1,000
			Total Cost:	441,716	0	441,716
			Original Cost:	56,211		

HYD - Upper Lake Falls 2 Overhaul
Summary of Alternatives

Division :	Power Production	**Date :**	**17-Nov-13**
Department :	Hydro & Wind	**CI Number:**	45189
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Perform Overhaul	6.49%	-4,658,895	3,916,798	1	40.57%	4.0 years
B	Replace Equipment	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Complete overhaul to mitigate the risk of an extended, unplanned outage.

Notes/Comments :

Perform Overhaul

This overhaul replaces / corrects bushing and gate arm tolerances and associated assemblies. The avoided costs are based on a wicket gate failure due to excessive clearances. A wicket gate failure would result downtime of four months. A failure of this type has an estimated probability of 10%, increasing 5% per year.

Replace Equipment

Replacement of equipment is not required at this time, and would be significantly more costly than overhaul and refurbishment, including replacment of certain components. Therefore, this option is not evaluated further.

Test 3

Test 4

HYD - Upper Lake Falls 2 Overhaul
Summary of Sensitivities

Division :	Power Production	**Date :**	**17-Nov-13**
Department :	Hydro & Wind	**CI Number:**	45189
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Perform Overhaul	6.49%	-4,658,895	3,916,798	1	40.57%	4.0 years
B	Replace Equipment	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Perform Overhaul	10%	-4,621,969	3,886,598	1	37.92%	4.4 years
B	Replace Equipment	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
Change:	**A**		36,925	-30,200	0	-2.66%	0.3 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Perform Overhaul	-10%	-4,156,080	3,494,918	1	37.65%	4.4 years
B	Replace Equipment	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
Change:	**A**		502,815	-421,880	0	-2.92%	0.3 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement		PV of Revenue Requirement	PV of Revenue Requirement	PV of Revenue Requirement	Delay?
	Yrs Delay:	1	2	3	
	A	59,185	127,018	204,183	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

HYD - Upper Lake Falls 2 Overhaul
Avoided Cost Calculations

Division :	Power Production	**Date :**	**17-Nov-13**
Department :	Hydro & Wind	**CI Number:**	45189
Originator :		**Project No. :**	

Perform Overhaul

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			213,176	217,440		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	10%	15%	10%	15%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	[redacted]					
Duration (Hours)	2880	2880				
Totals	$42,473	$63,231	$21,318	$32,616	$63,790	$95,846
Total Capital Cost of Alternative						$441,716

Replace Equipment

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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)	[redacted]					
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

Test 3

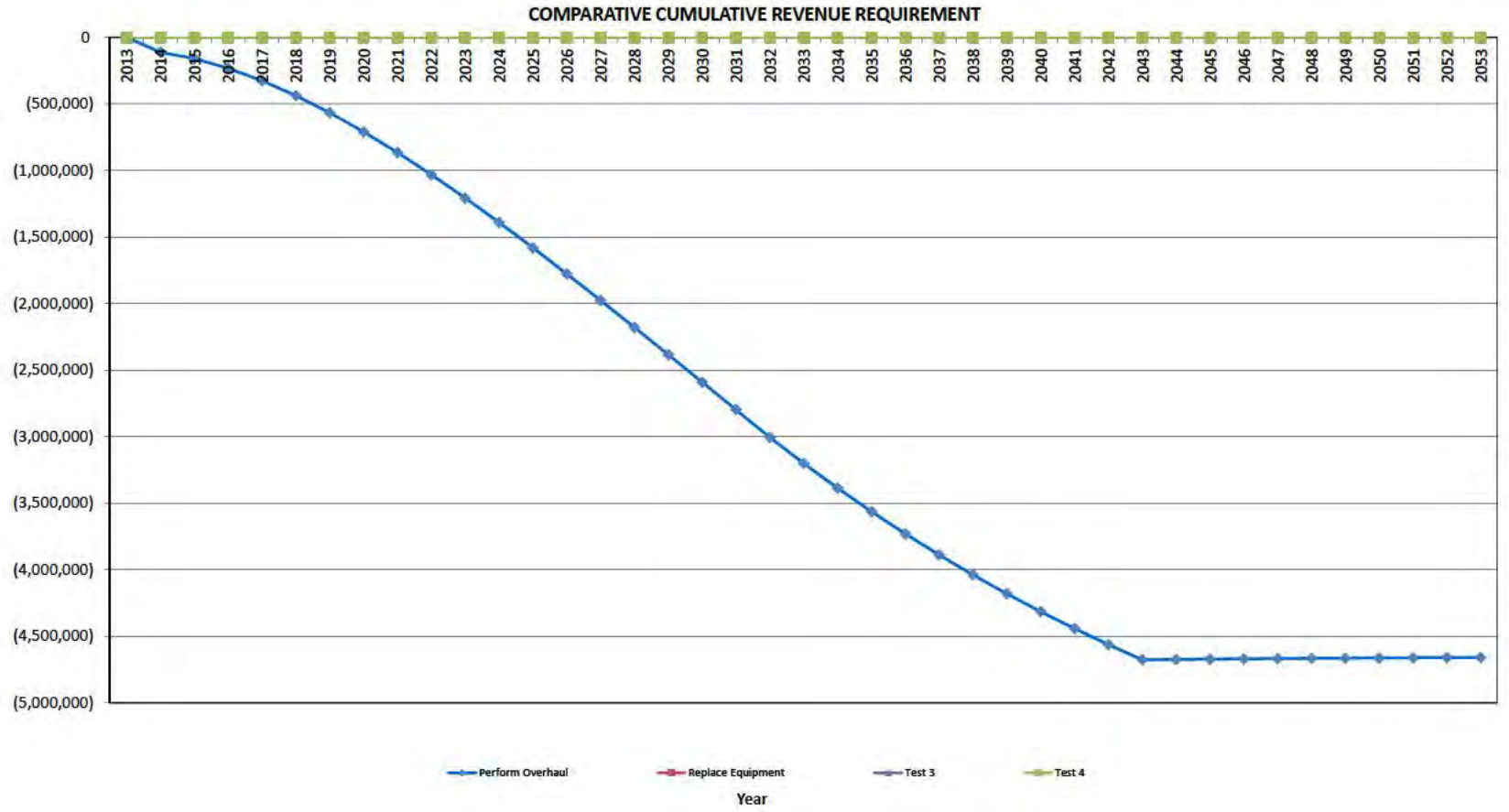
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	100%	100%				
Energy Replaced (MW)	[redacted]					
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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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)	[redacted]					
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0
Total Capital Cost of Alternative						$0

HYD - Upper Lake Falls 2 Overhaul
Perform Overhaul

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	63,790.1	(389,502.4)	15,417.8	384,438.3	(325,712.2)	(14,995.4)	(340,707.7)	(319,943.3)	0.94	(319,943.3)
2015	-	-	95,846.5	-	29,602.2	352,430.1	95,846.5	(20,535.7)	75,310.7	66,410.9	0.88	(253,532.4)
2016	-	-	130,351.2	-	27,234.0	322,982.6	130,351.2	(31,966.3)	98,384.9	81,470.8	0.83	(172,061.7)
2017	-	-	166,197.8	-	25,055.3	295,890.8	166,197.8	(43,754.2)	122,443.6	95,214.0	0.78	(76,847.7)
2018	-	-	203,426.1	-	23,050.9	270,966.4	203,426.1	(55,916.3)	147,509.8	107,715.1	0.73	30,867.4
2019	-	-	242,077.0	-	21,206.8	248,036.0	242,077.0	(68,469.8)	173,607.3	119,046.0	0.69	149,913.5
2020	-	-	282,192.7	-	19,510.2	226,940.0	282,192.7	(81,431.5)	200,761.1	129,276.0	0.64	279,189.4
2021	-	-	323,816.1	-	17,949.4	207,531.6	323,816.1	(94,818.7)	228,997.4	138,471.4	0.60	417,660.8
2022	-	-	366,991.6	-	16,513.5	189,676.0	366,991.6	(108,648.2)	258,343.4	146,695.9	0.57	564,356.7
2023	-	-	411,764.5	-	15,192.4	173,248.7	411,764.5	(122,937.4)	288,827.2	154,010.3	0.53	718,367.0
2024	-	-	458,181.6	-	13,977.0	158,135.7	458,181.6	(137,703.4)	320,478.2	160,472.8	0.50	878,839.8
2025	-	-	506,290.7	-	12,858.8	144,231.7	506,290.7	(152,963.9)	353,326.8	166,138.7	0.47	1,044,978.4
2026	-	-	556,140.9	-	11,830.1	131,440.1	556,140.9	(168,736.3)	387,404.5	171,060.6	0.44	1,216,039.0
2027	-	-	607,782.5	-	10,883.7	119,671.7	607,782.5	(185,038.6)	422,743.9	175,288.6	0.41	1,391,327.6
2028	-	-	661,267.4	-	10,013.0	108,844.8	661,267.4	(201,888.8)	459,378.5	178,870.3	0.39	1,570,197.9
2029	-	-	716,648.5	-	9,212.0	98,884.1	716,648.5	(219,305.3)	497,343.2	181,850.7	0.37	1,752,048.6
2030	-	-	773,980.4	-	8,475.0	89,720.3	773,980.4	(237,306.7)	536,673.7	184,272.4	0.34	1,936,321.0
2031	-	-	833,318.9	-	7,797.0	81,289.5	833,318.9	(255,911.8)	577,407.1	186,175.8	0.32	2,122,496.8
2032	-	-	894,721.3	-	7,173.3	73,533.2	894,721.3	(275,139.9)	619,581.4	187,599.1	0.30	2,310,095.9
2033	-	-	912,615.8	-	6,599.4	66,397.4	912,615.8	(280,865.1)	631,750.7	179,626.0	0.28	2,489,721.9
2034	-	-	930,868.1	-	6,071.4	59,832.5	930,868.1	(286,687.0)	644,181.1	171,997.7	0.27	2,661,719.6
2035	-	-	949,485.4	-	5,585.7	53,792.8	949,485.4	(292,608.9)	656,876.5	164,698.5	0.25	2,826,418.1
2036	-	-	968,475.1	-	5,138.9	48,236.2	968,475.1	(298,634.2)	669,840.9	157,713.4	0.24	2,984,131.5
2037	-	-	987,844.6	-	4,727.8	43,124.2	987,844.6	(304,766.2)	683,078.4	151,028.4	0.22	3,135,159.9
2038	-	-	1,007,601.5	-	4,349.5	38,421.1	1,007,601.5	(311,008.1)	696,593.4	144,630.1	0.21	3,279,790.0
2039	-	-	1,027,753.6	-	4,001.6	34,094.3	1,027,753.6	(317,363.1)	710,390.5	138,505.7	0.19	3,418,295.7
2040	-	-	1,048,308.6	-	3,681.5	30,113.6	1,048,308.6	(323,834.4)	724,474.2	132,643.1	0.18	3,550,938.8
2041	-	-	1,069,274.8	-	3,386.9	26,451.4	1,069,274.8	(330,425.2)	738,849.6	127,030.8	0.17	3,677,969.5
2042	-	-	1,090,660.3	-	3,116.0	23,082.1	1,090,660.3	(337,138.7)	753,521.6	121,657.7	0.16	3,799,627.3
2043	-	-	1,112,473.5	-	2,866.7	19,982.4	1,112,473.5	(343,978.1)	768,495.4	116,513.6	0.15	3,916,140.8
2044	-	-	-	-	2,637.4	17,130.7	-	817.6	817.6	116.4	0.14	3,916,257.2
2045	-	-	-	-	2,426.4	14,507.1	-	752.2	752.2	100.6	0.13	3,916,357.8
2046	-	-	-	-	2,232.3	12,093.4	-	692.0	692.0	86.9	0.13	3,916,444.7
2047	-	-	-	-	2,053.7	9,872.8	-	636.6	636.6	75.1	0.12	3,916,519.7
2048	-	-	-	-	1,889.4	7,829.8	-	585.7	585.7	64.8	0.11	3,916,584.6
2049	-	-	-	-	1,738.2	5,950.3	-	538.9	538.9	56.0	0.10	3,916,640.6
2050	-	-	-	-	1,599.2	4,221.2	-	495.7	495.7	48.4	0.10	3,916,689.0
2051	-	-	-	-	1,471.2	2,630.3	-	456.1	456.1	41.8	0.09	3,916,730.8
2052	-	-	-	-	1,353.5	1,166.8	-	419.6	419.6	36.1	0.09	3,916,766.9
2053	-	-	-	-	1,245.3	(179.7)	-	386.0	386.0	31.2	0.08	3,916,798.1
Total	**-**	**-**	**19,400,147.2**	**(389,502.4)**	**371,124.5**		**19,010,644.8**	**(5,898,997.0)**	**13,111,647.8**	**3,916,798.1**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(500,000)
(1,000,000)
(1,500,000)
(2,000,000)
(2,500,000)
(3,000,000)
(3,500,000)
(4,000,000)
(4,500,000)
(5,000,000)
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
2053
Perform Overhaul
Replace Equipment
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: Hydro
CI# / FP#: 45189
Title: HYD Upper Lake Falls #2 Overhaul
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Hydro River Staff - Construction	pd	190.0	345	$ 65,634		
1 2	Engineering Staff	pd	22.1	384	$ 8,499		
1 3	Hydro River Staff - Removal	pd	120.0	345	$ 41,453		
				Sub-Total	$ 115,585		
2	**012 Materials**						
2.1	Bearings, Bushings	lot	1	$ 50,000.00	$ 50,000		41806
2 2	Consumables (Paint, dry ice, solovents, fasteners)	lot	1	$ 25,000	$ 25,000		
2 3					$ -		
				Sub-Total	$ 75,000		
3	**013 Power Production Contracts**						
3.1	Machining	lot	1	$ 25,000.00	$ 25,000		41806
3.2	Concrete Repairs	lot	1	$ 30,000.00	$ 30,000		
3.3	Painting	lot	1	$ 20,000.00	$ 20,000		
3.4					$ -		
				Sub-Total	$ 75,000		
4	**002 Overtime Labour**						
4.1	Hydro River Staff	pd	25 0	691	$ 17,272		
4.2							
				Sub-Total	$ 17,272		
5	**004 Term Labour**						
5.1	Hydro River Staff - Construction	pd	120 0	345	$ 41,453		
5.2	Hydro River Staff - Removal	pd	80 0	345	$ 27,635		
5.3					$ -		
				Sub-Total	$ 69,088		
6	**011 Travel Expenses**						
6.1	Mileage, accomodation	lot	1	$ 2,500.00	$ 2,500		
6.2					$ -		
				Sub-Total	$ 2,500		
7	**028 Consulting**						
7.1	Testing	lot	1	$ 30,000.00	$ 30,000		
7.2					$ -		
				Sub-Total	$ 30,000		
8	**041 Meals and Entertainment**						
8.1	Meals	lot	1	$ 1,000.00	$ 1,000		
8.2					$ -		
				Sub-Total	$ 1,000		
9	**094 Interest Capitalized**						
9.1	AFUDC	lot	1	$ 4,057.30	$ 4,057		
9.2					$ -		
				Sub-Total	$ 4,057		
10	**095 Administrative Overhead**						
10.1	Hydro Regular Labour AO	lot	1	$ 26,838.87	$ 26,839		
10.2	T&C Regular Labour AO	lot	1	$ -	$ -		
10.3	Hydro OT Labour AO	lot	1	$ 2,005.30	$ 2,005		
10.4	Hydro Term Labour AO	lot	1	$ 16,042.25	$ 16,042		
10.5	Thermal & Hydro Contracts AO	lot	1	$ 7,327.50	$ 7,328		
				Sub-Total	$ 52,214		
				Sub-Total (no AO, AFUDC)	$ 385,445		
Project Cost Estimate				**Total**	$ 441,716		
11	**Original Cost**						
11.1					$ 56,211		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

NOVA SCOTIA POWER
An Emera Company

*** Work Order 52092 ***

BSU :
UNIT :
SYSTEM : 01W1 -Created from upload
SUBSYSTEM :

Type:	PM	**Job Type:**	INSP	**PM #:**	PM02-52
Status:	S	**Impact:**	OTHER	**Frequency:**	364
Priority:	1	**Severity:**	~~LOW (ANY CATEGORY)~~	**Standard Doc.#:**	
Submitted By:	PM SCHEDULER	**Date Due:**	2012-05-24	**Safety Doc#:**	
Submitted Date:	2012-05-01	**Planned Date:**	2012-05-24	**HIT/EM Flag:**	NO
Assigned To:	WHS	**Planned By:**	PM SCHEDULER	**Issued To:**	
Isolation:	N	**WO Location:**			

------- EQUIPMENT -------

Equipment	Description	Location	Criticality	Tag #
01W1-02-02	TURBINE	01W1-02		

------- DESCRIPTION -------

ANNUAL MECHANICAL / ELECTRICAL INSPECTION - MER2

------- MATERIAL (ESTIMATED REQUIREMENTS) - Mat. Account: - - - - -------

Equipment	Part Number	Description	Quantity

------- LABOUR (ESTIMATED REQUIREMENTS) - Lab. Account: 1-001-365-470-0000 -------

Equipment	Trade	Function	People	Hrs
01W1-02-02	WHS-UTIL-OP		2	8.00
01W1-02-02	WHS-ELEC		1	8.00
01W1-02-02	WHS-MPC		1	8.00

------- NOTES -------

Complete
Mechical ~~Not~~ Done

Completed By: MH / JR Mansfield **Completion Date:** Oct. 29, 2012.

Printed JUN 28 2012

- CheckList PMMER-0015 -

Checklist:	PMMER-0015	**Author:**	DirectLine
Description:	ANNUAL - MECHANICAL & ELECTRICAL - MERS	**Date:**	2010-11-29
WO#:	52092		
Eqp#:	01W1-02-02 - TURBINE		

Task	Observation	Measurement	Points
TRAVEL	✓		
INSPECTION PERFORMED BY	✓	BH AW GA JRM	
TAILBOARD - PERFORM HAZARD RISK ASSESSMENT	✓	Done	
RECORD UPPER GUIDE BEARING VIBRATION	✓ .02		
RECORD TURBINE BEARING VIBRATION	X translucent	needs repair or replacement	
RECORD MECHANICAL RUNOUT LOWER GUIDE	NA		
RECORD MECHANICAL RUNOUT TURBINE	✓ .010		
PERORM GOVERNOR OPERATIONAL TEST	✓ Good		
VISUALLY CONFIRM LUBE OIL FLOW	✓ "		
CONFIRM/ADJUST SHUT DOWN FOR LOW GOV OIL PRESSURE (SHOULD BE 150 PSI)	✓ 151 PSI		
CONFIRM BRAKE OPERATION	✓ Good		
VISUALLY CHECK BRAKE PAD THICKNESS - (USABLE PAD THICKNESS)	5/8"		
GREASE UNIT - LINKS	→ These two	steps will be preformed at a later date.	
NOTE: GATE LINKS ARE GREASED SPRING AND FALL ONLY			
CHECK HEADCOVER SYPHON HOSE AND STRAINER	✓ ball type	syphon looks good, no strainer.	
CONFIRM COOLING AND TURBINE BEARING WATER PROTECTION	✓ Good		
CONFIRM TEMPERATURE TRIP ALARM OPERATION - THRUST BEARING TEMP	✓ "		
CONFIRM TEMPERATURE TRIP ALARM OPERATION - UPPER GUIDE BEARING TEMP	✓ "		
CONFIRM TEMPERATURE TRIP ALARM OPERATION - LOWER GUIDE BEARING TEMP	✓ "		
CONFIRM OPERATION OF PLANT AUXILIARIES (FAN	✓ "		
INSPECT FIELD BREAKER AND TEST TRIP PROTECTION	✓ "		
CONFIRM OPERATION OF LOUVERS AND VENTILATION	✓ "		
ENSURE THAT UNIT IS ISOLATED AND PERMIT ISSUED	✓		

Printed JUN 28 2012

- CheckList PMMER-0015 -

NOTE:MERSEY UNITS:CHECK PENSTOCK DIFFERENTIAL ALARM AT ECC WHEN DRAINING PENSTOCK ON ANNUAL INSPECTION	✓ Good			
REMOVE MANHOLE COVER	✓	Done		
COMPLETE CONFINED SPACE ENTRY PROCEDURE	✓	Done		
JOB SET-UP (ACCESS	✓	Done		
COMPLETE GOVERNOR LOCK-OUT PROCEDURE	✓	Done		
CHECK MANHOLE STUDS	✓	ok		
~~RECORD CLEARANCES UPPER SEAL RING RIGHT~~	N			turbine not Francis so it doesn't have upper + lower seals
~~RECORD CLEARANCES UPPER SEAL RING LEFT~~				
~~RECORD CLEARANCES UPPER SEAL UP STREAM~~				
~~RECORD CLEARANCES UPPER SEAL DOWN~~ STREAM				
RECORD CLEARANCES LOWER SEAL RING RIGHT	.597			
RECORD CLEARANCES LOWER SEAL RING LEFT	.608			
RECORD CLEARANCES LOWER SEAL RING UP STREAM	.651			
RECORD CLEARANCES LOWER SEAL RING DOWN STREAM	.603			
DRAIN WATER FROM KAPLAN RUNNERS	NA			not Kaplan
VISUALLY CHECK RUNNER	—	ok		
VISUALLY CHECK DRAFT TUBE	✓	ok		
NOTE CONDITION OF STAY VANES	✓	ok		
CHECK GATE BUSHING PLAY WITH 2X4				
VISUALLY CHECK FILLER GATE AND HEADGATES FOR LEAKS	✓	Done		used bank to lower water before doing Inspection
TEMPORARILY SURRENDER GOVERNOR LOCKOUT PERMIT	✓			
CLOSE WICKET GATES	✓			
MEASURE RECORD MAXIMUM BOTTOM CLEARANCE (GATE TO BOTTOM RING)	.288			
MEASURE RECORD MINIMUM BOTTOM CLEARANCE (GATE TO BOTTOM RING)	.130			
MEASURE RECORD MAXIMUM CENTER CLEARANCE (GATE TO GATE)	.112			
MEASURE RECORD MAXIMUM TOP CLEARANCE (GATE TO HC)	.123			

Printed JUN 28 2012

- CheckList PMMER-0015 -

MEASURE RECORD MINIMUM TOP CLEARANCE (GATE TO HC)	0		
ADJUST AS REQUIRED - NOTE COMMENTS ON THE AS LEFT CONDITION	gates looked ok		
VISUALLY INSPECT SCROLL CASE DRAIN VALVES AND PLUGS	✓	ok	
CHECK SPEED SWITCH/CHECK FIBER COUPLING - GENERATE WO TO REPLACE	✓ Good		
SURRENDER ALL PERMITS AND WATER UP	✓		
NOTE: TIE BACK CREEP SWITCH PRIOR TO TESTING SPEED SWITCH / UNTIE AFTER TESTING	✓ (ti-rap is removed)		
CONFIRM SPEED SWITCH SETTING - OVERSPEED TRIP - 115%	✓ Low 172	Hi 211 rpm	
CONFIRM CREEP PROTECTION	✓ Good		
CONFIRM GATE POSITION WITH ECC	✓ at plant 80%	ECC 79%	
TURN UNIT OVER TO ECC	✓		

/7 2011 → for info only from 2011 annuals. 480-48316

Page 3

- CheckList PMMER-0015 -

SURE RECORD MINIMUM TOP CLEARANCE (E TO HC)	less than .003	on gate with Bushing rotated .273 BOT	
JUST AS REQUIRED - NOTE COMMENTS ON THE S LEFT CONDITION	SEE NOTES		
VISUALLY INSPECT SCROLL CASE DRAIN VALVES AND PLUGS	✓		
CHECK SPEED SWITCH/CHECK FIBER COUPLING - GENERATE WO TO REPLACE	✓ Good		
SURRENDER ALL PERMITS AND WATER UP	✓		
NOTE: TIE BACK CREEP SWITCH PRIOR TO TESTING SPEED SWITCH / UNTIE AFTER TESTING	✓		
CONFIRM SPEED SWITCH SETTING - OVERSPEED TRIP - 115%	✓ Low 173	41.212	
CONFIRM CREEP PROTECTION	✓ Good		
CONFIRM GATE POSITION WITH ECC	✓ UW = 87%	at ECC 85%	
TURN UNIT OVER TO ECC	✓		

Note: * "important (same fix as G3, 4+11).

Due to large amount of clearance in gate linkages. I suggest that this issue be repaired before gate to gate clearance be corrected. There is wear on both pins on gate links and the operating ring has between 1/4 to 3/8" wear. These Items need to be address in the near future.

Left coupling weeping (bolt bushes) W.O.# 52254

CI Number: 44888

Title: PHB - Boiler Refurbishment 2014

Start Date: 2014/06
Final Cost Date: 2014/12
Function: Generation
Forecast Amount: $742,129

DESCRIPTION:

Refurbishment of sections of the biomass boiler is required to ensure reliable operation of the plant. Due to the significant volume of material (biomass) that passes through the boiler, it has many erosion susceptible areas including conveyors, feed screws and reciprocating grates. As this facility is new to NS Power's fleet, this is the first boiler refurbishment project on the unit executed by NS Power. This project will provide a baseline for future investment on this asset, and falls within the projected sustaining capital investment for the biomass plant. Similar to the boilers on coal-fired units, the biomass boiler will require refurbishment and select component replacements over its life in response to exposure to elevated temperatures, temperature cycling, erosion and corrosion. Historical annual requirements, along with condition based assessment information, aided in the development of the scope for this project.

Summary of Related CIs +/- 2 years:
2015 CI TBD PHB Boiler Refurbishment 2015 $760K (est.)
2016 CI TBD PHB Boiler Refurbishment 2016 $800K (est.)

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Maintenance

Why do this project?

Ongoing asset management activities have identified the requirement for boiler component replacement to maintain the long term reliability of the boiler and mitigate the risk of unplanned outages due to tube leaks. The Port Hawkesbury Biomass (PHB) Plant is a critical component of NS Power's strategy to achieve required renewable energy targets in 2014 and beyond.

Why do this project now?

Some of the tubes and other equipment to be inspected and replaced are difficult to access. Work must be completed during an outage of sufficient duration to complete the necessary work. The planned outage for the biomass boiler in 2014 will be of sufficient duration to complete the work.

Why do this project this way?

The work will be completed in the most cost effective manner to ensure reliable and efficient operation of the boiler. By replacing the tubes, tube bends and other equipment, the risk of tube leaks and other unplanned outages associated with the boiler will be reduced.

CI Number : 44888 - PHB - Boiler Refurbishment 2014 **Project Number**

Parent CI Number : -

Cost Centre : 251 - 251-PH Biomass Capital **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		0	0	0
095		095-Thermal Regular Labour AO		10,706	0	10,706
095		095-Thermal & Hydro Contracts AO		23,076	0	23,076
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	56,142	0	56,142
012	013	012 - Materials	013 - SGP - Boiler	392,016	0	392,016
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	236,189	0	236,189
015	013	015 - Frt, Post & Delivery	013 - SGP - Boiler	24,000	0	24,000
			Total Cost:	742,129	0	742,129
			Original Cost:	514,532		

Location: Port Hawkesbury Biomass
CI# / FP#: 44888
Title: PHB Boiler Refurbishment 2014
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	pd	15.0	$ 339	$ 5,089		
1.2	Maintenance Trades	pd	86.3	$ 345	$ 29,794		
1.3	Power Engineer	pd	10.0	$ 370	$ 3,697		
1.4	Power Plant Technician	pd	31.3	$ 362	$ 11,308		
1.5	Utility	pd	27.5	$ 227	$ 6,255		
1.6				$ -	$ -		
				Sub-Total	$ 56,142		
2	**012 Materials**						
2.1	Water cooled beams	ea	4	$ 5,200	$ 20,800		
2.2	Fixed Grates	ea	150	[redacted]		Cost Support 1	
2.3	Moving Grates	ea	150			Cost Support 1	
2.4	Sealing Nose	ea	20			Cost Support 1	
2.5	Bottom Grates	ea	25			Cost Support 1	
2.6	Glide Plates	ea	675			Cost Support 1	
2.7	Bottom ash screw seals	ea	5	$ 2,050	$ 10,250		
2.8	Expansion joints for minibins	ea	4	$ 2,500	$ 10,000		
2.9	Trancel screws - one half of boiler total	ea	6	$ 11,118	$ 66,708		
2.10	Sprockets and chain replacements	ea	2	$ 8,884	$ 17,769		
2.11	Precip conveyor troughs	ea	4	[redacted]		Cost Support 2	
2'.12	Precip screws	ea	4	$ 2,632	$ 10,530		
				Sub-Total	$ 392,016		
3	**013 Power Production Contracts**						
3.1	Prep and Post	lot	1	$ 31,800	$ 31,800		
3.2	Reciprocating Grates & WC Beams	lot	1	$ 103,749	$ 103,749		
3.3	SH staging and inspection	lot	1	$ 14,034	$ 14,034		
3.4	Precips	lot	1	$ 38,000	$ 38,000		
3.5	Scaffolding	lot	1	$ 20,000	$ 20,000		
3.6	Safety Valves	lot	1	$ 16,800	$ 16,800		
3.7	Non-Destructive Testing	lot	1	$ 11,806	$ 11,806		
				Sub-Total	$ 236,189		
4	**015 Freight**						
4.1	Freight for materials	lot	1	$ 24,000.00	$ 24,000		
4.2							
				Sub-Total	$ 24,000		
5	**095 Administrative Overhead**						
5.1	Regular Labour AO	lot	1	$ 10,706	$ 10,706		
5.2	Contract AO	lot	1	$ 23,076	$ 23,076		
5.3					$ -		
				Sub-Total	$ 33,782		
				SUB-TOTAL (no AO, AFUDC)	$ 708,347		
				TOTAL (AO, AFUDC included)	$ 742,129		
6	**Original Cost**						
6.1					$ 514,532		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

THOMPSON FOUNDRY LTD

Quality castings made in Gray iron, Ductile Iron, Ni-Resist, Ni-Hard, High Chrome, Stainless Steel, Mild Steel and Alloy Steel, Heat Treating, Metallurgy Lab, Pattern Makers, Machinists, Fabrication.

Email thompson_foundry@telus.net web www.thompsonfoundry.com
12540 82nd Ave. Surrey, B.C. V3W 3E9 Phone (604) 596-9611 Fax (604) 596-7566

To: **Michelle Sampson**
Nova Scotia Power
(v): 902 631 2670
(f): 902 625 1105

From: [redacted]
Date: June 13, 2013
Re: RFQ June 7,2013

QUOTATION: **K 061113-4**

Description	Qty Ea	Material	Cost Each
TF 154 Fixed Grate	150	30 Chr/15 Ni.	[redacted]
TF 155 Moving Grate	150	30 Chr/15 Ni.	
TF 668 Sealing Nose	20	30 Chr/15 Ni.	
TF 837 Bottom Grate	25	30 Chr/15 Ni.	
TF 872 Glide Plate	375	HH Type 2	
TF 873 Glide Plate	300	HH Type 2	
		TOTAL:	[redacted]

*** NOTE -** The material used for our grates, 30% Chrome 15% Nickel alloy is different from the OEM material which is 15% Chrome only. Thompson Foundry developed this alloy to counteract the problem of breakage in service in the boiler which was being encountered with the OEM grates. The higher chrome percentage and the addition of nickel was found to vastly improve boiler deck life resulting in fewer service shutdowns and mechanical issues.

Material Buy Back Program :
Thompson Foundry will purchase used Thompson Foundry grates in our 30/15 alloy at 1.20 per lb FOB our dock.

Grates returned to us manufactured by other suppliers will only realize a credit of 0.55 per lb FOB our dock due to unknown alloy content.

Delivery: Please allow 10 – 12 weeks from receipt of PO at our current backlog.

Terms: FOB Thompson Foundry Ltd., Surrey BC. Net 30 days, All taxes extra, Prices valid for 30 days.

Regards,

[redacted]

Thompson Foundry Ltd.

QUOTATION

ALSTOM
Thermal Services

600-1430 Blair Place
Ottawa, ON K1J 9N2
CANADA

Company: NOVA SCOTIA POWER
PORT HAWKESBURY

To: Benjamin Breen

E-mail: benjamin.breen@nspower.ca

From: Debbie Seguin

Title: Parts Specialist

Sender Phone: [redacted]

Sender Fax: [redacted]

Sender e-mail: [redacted]

Date of transmission **Sept 27, 2013**

SUBJECT: ALSTOM QUOTATION: 20029838 **Number of Pages: TWO**

We are pleased to quote as follows:

Item	Qty	DESCRIPTION	Unit Price Per set	Total Price
1	4 Sets	**CONVEYOR TROUGH** Consisting of: (1) 10'-0" Length CTA907, 9" Angle Flange Trough, 3/16" Thick Mild Steel. (2) 5'-0" Length CTA907, 9" Angle Flange Trough, 3/16" Thick Mild Steel. (1) 8'-9 1/2" Length CTA907, 9" Angle Flange Trough, 3/16" Thick Mild Steel. C/W CSD907 Stub Discharge Spout Welded to Trough (203MM) 8 inch C.L. to end. Mild Steel Exterior: PAINTED [redacted]	[redacted]	[redacted]

CONFIDENTIALITY : This fax and any attachments are confidential and may be privileged. If you are not a named recipient, please notify the sender immediately and do not disclose the contents to another person, use it for any purpose or store or copy the information in any medium.

QUOTATION

DELIVERY TERMS: FCA CANNINGTON, ONTARIO, COLLECT
5 WEEKS ARO

Payment Terms: N30 FROM DATE OF INVOICE

Quote Validity: 30 days

In consideration for the care, fitness and accuracy of installation of the above component, due consideration is recommended for using the services of a qualified ALSTOM Technical Services Representative. The cost of this service is not included in the component quotation, but can be provided separately upon request. In cases where no ALSTOM technical or construction services support is used, and installation by others is found to be incorrect, warranty may be compromised.

All taxes extra.

ALSTOM Canada Inc's standard shipping practices to apply.
Prices are quoted in Canadian funds and are fixed and firm for delivery.
The above delivery dates are subject to the availability of material and the manufacturing schedule at time of order.

ALSTOM Canada Terms and Conditions of Sale are attached.
Please do not hesitate to contact me should you require further information concerning the above quotation.

Sincerely,

Deborah J Seguin

Debbie Seguin
Parts Specialist
Alstom Power & Transport Canada Inc.
Ottawa, Ontario
K1J 9N2

CONFIDENTIALITY : This fax and any attachments are confidential and may be privileged. If you are not a named recipient, please notify the sender immediately and do not disclose the contents to another person, use it for any purpose or store or copy the information in any medium.

CI Number: 44732

Title: TRE5 Boiler Refurbishment

Start Date: 2014/06
Final Cost Date: 2015/01
Function: Generation
Forecast Amount: $626,649

DESCRIPTION:

This project is to undertake necessary boiler tube replacements and alignment, with a primary focus on the secondary superheat outlet section of Trenton Unit 5 (TRE5). In addition, support hangers throughout the boiler will be replaced as required, and leaking boiler doors will be upgraded.

The Secondary Superheater Outlet section is the primary focus of the 2014 boiler refurbishment work due to the condition of the tubes. Tube repair or replacement is required when the wall thickness remaining is 70 percent of the original minimum tube wall thickness in accordance with the ASME Boiler Code. This tolerance maximizes the economic tube life while maintaining boiler reliability. NS Power employs comprehensive boiler tube inspection surveys, metallurgical analysis of boiler tube failures, industry experience with boiler tube failure mechanisms and engineering best practices as key components of the fleet wide Boiler Tube Failure Reduction Program. This program serves to selectively identify weak and degraded boiler tubes that require replacement before they fail, which would result in unplanned forced outages of the generating unit and extra fuel/operating costs. Selective tube replacement allows for the economic life to be achieved.

Tube alignment in this section will also be improved. Misalignment of the boiler tubes leads to excessive wear due to flyash erosion and subsequent tube leaks.

The condition of the boiler doors has deteriorated resulting in unacceptable leakage of fly-ash and flue gases into the boiler house.

Summary of Related CIs +/- 2 years:
2012 CI 41667 TRE5 UU Boiler Upgrades $243K
2016 CI TBD TRE5 Boiler Refurbishment TBD

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Maintenance

Why do this project?

The 2006 life extension study outlined remedial work required to extend the life of the TRE5 boiler. Outage inspections have been completed since that time, tracking the performance of the work completed to date, and evaluating the condition of the boiler components to prioritize the work remaining. This has allowed for an effective, staged program of upgrades.

Why do this project now?

The project is planned to be undertaken coincidental with the 2014 annual outage in order to ensure the reliability of the unit, and preserve the asset. Efficiencies of executing the work in conjunction with other boiler projects and plant work will assist in keeping costs to a minimum. The planned outage for TRE5 in 2014 is of sufficient duration to complete this work.

Why do this project this way?

The boiler upgrades are planned to be undertaken coincidental with the 2014 annual outage. This allows for cost-efficient use of both boilermakers and plant support personnel.

The phased approach to addressing the life extension work allows the work to be performed in order of priority.

CI Number : 44732 - TRE5 Boiler Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 340 - 340-Trenton Unit 5 Capital **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		6,703	0	6,703
095		095-Thermal Overtime Labour AO		867	0	867
095		095-Thermal Term Labour AO		5,422	0	5,422
095		095-Thermal Regular Labour AO		7,119	0	7,119
095		095-Thermal & Hydro Contracts AO		43,281	0	43,281
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	29,653	0	29,653
002	013	002 - THERMAL Overtime Labour	013 - SGP - Boiler	9,098	0	9,098
004	013	004 - THERMAL Term Labour	013 - SGP - Boiler	28,430	0	28,430
012	013	012 - Materials	013 - SGP - Boiler	30,000	0	30,000
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	443,000	0	443,000
001	085	001 - THERMAL Regular Labour	085 Design	3,290	0	3,290
001	087	001 - THERMAL Regular Labour	087 Field Super.& Ops.	4,386	0	4,386
011	087	011 - Travel Expense	087 Field Super.& Ops.	500	0	500
021	087	021 - Telephones	087 Field Super.& Ops.	250	0	250
028	087	028 - Consulting	087 Field Super.& Ops.	14,400	0	14,400
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	250	0	250
			Total Cost:	626,649	0	626,649
			Original Cost:	104,907		

TRE5 Boiler Refurbishments
Summary of Alternatives

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Trenton Generating Station	**CI Number:**	44732
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Boiler Refubishments	6.49%	-1,178,783	808,601	1	65.27%	1.9 years
B	Boiler Section Replacement	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Based on favorable economic analysis data, it is recommended to fund boiler upgrades for Trenton Unit 5.

Notes/Comments :

Boiler Refubishments

This scenario compares the cost of the boiler upgrades versus the avoided replacement energy costs due to future unplanned outages (over the next five years) if the refurbishments are not completed. Assumptions: 1) Over the next five years, the unit will experience an increasing frequency of unplanned outages 2) Average outage of 120hr 3) Average labour hours to return the asset to operation 600hr, and 4) Average cost of materials for an unplanned repair $30k.

Boiler Section Replacement

Replacement of a full section of the boiler is not required, and would cost significantly more than the selective work being proposed under this project. This option is not evaluated further.

Test 3

Test 4

TRE5 Boiler Refurbishments
Summary of Sensitivities

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Trenton Generating Station	**CI Number:**	44732
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Boiler Refubishments	6.49%	-1,178,783	808,601	1	65.27%	1.9 years
B	Boiler Section Replacement	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Boiler Refubishments	10%	-1,122,695	764,396	1	56.66%	2.1 years
B	Boiler Section Replacement	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
	Change: **A**		56,088	-44,205	0	-8.62%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Boiler Refubishments	-10%	-1,004,817	683,536	1	55.80%	2.2 years
B	Boiler Section Replacement	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
	Change: **A**		173,966	-125,065	0	-9.47%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	161,852	481,930	769,409	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

TRE5 Boiler Refurbishments
Avoided Cost Calculations

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Trenton Generating Station	**CI Number:**	44732
Originator :		**Project No. :**	

Boiler Refubishments

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			90,000	93,624		
Events/Outages (#)	1	2	1	2		
Probability of Occurance (%)	95%	95%	95%	95%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	160	160				
Duration (Hours)	120	120				
Totals	$88,944	$218,103	$85,500	$177,886	$174,444	$395,989
Total Capital Cost of Alternative						$626,649

Boiler Section Replacement

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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

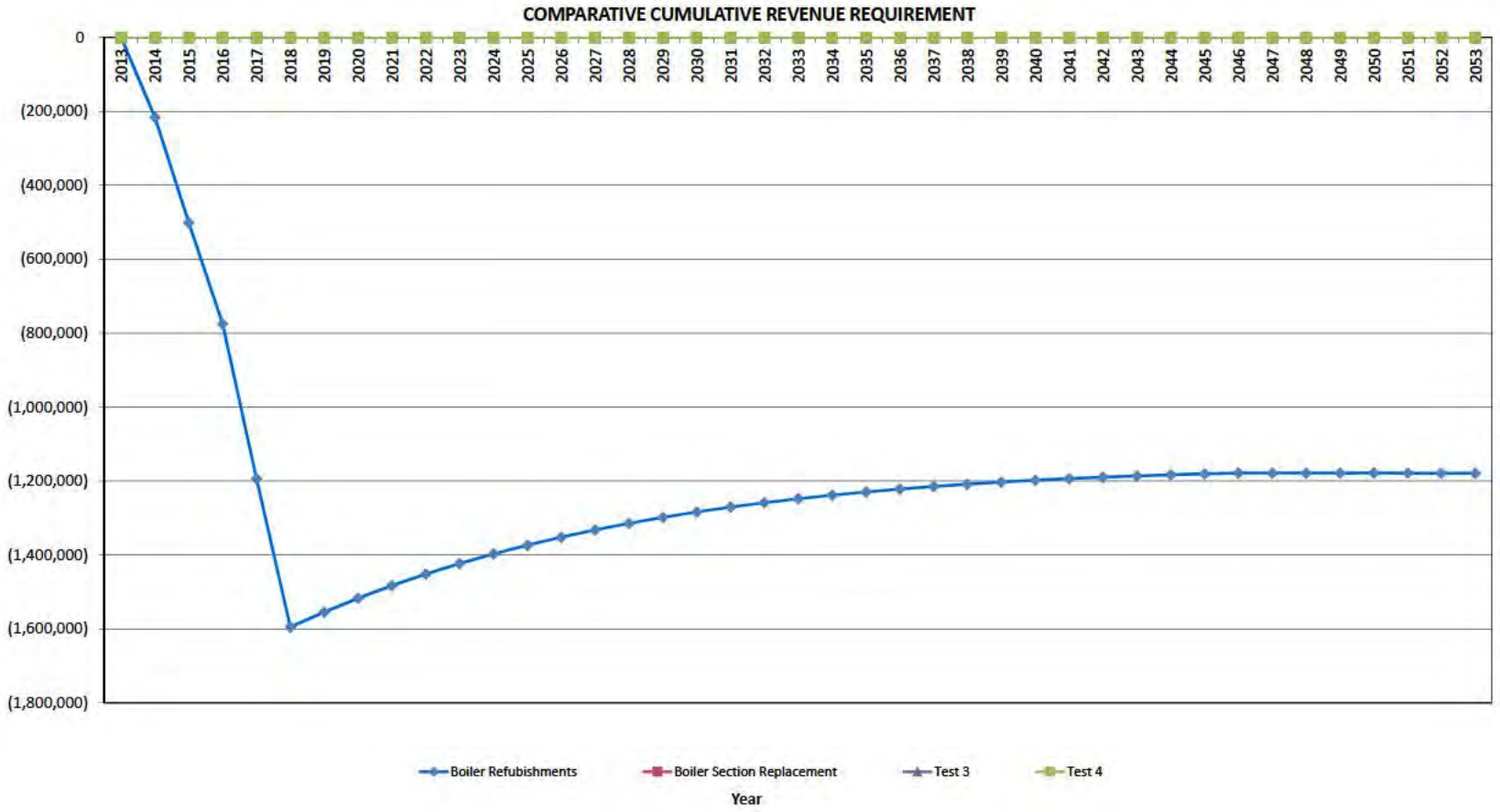
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity 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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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 Boiler Refurbishments
Boiler Refubishments

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	174,443.7	(569,959 9)	22,530.3	556,372.4	(395,516 2)	(47,093.2)	(442,609.4)	(415,634.7)	0.94	(415,634.7)
2015	-	-	395,988.9	-	43,258.1	510,502.1	395,988 9	(109,346.6)	286,642.4	252,768.4	0.88	(162,866.3)
2016	-	-	407,513.9	-	39,797.5	468,301.4	407,513 9	(113,992.1)	293,521.8	243,060 2	0.83	80,193.9
2017	-	-	629,121.7	-	36,613.7	429,476.7	629,121.7	(183,677.5)	445,444.2	346,384 2	0.78	426,578.1
2018	-	-	647,556.2	-	33,684.6	393,758.1	647,556 2	(190,300.2)	457,256.0	333,899.1	0.73	760,477.2
2019	-	-	-	-	30,989.8	360,896.9	-	9,606.8	9,606.8	6,587.6	0.69	767,064.8
2020	-	-	-	-	28,510.6	330,664.6	-	8,838.3	8,838.3	5,691 2	0.64	772,756.0
2021	-	-	-	-	26,229.8	302,850.9	-	8,131.2	8,131.2	4,916 8	0.60	777,672.9
2022	-	-	-	-	24,131.4	277,262.3	-	7,480.7	7,480.7	4,247 8	0.57	781,920.7
2023	-	-	-	-	22,200.9	253,720.8	-	6,882.3	6,882.3	3,669 8	0.53	785,590.5
2024	-	-	-	-	20,424.8	232,062.6	-	6,331.7	6,331.7	3,170 5	0.50	788,760.9
2025	-	-	-	-	18,790.8	212,137.1	-	5,825.2	5,825.2	2,739.1	0.47	791,500.0
2026	-	-	-	-	17,287.6	193,805.6	-	5,359.1	5,359.1	2,366.4	0.44	793,866.4
2027	-	-	-	-	15,904.6	176,940.6	-	4,930.4	4,930.4	2,044.4	0.41	795,910.7
2028	-	-	-	-	14,632.2	161,424.8	-	4,536.0	4,536.0	1,766 2	0.39	797,676.9
2029	-	-	-	-	13,461.6	147,150.3	-	4,173.1	4,173.1	1,525 9	0.37	799,202.8
2030	-	-	-	-	12,384.7	134,017.8	-	3,839.3	3,839.3	1,318 2	0.34	800,521.0
2031	-	-	-	-	11,393.9	121,935.8	-	3,532.1	3,532.1	1,138 9	0.32	801,659.9
2032	-	-	-	-	10,482.4	110,820.4	-	3,249.5	3,249.5	983 9	0.30	802,643.8
2033	-	-	-	-	9,643.8	100,594.3	-	2,989.6	2,989.6	850 0	0.28	803,493.8
2034	-	-	-	-	8,872.3	91,186.2	-	2,750.4	2,750.4	734.4	0.27	804,228.2
2035	-	-	-	-	8,162.5	82,530.8	-	2,530.4	2,530.4	634.4	0.25	804,862.7
2036	-	-	-	-	7,509.5	74,567.8	-	2,327.9	2,327.9	548.1	0.24	805,410.8
2037	-	-	-	-	6,908.8	67,241.8	-	2,141.7	2,141.7	473 5	0.22	805,884.3
2038	-	-	-	-	6,356.1	60,502.0	-	1,970.4	1,970.4	409.1	0.21	806,293.4
2039	-	-	-	-	5,847.6	54,301.3	-	1,812.7	1,812.7	353.4	0.19	806,646.8
2040	-	-	-	-	5,379.8	48,596.7	-	1,667.7	1,667.7	305 3	0.18	806,952.2
2041	-	-	-	-	4,949.4	43,348.4	-	1,534.3	1,534.3	263 8	0.17	807,216.0
2042	-	-	-	-	4,553.4	38,520.0	-	1,411.6	1,411.6	227 9	0.16	807,443.9
2043	-	-	-	-	4,189.2	34,077.9	-	1,298.6	1,298.6	196 9	0.15	807,640.8
2044	-	-	-	-	3,854.0	29,991.1	-	1,194.7	1,194.7	170.1	0.14	807,810.9
2045	-	-	-	-	3,545.7	26,231.3	-	1,099.2	1,099.2	147 0	0.13	807,957.8
2046	-	-	-	-	3,262.0	22,772.3	-	1,011.2	1,011.2	127 0	0.13	808,084.8
2047	-	-	-	-	3,001.1	19,590.0	-	930.3	930.3	109.7	0.12	808,194.5
2048	-	-	-	-	2,761.0	16,662.2	-	855.9	855.9	94.8	0.11	808,289.2
2049	-	-	-	-	2,540.1	13,968.7	-	787.4	787.4	81.9	0.10	808,371.1
2050	-	-	-	-	2,336.9	11,490.7	-	724.4	724.4	70.7	0.10	808,441.8
2051	-	-	-	-	2,150.0	9,210.9	-	666.5	666.5	61.1	0.09	808,502.9
2052	-	-	-	-	1,978.0	7,113.5	-	613.2	613.2	52.8	0.09	808,555.7
2053	-	-	-	-	1,819.7	5,183.9	-	564.1	564.1	45.6	0.08	808,601.3
Total	**-**	**-**	**2,254,624.4**	**(569,959.9)**	**542,329.8**		**1,684,664.5**	**(530,811.3)**	**1,153,853.2**	**808,601.3**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(200,000)
(400,000)
(600,000)
(800,000)
(1,000,000)
(1,200,000)
(1,400,000)
(1,600,000)
(1,800,000)
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
2053
Boiler Refubishments
Boiler Section Replacement
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: Trenton Generating Station
CI# / FP#: 44732
Title: TRE5 Boiler Refurbishments
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Mechanical (20% removal)	pd	20 0	$ 345	$ 6,909		
1 2	Utility (20% removal)	pd	100.0	$ 227	$ 22,744		
1 3	Engineering	pd	8.6	$ 384	$ 3,290		
1.4	Supervision	pd	11.4	$ 384	$ 4,386		
1 5					$ -		
				Sub-Total	$ 37,329		39602
2	**002 Overtime Labour**						
2.1	Utility (20% removal)	pd	20	$ 454.88	$ 9,098		
2 2					$ -		
2 3					$ -		
				Sub-Total	$ 9,098		39602
3	**004 Term Labour**						
3.1	Utility - Confined Space Attendant (20% removal)	pd	125	$ 227.44	$ 28,430		
3 2					$ -		
3 3					$ -		
3.4					$ -		
				Sub-Total	$ 28,430		39602
4	**012 Materials**						
4.1	Bifurcates	lot	1	$ 5,000.00	$ 5,000		
4 2	Tubes	lot	1	$ 5,000.00	$ 5,000		
4 3	Doors/Miscellaneous Materials	lot	1	$ 20,000.00	$ 20,000		
4.4					$ -		
4 5					$ -		
4 6					$ -		
				Sub-Total	$ 30,000		39602
5	**013 Contracts/Contract Labour**						
5.1	Suspended Floor	lot	1	$ 25,000.00	$ 25,000		
5 2	Vacuum Services	lot	1	$ 50,000.00	$ 50,000		
5 3	Inspection	hr	1600	$ 70.00	$ 112,000		
5.4	Boilermaker Labour (20% removal)	hr	3200	$ 80.00	$ 256,000		
5 5					$ -		
				Sub-Total	$ 443,000		39602
6	**028 Consultants**						
6.1	External Supervision	hr	240	$ 60.00	$ 14,400		
6 2					$ -		
				Sub-Total	$ 14,400		
7	**011 Travel**						
7.1	Travel	lot	1	$ 500.00	$ 500		
				Sub-Total	$ 500		
8	**021 Phones**						
8.1	Phone	lot	1	$ 250.00	$ 250		
				Sub-Total	$ 250		
9	**041 Meals**						
9.1	Meals	lot	1	$ 250.00	$ 250		
				Sub-Total	$ 250		
10	**094 Interest Capitalized**						
10.1	AFUDC		1	$ 6,703.30	$ 6,703		
				Sub-Total	$ 6,703		
11	**095 Administrative Overhead**						
11.1	Regular AO	lot	1	$ 7,118.64	$ 7,119		
11.2	Overtime AO	lot	1	$ 867.45	$ 867		
11.3	Term AO	lot	1	$ 5,421.60	$ 5,422		
11.4	Contracts AO	lot	1	$ 43,280.92	$ 43,281		
				Sub-Total	$ 56,689		
				SUB-TOTAL (no AO, AFUDC)	$ 563,257		
				TOTAL (AO, AFUDC included)	$ 626,649		
12	**Original Cost**						
12.1					$ 104,907		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

EXECUTIVE SUMMARY REPORT

Nova Scotia Power Incorporated
Trenton Generating Station
Unit # 5
March-October 2012 – Shutdown

Summary

The utility boiler for Unit # 5 at Trenton Generating Station was shut down in March 2012 due to a failure in Row 21 of the IP stage of the Rotor in March 2012.

The major scope of work for this shutdown was the replacement of Row 21 of IP Rotor. The boiler inspection revealed wall thinning in the Cold RH Section. There were eight {8} tubes and one {1} wall hanger support tube for the Cold RH replaced as well during this shutdown. There was an acid wash performed by Babcock Wilcox during this shutdown. There was additional tube replacements carried out as defined in the following sections.

Introduction

During the 2012 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. Gary MacDonnell and Roland McLaughlin carried out the repairs. Alstom under the Supervision of Mr. Gerard LeBlanc carried out the Non-Destructive Testing. Mr. Matthew Muise carried out Quality Assurance and Mr. Ernie Aker carried out Safety Officer function.

Lower Furnace

A visual and UT survey was carried out on the waterwalls with the following.

The North Waterwall {Front} was visually inspected with photos taken of each burner. There were two {2} areas for a total of ten inches {10"} identified for pad weld overlay. These areas were repaired and inspected with Color Contrast Magnetic Particles.

The South Waterwall {Rear} was surveyed with nine {9} areas for a total of one hundred eighty-eight inches {188"} identified for pad weld overlay. These areas were repaired and inspected with Color Contrast Magnetic Particles.

The East Waterwall {Left} was surveyed with three {3} areas for a total of twenty-three inches {23"} identified for pad weld overlay. These areas were repaired and inspected with Color Contrast Magnetic Particles.

The West Water-wall {Right} was surveyed with four {4} areas for a total of seventy inches {70"} identified for pad weld overlay. These areas were repaired and inspected with Color Contrast Magnetic Particles.

c/o Nova Scotia Power Inc
Lingan Generating Station
New Waterford, N.S. Canada
Tel.: (902) 862-6422 Ext 3331
Fax: (902) 862-6087

ALSTOM Canada Inc.

Cold Re-Heat - Up Pass # 6 - Tubes 1-20 – 8th Floor

A QUIKDECK Suspended bulkhead was installed by SAFWAY. This bulkhead provided 100% accessibility for the Cold RH Section. There were eight {8} tube replacements identified and replaced in the Cold RH Section. There were also eight {8} areas identified for a total of twenty-eight inches {28"} for pad weld overlay. These areas were repaired and inspected with Color Contrast Magnetic Particles. In addition, there was one wall hanger support tube replaced. There were three {3} shields replaced. All butt welds were radiographed in this section.

Secondary SH Inlet – Up Pass 5 - 6 – Tubes 1-24 – 8-8 ½ Floor

The survey of this section revealed twenty {20} areas for a total of fifty-eight inches {58"} identified for pad weld overlay. These areas were repaired, inspected and found acceptable. In addition, thirty-four {34} shields were identified for replacement.

Secondary SH Intermediate – Up Pass 4-5 – Tubes 25-56 – 8 ½ - 9th Floor

The survey of this section revealed no pad welds required. There were three {3} shields identified for replacement. These shields were replaced during this shutdown.

Sec SH Outlet / RH-2 – Up Pass 3–4 – Tubes 57-68; 1-10; 9–9 1/2 Floor

A survey was carried out in the Sec SH / RH 2 Outlet Sections. One area {1} for a total of two inches {2"} was identified for pad weld overlay. This area was repaired and inspected. There were one hundred two {102} shields identified for replacement. These shields were replaced during this shutdown. There was one tube replaced due to wall thinning. In addition, there were twenty-seven {27} platens misaligned. There were pieces welded to existing alignment lugs to re-align elements. There was also one tube off a wall bracket that was repaired.

Re-Heat 2 Intermediate – Up Pass 2 - 3 – Tubes 11-30; 9 ½ - 10th Floor

The survey of this section revealed no pad welds required. There were also twenty-seven {27} shields identified for replacement. These shields were replaced during this shutdown. There were also six {6} misaligned, fourteen {14} kicked out tubes and one {1} tube off wall bracket. Pieces were welded to existing alignment lugs to re-align elements.

ReHeat Finish – Pri SH Finish – Up Pass 1-2 – Tubes 31-40; Tubes 1-4 – 10 – 10 ½ Floor

The survey of this section revealed five {5} areas for a total of sixty {60"} inches identified for pad weld overlay. These areas were repaired and found acceptable. Also, there was one {1} tube identified and replaced during this shutdown. No shields were required to be replaced.

Crossover Tubes - Up Pass 1 – 10 ½ Floor

The survey of this section revealed three {3} areas for a total of twenty-two inches {22"} identified for pad weld overlay. These areas were repaired and found acceptable. There were seventeen {17} shields identified and replaced during this shutdown.

Primary SH 3 – Down Pass # 1-2 – Tubes 5-20 - 10 ½ - 10th Floor

c/o Nova Scotia Power Inc
Lingan Generating Station
New Waterford, N.S. Canada
Tel.: (902) 862-6422 Ext 3331
Fax: (902) 862-6087

ALSTOM Canada Inc.

The survey of this section revealed five {5} areas for a total of eight inches {8"} identified for pad weld overlay. These areas were repaired and found acceptable. There were also three {3} tubes identified and replaced due to wall thinning. There were six {6} shields identified for replacement.

Primary SH 2 – Down Pass # 2-3 – Tubes 21-44 – 10-9 1/2 Floor

The survey of this section revealed seven areas {7} for a total of thirty inches {30"} identified for pad weld overlay. These areas were repaired and found acceptable. In addition, there were four {4} tube replacements carried out in this section. Also there were twenty {20} shields identified for replacement.

Primary SH 1 – Down Pass # 3-4 – Tubes 45-66 - 9 ½ - 9th Floor

The survey of this section revealed ten {10} areas for a total of forty-eight inches {48"} identified for pad weld overlay. These areas were repaired and found acceptable. There was also one {1} shield identified and replaced during this shutdown.

Primary SH 1 – Down Pass # 4-5 – Tubes 67-70 – 9th – 8th Floor

The survey of this section revealed eight {8} areas for a total of thirty-two inches {32"} identified for pad weld overlay. These areas were repaired and accepted. There were four {4} shields identified and replaced during this shutdown.

West, Center and East Economizer – 8th Floor

There were nine areas {9} for a total of seventy inches {70"} in the West Economizer. There were fifteen {15} areas for a total of fifty-two inches {52"} in the Center Economizer. There were seven {7} areas for a total of eighty-six inches {86"} in the East Economizer. All above areas were repaired and inspected. In addition, there was one {1} shield in the East and one {1} shield in the West Economizer Sections identified and replaced.

Headers & Front Vestibule

A Magnetic Particle Inspection was carried out on tube ligaments on Plt 1-5 and Plt 40-44 on the RH 2 Outlet Header. The existing pad weld overlay area was also inspected The East and West "T" Sections were also inspected with MPI. No defects were noted during this inspection.

The Primary SH Finish Header East and West saddles were inspected with missing bolts detected in the East end and loose bolts in the West end.

Steam Drum

A visual internal inspection was carried out in the West and East ends of the steam drum. There were indications in attachment welds from support plates to the drum identified. These indications were removed, re-welded, re-inspected and found acceptable. None of these indications had propagated into the drum. A Wet Fluorescent Magnetic Particle Inspection was carried out on the drains, attachment and circumferential welds on the West and East Heads. No indications were detected at the time of inspection.

Blow-down Tank

A visual and UT Thickness survey was carried out internally in the blow-down tank. Erosion was noted in a previously repaired overlaid area. Wall loss was also detected on the nozzle penetration of the manway. Both of these areas were repaired with pad weld overlay. These areas were inspected after repair with Magnetic Particles and found acceptable.

c/o Nova Scotia Power Inc
Lingan Generating Station
New Waterford, N.S. Canada
Tel.: (902) 862-6422 Ext 3331
Fax: (902) 862-6087

ALSTOM Canada Inc.

Deaerator Heater and Storage Tanks

A visual, Magnetic Particle and Ultrasonic thickness survey was carried out in the Deaerator Heater vessel. All accessible internal and external attachment welds were inspected with Color Contrast Magnetic Particles with no defects noted. In addition to the above, there were holes identified in the box structure. Patching a plate over existing holes repaired these areas.

A visual and Magnetic Particle inspection was carried out on the Dearator Storage Tank. All circumferential, longitudinal, attachment welds and drains were inspected with no defects noted. However, there was a support leg weld found to be cracked. This indication was removed, re-welded, re-inspected and found acceptable.

Air Heater

A visual inspection was carried out in the tubular Air Heater.

The East Side Air Heater has five hundred seventy-two {572} tubes. There are thirty {30} tubes plugged with welded plate. There are twelve {12} additional tubes plugged, 11 sleeved and thirteen {13} tubes marked up for sleeves or plugs.

The West Side Air Heater has five hundred seventy-two {572} tubes. There are thirty {30} tubes plugged with welded plate. There are twelve {12} tubes plugged, twenty-seven {27} tubes sleeved and thirteen {13} tubes marked up for sleeves or plugs.

The above marked up tubes were not plugged or sleeved.

De-Superheater Attemperators

The West and East side De-Superheater Attemperators were removed and new ones were installed during this shutdown. All butt welds were radiographed and all attachment welds were inspected with Magnetic particles. All welds were found to be acceptable.

Conclusions and Recommendations

During the next Planned Shutdown, the following areas should be surveyed in addition to the normal boiler survey:

-Due to new and existing pad welds, NSPI Engineering investigates the feasibility of replacing the following wall panels: South {Rear Wall} – Tubes 58-74, Elev. 87'-104'{ 1 panel 21' X 17Tubes}; Tubes 99-134, Elev. 86'-104'{ 2 panels 22' X 18 Tubes}. East {Left Wall} – Tubes 82-100, Elev. 87' – 105' {1 Panel 19 Tubes X 22'}.
-Re-install the QUIK-DECK to access the Cold RH Section.
-Re-inspect the Front and Rear Support Bifurcate tubes.
-Re-inspect the shielded tubes in the Sec SH Outlet.
-Carry out a full boiler survey for tube shield identification locations and establish a tube shield drawing,

c/o Nova Scotia Power Inc
Lingan Generating Station
New Waterford, N.S. Canada
Tel.: (902) 862-6422 Ext 3331
Fax: (902) 862-6087

ALSTOM Canada Inc.

Nova Scotia Power Inc.

ALSTOM

Trenton Generating Station

Unit # 5

Boiler Summaries 2012

Section	# Pad Welds	# Inches	Total Remaining	# Shields	Total Remaining	# Butt welds	Total Remaining	Other
Up 1	3	22	0	17	0	0	0	
Up 1 - 2	5	60	0	0	0	2	0	
Up 2 - 3	0	0	0	27	0	0	0	6 misaligned, 14 kick out, 1 off bracket
Up 3 - 4	1	2	0	102	0	2	0	27 Plts misaligned with tube kicked out
Up 4 - 5	0	0	0	3	0	0	0	
Up 5 - 6	20	58	0	34	0	0	0	
Under Bulkhead	8	28	0	3	0	18	0	
Dn 1 - 2	5	8	0	6	0	6	0	7 off wall hangers
Dn 2 - 3	7	30	0	20	0	8	0	15 Off saddles, 12 off wall hanger
Dn 3 - 4	10	48	0	1	0	0	0	2 Off saddles, 7 off wall hangers
Dn 4 - 5	8	32	0	4	0	0	0	1 off wall hanager
East Econ	7	86	0	1	0	0	0	1 Repair Bracket
Cen Econ	15	52	0	0	0	0	0	8 Repair Brackets
West Econ	9	70	0	1	0	0	0	
East WW	3	23	0	0	0	0	0	2 - IRs with cracked nozzles
West Wall	4	70	0	0	0	0	0	1 - IR with cracked nozzle
North Wall	2	10	0	0	0	0	0	
South WW	9	188	0	0	0	0	0	3 - IRs with cracked nozzles
Totals	107	787	0	219	0	36	0	
% complete			100		100		100	

10/11/20129:59 AM

CI Number: 44351

Title: LIN Mill Refurbish 2014

Start Date: 2014/04
Final Cost Date: 2015/03
Function: Generation
Forecast Amount: $536,481

DESCRIPTION:

This project is to replace mill 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, worm gear and shaft, vertical shaft and other non-repairable mill components. The scope of this project is to refurbish two mills with new ceramic tables and rollers. Components either 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 mill. Mills 3C (Unit 3) and 4C (Unit 4) are planned for refurbishment in 2014. Going forward, regular refurbishments of the Lingan mills will still be required to extend asset life and ensure the reliability of this equipment is maintained.

Summary of Related CIs +/- 2 years:
2012 CI 40655 LIN Pulverizer Refurbishment $461K
2013 CI 43166 LIN Mill Refurbishment $549K
2015 CI TBD LIN Mill Refurbishment $500K (est)
2016 CI TBD LIN Mill Refurbishment $500K (est)

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Maintenance

Why do this project?

A failed mill could limit peak generation of a unit depending on the fuel blend in service. This makes it imperative that the mills are available and able to operate for extended lengths between scheduled outages. The replacement of mechanical components and the upgrading of the ceramics help to achieve this initiative.

Why do this project now?

A phased approach to upgrading the mills allows for scheduled outages of selected mills, reducing the risk of extended unplanned outages. By planning refurbishments in a given year, the refurbishment efforts can be made more efficiently, with dedicated labour and parts available as required.

Why do this project this way?

Operating and maintenance experience with the mills has identified several areas of concern that need to be addressed in order for the mills to meet availability targets. Replacement parts are now needed due to age and wear on many of the components. During periods of lower load it is possible to take 1 of 4 mills out of service without affecting generation. Isolated repairs and minor refurbishment are not typically possible for the mills. It is often necessary to disassemble major components and therefore an overall refurbishment versus isolated repairs is more effective.

CI Number : 44351 - LIN Mill Refurbish 2014 **Project Number**

Parent CI Number : -

Cost Centre : 301 - 301-Lingan Admin./Common Capital **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		8,136	0	8,136
095		095-Thermal Regular Labour AO		23,266	0	23,266
001	018	001 - THERMAL Regular Labour	018 - SGP - Fuel Hndlg.Coal	122,001	0	122,001
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:	536,481	0	536,481
			Original Cost:	93,700		

44351 LIN 2014 Mill Refurbishments
Summary of Alternatives

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Lingan	**CI Number:**	44351
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Refurbish Mills	6.49%	-754,533	505,656	1	36.31%	3.2 years
B	Replace Mills	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	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 sulfur, 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, including material lead time is 2 - 4 weeks. This scenario assumes the Mill is unavailable for 4 weeks for teardown and materials lead time.

Replace Mills

Replacement of the full mill is not required, and would be much more expensive than refurbishment. No other viable technical options were identified.

Test 3

Test 4

44351 LIN 2014 Mill Refurbishments
Summary of Sensitivities

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Lingan	**CI Number:**	44351
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Mills	6.49%	-754,533	505,656	1	36.31%	3.2 years
B	Replace Mills	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Mills	10%	-705,306	465,817	1	31.64%	3.4 years
B	Replace Mills	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
Change:	**A**		49,227	-39,839	0	-4.67%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Mills	-10%	-629,853	415,251	1	31.17%	3.5 years
B	Replace Mills	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
Change:	**A**		124,680	-90,404	0	-5.14%	0.3 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement		PV of Revenue Requirement	PV of Revenue Requirement	PV of Revenue Requirement	Delay?
	Yrs Delay:	1	2	3	
	A	88,816	221,852	373,904	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

44351 LIN 2014 Mill Refurbishments
Avoided Cost Calculations

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Lingan	**CI Number:**	44351
Originator :		**Project No. :**	

Refurbish Mills

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			159,544	175,235		
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	$0	$0	$95,726	$175,235	$95,726	$175,235
Total Capital Cost of Alternative						$536,481

Replace Mills

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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

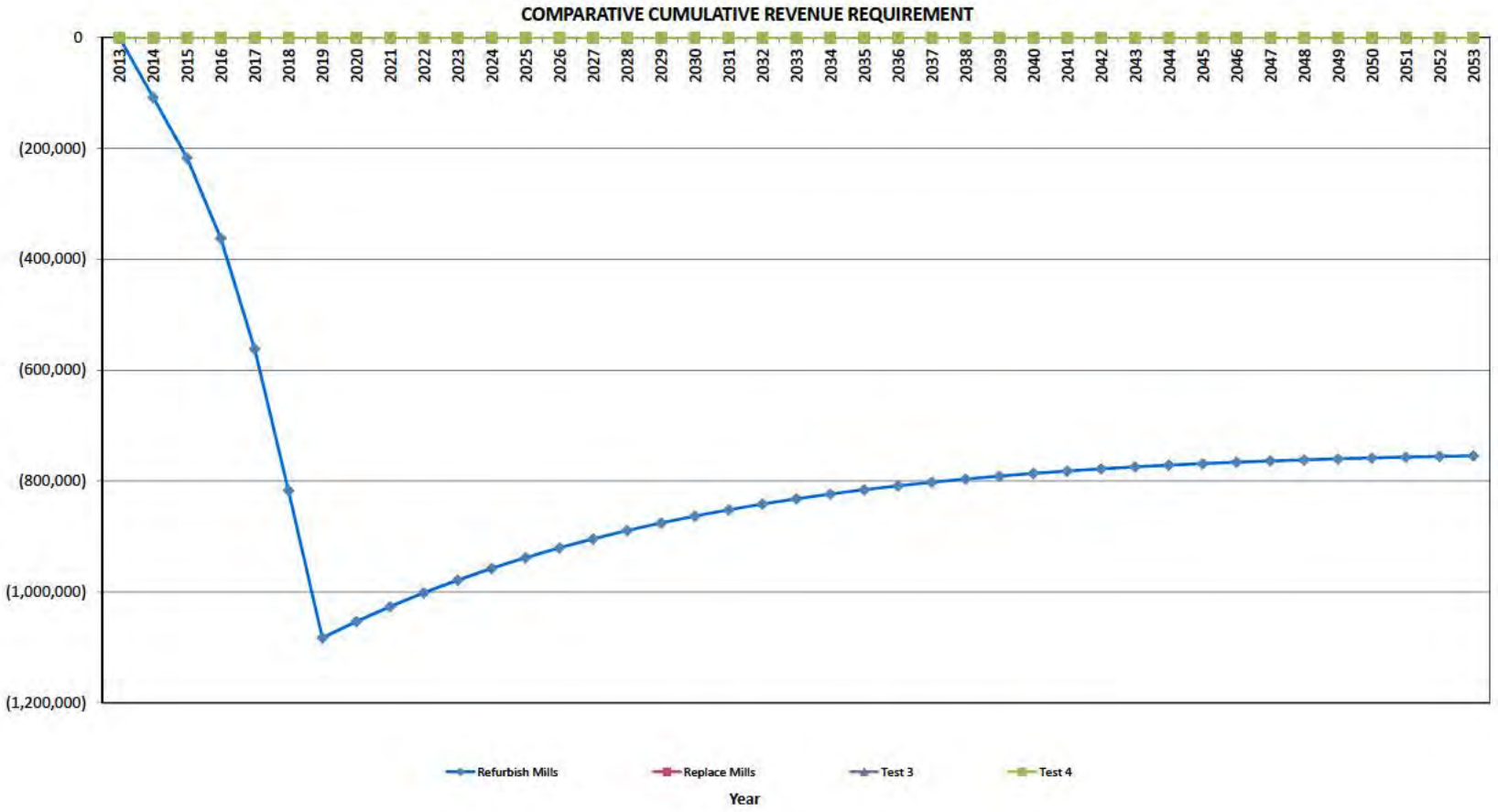
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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

44351 LIN 2014 Mill Refurbishments

Refurbish Mills

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	95,726.4	(513,215.0)	20,203.1	491,296.7	(417,488.6)	(23,412.2)	(440,900.8)	(414,030.3)	0.94	(414,030.3)
2015	-	-	175,234.9	-	38,790.0	451,434.6	175,234.9	(42,297.9)	132,937.0	117,227.1	0.88	(296,803.1)
2016	-	-	231,287.5	-	35,686.8	414,761 5	231,287.5	(60,636.2)	170,651.3	141,313.3	0.83	(155,489.8)
2017	-	-	318,411.6	-	32,831.9	381,022 2	318,411.6	(88,529.7)	229,881.9	178,759.6	0.78	23,269.8
2018	-	-	421,346.6	-	30,205.3	349,982 0	421,346.6	(121,253.8)	300,092.8	219,134.9	0.73	242,404.7
2019	-	-	465,177.7	-	27,788.9	321,425.1	465,177.7	(135,590.5)	329,587.2	226,004.7	0.69	468,409.3
2020	-	-	-	-	25,565.8	295,152.7	-	7,925.4	7,925.4	5,103.4	0.64	473,512.7
2021	-	-	-	-	23,520.5	270,982.1	-	7,291.4	7,291.4	4,409.0	0.60	477,921.7
2022	-	-	-	-	21,638.9	248,745 2	-	6,708.1	6,708.1	3,809.1	0.57	481,730.7
2023	-	-	-	-	19,907.8	228,287 2	-	6,171.4	6,171.4	3,290.8	0.53	485,021.5
2024	-	-	-	-	18,315.2	209,465 9	-	5,677.7	5,677.7	2,843.0	0.50	487,864.5
2025	-	-	-	-	16,849.9	192,150 2	-	5,223.5	5,223.5	2,456.1	0.47	490,320.6
2026	-	-	-	-	15,501.9	176,219 8	-	4,805.6	4,805.6	2,121.9	0.44	492,442.6
2027	-	-	-	-	14,261.8	161,563 9	-	4,421.2	4,421.2	1,833.2	0.41	494,275.8
2028	-	-	-	-	13,120.8	148,080.4	-	4,067.5	4,067.5	1,583.8	0.39	495,859.6
2029	-	-	-	-	12,071.2	135,675.6	-	3,742.1	3,742.1	1,368.3	0.37	497,227.8
2030	-	-	-	-	11,105.5	124,263 2	-	3,442.7	3,442.7	1,182.1	0.34	498,409.9
2031	-	-	-	-	10,217.0	113,763.7	-	3,167.3	3,167.3	1,021.2	0.32	499,431.2
2032	-	-	-	-	9,399.7	104,104 3	-	2,913.9	2,913.9	882.3	0.30	500,313.4
2033	-	-	-	-	8,647.7	95,217.6	-	2,680.8	2,680.8	762.2	0.28	501,075.7
2034	-	-	-	-	7,955.9	87,041 8	-	2,466.3	2,466.3	658.5	0.27	501,734.2
2035	-	-	-	-	7,319.4	79,520.1	-	2,269.0	2,269.0	568.9	0.25	502,303.1
2036	-	-	-	-	6,733.9	72,600.1	-	2,087.5	2,087.5	491.5	0.24	502,794.6
2037	-	-	-	-	6,195.2	66,233.7	-	1,920.5	1,920.5	424.6	0.22	503,219.2
2038	-	-	-	-	5,699.5	60,376.6	-	1,766.9	1,766.9	366.8	0.21	503,586.1
2039	-	-	-	-	5,243.6	54,988.1	-	1,625.5	1,625.5	316.9	0.19	503,903.0
2040	-	-	-	-	4,824.1	50,030.7	-	1,495.5	1,495.5	273.8	0.18	504,176.8
2041	-	-	-	-	4,438.2	45,469 9	-	1,375.8	1,375.8	236.5	0.17	504,413.3
2042	-	-	-	-	4,083.1	41,273 9	-	1,265.8	1,265.8	204.4	0.16	504,617.7
2043	-	-	-	-	3,756.5	37,413.6	-	1,164.5	1,164.5	176.6	0.15	504,794.2
2044	-	-	-	-	3,455.9	33,862 2	-	1,071.3	1,071.3	152.5	0.14	504,946.8
2045	-	-	-	-	3,179.5	30,594 8	-	985.6	985.6	131.8	0.13	505,078.6
2046	-	-	-	-	2,925.1	27,588 9	-	906.8	906.8	113.8	0.13	505,192.4
2047	-	-	-	-	2,691.1	24,823.4	-	834.2	834.2	98.4	0.12	505,290.8
2048	-	-	-	-	2,475.8	22,279.1	-	767.5	767.5	85.0	0.11	505,375.7
2049	-	-	-	-	2,277.8	19,938.4	-	706.1	706.1	73.4	0.10	505,449.1
2050	-	-	-	-	2,095.5	17,785 0	-	649.6	649.6	63.4	0.10	505,512.6
2051	-	-	-	-	1,927.9	15,803 8	-	597.6	597.6	54.8	0.09	505,567.3
2052	-	-	-	-	1,773.7	13,981.1	-	549.8	549.8	47.3	0.09	505,614.7
2053	-	-	-	-	1,631.8	12,304 3	-	505.8	505.8	40.9	0.08	505,655.6
Total	**-**	**-**	**1,707,184.7**	**(513,215.0)**	**486,313.3**		**1,193,969.7**	**(378,470.1)**	**815,499.5**	**505,655.6**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(200,000)
(400,000)
(600,000)
(800,000)
(1,000,000)
(1,200,000)
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
2053
Refurbish Mills
Replace Mills
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: Lingan
CI# / FP#: 44351
Title: L N Mill Refurbishments 2014
Execution Year: 2014

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)	pd	2.9	$ 384	$ 1,097		
1.2	Maintenance Trades	pd	280.0	$ 345	$ 96,723		
1.3	Maintenance Trades (Removal)	pd	70.0	$ 345	$ 24,181		
				Sub-Total	$ 122,001		40655, 43166
2	**012 Materials**						
2.1	Materials	lot	1	$ 383,078.00	$ 383,078	Cost Support 1	
2.2					$ -		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 383,078		40655, 43166
3	**094 Interest Capitalized**						
3.1	Interest Capitalized	lot	1	$ 8,136.41	$ 8,136		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 8,136		
4	**095 Administrative Overhead**						
4.1	Regular Labour AO	lot	1	$ 23,265.51	$ 23,266		
4.2							
4.3					$ -		
				Sub-Total	$ 23,266		
				SUB-TOTAL (no AO, AFUDC)	$ 505,079		
				TOTAL (AO, AFUDC included)	$ 536,481		
5	**Original Cost**						
5.1					$ 93,700		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

Item	Description	Approx cost	2013 Qty	Total Cost
1	Shaft End Cap 1	$ 3,172.00	1	$ 3,172.00
2	Shaft End Cap 2	$ 3,789.00	1	$ 3,789.00
3	Journal Head Skirt	$ 2,155.00	1	$ 2,155.00
4	Journal Pressure Spring Cup	$ 2,231.00	1	$ 2,231.00
5	Journal Head	$ 11,520.00	1	$ 11,520.00
6	Trunnion Bushing Retainer (Thrust End)	$ 575.00	1	$ 575.00
7	Trunnion Bushing Retainer (Free End)	$ 575.00	1	$ 575.00
8	Trunning Shafts		1	$ -
9	Exhauster Fan Blades	$ 3,417.00	24	$ 82,008.00
10	Whizzer Blade	$ 458.00	24	$ 10,992.00
11	Whizzer Disc and Clip Assembly	$ 5,750.00	3	$ 17,250.00
12	Ceramic Lined Hub Protector	$ 893.00	1	$ 893.00
13	Spider Arm Protector	$ 161.00	24	$ 3,864.00
14	Keyless Shaft and Bowl Hub	$ 54,684.00	1	$ 54,684.00
15	Grinding Roll	$ 11,090.00	9	$ 99,810.00
16	Exhauster Spider	$ 7,155.00	1	$ 7,155.00
17	Bull Ring Assembly	$ 15,151.00	2	$ 30,302.00
18	Journal Shaft	$ 4,607.00	1	$ 4,607.00
19	Trunnion Shaft Bushing	$ 1,225.00	1	$ 1,225.00
20	Upper Journal Housing	$ 5,602.00	1	$ 5,602.00
21	Journal Stop Bolt	$ 340.00	6	$ 2,040.00
22	Nut for Journal Stop Bolt	$ 90.00	6	$ 540.00
23	Thrust Plate (Thrust End)	$ 125.00	3	$ 375.00
				$ -
Local Fabrication:				$ -
1	Roof Liners	$ 3,825.00	2	$ 7,650.00
2	Inner Cone	$ 3,550.00	2	$ 7,100.00
3	Reject Scraper	$ 420.00	$3	$ 1,260.00
4	Wall Liners	$ 465.00	4	$ 1,860.00
5	Bowl Ext Ring	$ 460.00	4	$ 1,840.00
6	Vane Wheel	$ 3,335.00	4	$ 13,340.00
7	Elbow Damper	$ 600.00	2	$ 1,200.00
8	Brushes	$ 360.00	6	$ 2,160.00
9	Riffle Boxes	$ 652.00	2	$ 1,304.00

	$ 383,078.00

CI Number: 45126

Title: TRE5 Continuous Emissions Monitor for Mercury Measurement

Start Date: 2014/01
Final Cost Date: 2015/04
Function: Generation
Forecast Amount: $515,698

DESCRIPTION:

NS Power will install a Mercury Continuous Emissions Monitoring System (Hg CEMS) to accurately and reliably measure the mercury emissions being released from the Trenton Unit 5 (TRE5) stack on a continuous, real-time basis. The installation of Hg CEMS will allow NS Power to optimize mercury capture and powdered activated carbon (PAC) consumption rates, thereby demonstrating compliance with the Nova Scotia Environment (NSE) regulations for mercury emissions and ensuring adequate mercury capture calculations. The Hg CEMS will be installed within a shelter at the base of the Unit 5 stack and will measure elemental, ionic, and total mercury in the flue gas. Total vapor-phase mercury detection is performed by using aqueous reagents or heated catalysts to reduce oxidized forms of mercury to elemental mercury.

This project is fundamental to NS Power's strategy for compliance with the regulations, and ensuring adequate calculations of mercury capture and emissions.

Summary of Related CIs +/- 2 years: None

JUSTIFICATION:

Justification Criteria: Environment

Sub Criteria:

Why do this project?

Nova Scotia has integrated the Canada-wide Standards (CWS) for mercury emissions into the Air Quality Regulations under the NS Environment Act. NSE has regulated an 85 kg cap of Mercury emissions for 2013, decreasing to a cap of 65 kg in 2014. Currently, NS Power uses the Mass Balance Method for calculating mercury emissions and has determined that this method underestimates the mercury capture rate at Trenton 5. The Mass Balance Method measures mercury input through the fuel and output in residues, and then determines stack emissions from the total mercury difference. There are several pieces of information that must be collected to successfully complete the required calculation, including: volume of coal consumed, coal moisture, mercury content of coal, total ash produced, and the percent of ash content in the coal.

Trenton 5 has a greater likelihood of inaccuracies in Mass Balance calculations due to its unique design. This unit has a dual particulate control system, in which an electrostatic precipitator (ESP) is followed by a baghouse. This system requires numerous assumptions to be made to complete the Mass Balance calculations and, as a result, the Mass Balance Method is not proving to be an accurate monitoring approach for this unit. NS Power has performed stack tests using Method 30B Sorbent Traps at Trenton 5, and has verified that mercury capture has been underestimated and there is an over-reporting of mercury emissions.

The Hg CEMS measures mercury concentrations leaving the stack on a real-time basis, updated within minutes, and avoids calculation assumptions leading to over-reporting.

Why do this project now?

Accuracy within the monitoring approach is essential for compliance with both present (85 kg in 2013, 65 kg in 2014) and future (35 kg by 2020) mercury emission limits as prescribed by Nova Scotia Environment.

Why do this project this way?

An industry-recognized alternative to Hg CEMS is the Appendix K Long Term Sorbent Trap Method. Appendix K sorbent traps are long-term traps typically used for up to two weeks of sampling, but do not provide real-time data results. The sorbent traps require specialized personnel (stack testers) to maintain and test, and require specialized laboratory analysis for results. Trenton 5 does not have an in-house stack tester, nor the necessary laboratory equipment to analyze the sorbent traps; this would need to be contracted out. With a lack of real-time data there is significant lag between sampling and reporting, often on the order of a 3-4 week turn-around per sample. This lag can significantly inhibit the optimization of the PAC injection system and mercury capture rates, and lead to an unnecessary overspending on PAC and labor. Additionally, NS Power does not have a system set up to use sorbent traps; both NOx and SO_2 CEMS are currently in use.

With the regulations becoming more stringent, Hg CEMS provides real-time feedback and eliminates any calculation assumptions. Stack tests (Method 30B Sorbent Traps) conducted over the last year have determined that mercury capture has been significantly higher than the Mass Balance approach would indicate.

CI Number : 45126 - TRE5 Continuous Emissions Monitor for Mercury Measurement **Project Number**

Parent CI Number : -

Cost Centre : 340 - 340-Trenton Unit 5 Capital **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		27,609	0	27,609
095		095-Thermal Regular Labour AO		15,510	0	15,510
001	007	001 - THERMAL Regular Labour	007 - SGP - Environmental	81,330	0	81,330
011	007	011 - Travel Expense	007 - SGP - Environmental	2,000	0	2,000
012	007	012 - Materials	007 - SGP - Environmental	[redacted]	0	[redacted]
013	007	013 - OTHER Contracts	007 - SGP - Environmental	125,000	0	125,000
028	007	028 - Consulting	007 - SGP - Environmental	[redacted]	0	[redacted]
041	007	041 - Meals & Entertainment	007 - SGP - Environmental	500	0	500
			Total Cost:	515,698	0	515,698
			Original Cost:			

Capital Project Detailed Estimate

Location: Trenton
CI# / FP#: 45126
Title: TRE5 Mercury CEMS
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	pd	25.0	$ 339	$ 8,482		
1.2	Engineering (P.Eng)	pd	57.1	$ 384	$ 21 932		
1.3	Power Plant Technician	pd	125.0	$ 362	$ 45,230		
1.4	Utility	pd	25.0	$ 227	$ 5,686		
1.5							
				Sub-Total	$ 81,330		
2	**012 Materials**						
2.1	Mercury CEMS System	lot	1	[redacted]	[redacted]	Cost Support 1, Currency risk is included in line 2.2	
2.2	Contingency on Materials	%	[redacted]				
2.3							
2.4							
2.5					$ -		
				Sub-Total	[redacted]		
3	**028 Consulting**						
3.1	Stack Testing	lot	1	[redacted]			
3.2							
3.3					$ -		
				Sub-Total	[redacted]		
4	**013 Contracts**						
4.1	Site Preparation	lot	1	$ 125,000.00	$ 125,000		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 125,000		
5	**011 Travel**						
5.1	Travel Costs	lot	1	$ 2,000	$ 2,000		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 2,000		
6	**041 Meals**						
6.1	Meals	lot	1	$ 500	$ 500		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 500		
7	**094 Interest Capitalized**						
7.1	Interest Capitalized	lot	1	$ 27 609	$ 27 609		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 27,609		
8	**095 Administrative Overhead**						
8.1	Regular Labour AO	lot	1	$ 15,510	$ 15,510		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 15,510		
				SUB-TOTAL (no AO, AFUDC)	$ 472,580		
				TOTAL (AO, AFUDC included)	$ 515,698		
9	**Original Cost**						
9.1					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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

SALES QUOTATION

THERMO ENVIRONMENTAL INSTRUMENTS, INC
27 FORGE PARKWAY
FRANKLIN, MA 02038
PH: 508-520-0430
PH: 866-282-0430

Date	06/18/13	RFQ/Bid#	
Quote #	FRAQ33629-A	Ship Via	Best Way
FOB	Franklin, MA	Delivery	12 Weeks ARO
Terms	Net 30 (Pending Review)		

Quotation Submitted By:
Contact Diane Wood
Phone # [redacted]

Quote To:
Nova Scotia Power Inc.
P.O. Box 910

Halifax
Nova Scotia B3J 2W5

ATTN:
Janna Morrison
(902) 428-6081

janna.morrison@nspower.ca

To Place Order:

eMail: orders.aqi@thermofisher.com
Fax: (508) 520-2800

Additional terms & conditions on last page

Please have PO made out to THERMO ENVIRONMENTAL INSTRUMENTS, INC.

Qty	Part #	Description	Unit Price	Ext. Price
		BUDGETARY PROPOSAL THERMO SCIENTIFIC MERCURY FREEDOM SYSTEM™ INCLUDES:		
1	80i-ADFNCB	Thermo Scientific Model 80i CVAF Mercury Analyzer A - 120 Vac 50/60 Hz (standard) D - Vaccum Pump F - No Glass Orifice Option (System, not needed) N - Not Available Yet C - 6 Channel 4-20mA Current Output, 8 Channel 0-10v Analog Input (standard) B - Ears & Handles, EIA 5225 Rack Mounts		
1	81i-ANNNAB	Thermo Scientific Model 81i Elemental Mercury Calibrator A - 120 Vac 50/60 Hz (standard) N - Hydrator (standard) N - Not Available Yet N - Not Available Yet A - No Optional I/O (standard) B - Ears & Handles, EIA 5225 Rack Mounts		
1	82i-BDEFGB	Thermo Scientific Model 82i Stack Probe Controller B - 220 Vac 50/60 Hz D - High Power E - Not Available Yet F - Not Available Yet G - Not Available Yet B - Ears & Handles, EIA 5225 Rack Mounts		
1	83i-HX1	Thermo Scientific Model 83i Inertial Sampling System (Probe) with Mercuric Chloride (Ionic) Generator Includes: dilution module, converter and calibration port H - Hastelloy Return Tube X - Hastelloy (72") Inlet Stinger w/ Oxidizer 1 - 36" (3FT) Hastelloy Mantle Assembly and Inlet Stinger Heater		
1	109574-00	Thermo Scientific Temperature Controller 5225 Rack Mounts		
1	105536-00	The MaxSense™ Nitrogen Generation Package creates clean dry compressed nitrogen gas from compressed air. ***Note: increases total system air requirement by three (3) CFM***		

Qty	Part #	Description	Unit Price	Ext. Price
1	104474-00	Standard Instrument Rack Includes: Air Clean Up System (three stage scrubber, inlet air filter, heatless air dryer and surge tank), outlet strips, exhaust system, tubing, wiring, AC Junction Box, network mini hub and cabling.		
1	HG-ENGINEERING	Engineering, Assembly, Test and Project Management		
		SubTotal		$[redacted]
		HEATED SAMPLE LINE		
135	HG-SAMPLE-LINE	Heated Sample Line $[redacted] per foot. Length 135 feet. Price not included in base bid.	$[redacted]	$[redacted]
		SPARE PARTS PACKAGE OPTION		
1	103959-00	83i Mecury Spare Parts Package 20% discount is offered if purchased with system. Discounted price is $[redacted]	$[redacted]	$[redacted]
		SERVICE OPTIONS		
1	HG-INSTALL	Estimate five (5) days of Installation Supervision, Startup Assistance and Training per Thermo Scientific Mercury Freedom System done during one (1) site visit. Includes the following: 1. INSTALLATION SUPERVISION Thermo Fisher Scientific will provide a Field Service Engineer to supervise installation of the CEM hardware at your site. Thermo Fisher is not a licensed contractor and our personnel do not engage in actual installation activities, but our factory-trained specialists can advise and counsel your installation crew with respect to the proper installation of our instrumentation systems. The primary deliverables from the Thermo Fisher Field Service Engineer include, 1. Verification of proper mechanical installation of probe and instrument rack. 2. Verification of correct signal wiring and tubing terminations. 3. Verification of correct power connections. 4. Thermo Fisher can physically land and connect the tubing umbilical connections at both the probe and analyzer rack area. 2. START-UP ASSISTANCE Thermo Fisher agrees to provide the following services at our standard rates (see Service Center Rate Sheet) concerning assisting you or your 3rd party representative to start-up the Thermo Scientific Mercury Freedom CEM system: 1. Power-up and alignment of the sample conditioning probe. 2. Power-up and alignment of the analyzer rack. 3. Complete calibration of Thermo Scientific Mercury Freedom System. 4. System operation and maintenance requirements available for review during start-up. 5. Verification and setup of requested analog signal outputs from the Thermo Scientific Mercury Freedom System.	$[redacted]	$[redacted]

Qty	Part #	Description	Unit Price	Ext. Price
		3. TRAINING Two days of on-site factory training by a Thermo Fisher qualified technician of the Thermo Mercury Freedom System for up to five (5) students.Training to be conducted at the customer's location. Thermo Fisher will be responsible for its own travel arrangements including airfare, hotel, car rental, and meals. Cancellation or rescheduling charges of up to 15% can be assessed if notice of cancellation of rescheduling is not received in writing via e-mail or fax at least 5 business days in advance.		
1	HG-FAT	Factory Acceptance Testing performed at Thermo's Franklin, MA facility for up to 3 people	$[redacted]	$[redacted]
		Freight and shipping container(s) not included in this quotation		

Regional Sales Manager:

Colin Bowler [redacted]

Competitive finance options are available with fast and simple documentation. Please contact your local sales representative for more information on our lease offerings from Thermo Fisher Financial Services.

This quotation is subject to the terms and conditions on the attachment labeled Thermo Environmental Instruments, Inc. Standard Terms and Condition of Sale, as well as the terms outlined in the Service Maintenance Agreement and any associated Service Level Descriptions, which shall constitute the exclusive terms governing the contracts between us for your order. Also, if applicable, a valid export license may be required for shipment of goods outside the territories of the U.S.A.

Product lead-times are subject to change. Our Minimum Order Amount is $50.00. For government agencies our Cage Code is: 0HTS3. Above pricing excludes freight charges and/or applicable hazardous materials fee.

NOTE: This quotation is only valid for product utilization within the United States. Quotation Valid for 60 days.

Please visit us on the web at www.thermo.com/aqi for order status, software downloads, manuals, and product literature.

Thermo Environmental Instruments Inc. is part of Thermo Fisher Scientific.

THERMO ENVIRONMENTAL INSTRUMENTS, INC
TERMS AND CONDITIONS OF SALE

UNLESS OTHERWISE EXPRESSLY AGREED IN WRITING, ALL SALES ARE SUBJECT TO THE FOLLOWING TERMS AND CONDITIONS:

1 GENERAL Thermo Environmental Instruments Inc ("Seller") hereby offers for sale to the buyer named on the face hereof ("Buyer") the products listed on the face hereof (the "Products") on the express condition that Buyer agrees to accept and be bound by the terms and conditions set forth herein Any provisions contained in any document issued by Buyer are expressly rejected and if the terms and conditions in this Agreement differ from the terms of Buyer's offer, this document shall be construed as a counter offer and shall not be effective as an acceptance of Buyer's document Buyer's receipt of Products or Seller's commencement of the services provided hereunder will constitute Buyer's acceptance of this Agreement This is the complete and exclusive statement of the contract between Seller and Buyer with respect to Buyer's purchase of the Products No waiver, consent, modification, amendment or change of the terms contained herein shall be binding unless in writing and signed by Seller and Buyer Seller's failure to object to terms contained in any subsequent communication from Buyer will not be a waiver or modification of the terms set forth herein All orders are subject to acceptance in writing by an authorized representative of Seller

2 PRICE All prices published by Seller or quoted by Seller's representatives may be changed at any time without notice All prices quoted by Seller or Seller's representatives are valid for thirty (30) days, unless otherwise stated in writing All prices for the Products will be as specified by Seller or, if no price has been specified or quoted, will be Seller's price in effect at the time of shipment All prices are subject to adjustment on account of specifications, quantities, raw materials, cost of production, shipment arrangements or other terms or conditions which are not part of Seller's original price quotation

3 TAXES AND OTHER CHARGES Prices for the Products exclude all sales, value added and other taxes and duties imposed with respect to the sale, delivery, or use of any Products covered hereby, all of which taxes and duties must by paid by Buyer If Buyer claims any exemption, Buyer must provide a valid, signed certificate or letter of exemption for each respective jurisdiction

4 TERMS OF PAYMENT Seller may invoice Buyer upon shipment for the price and all other charges payable by Buyer in accordance with the terms on the face hereof If no payment terms are stated on the face hereof, payment shall be net thirty (30) days from the date of invoice If Buyer fails to pay any amounts when due, Buyer shall pay Seller interest thereon at a periodic rate of one and one-half percent (1 5%) per month (or, if lower, the highest rate permitted by law), together with all costs and expenses (including without limitation reasonable attorneys' fees and disbursements and court costs) incurred by Seller in collecting such overdue amounts or otherwise enforcing Seller's rights hereunder Seller reserves the right to require from Buyer full or partial payment in advance, or other security that is satisfactory to Seller, at any time that Seller believes in good faith that Buyer's financial condition does not justify the terms of payment specified All payments shall be made in U S Dollars

5 DELIVERY; CANCELLATION OR CHANGES BY BUYER The Products will be shipped to the destination specified by Buyer, F O B Seller's shipping point Seller will have the right, at its election, to make partial shipments of the Products and to invoice each shipment separately Seller reserves the right to stop delivery of Products in transit and to withhold shipments in whole or in part if Buyer fails to make any payment to Seller when due or otherwise fails to perform its obligations hereunder All shipping dates are approximate only, and Seller will not be liable for any loss or damage resulting from any delay in delivery or failure to deliver which is due to any cause beyond Seller's reasonable control In the event of a delay due to any cause beyond Seller's reasonable control, Seller reserves the right to terminate the order or to reschedule the shipment within a reasonable period of time, and Buyer will not be entitled to refuse delivery or otherwise be relieved of any obligations as the result of such delay Products as to which delivery is delayed due to any cause within Buyer's control may be placed in storage by Seller at Buyer's risk and expense and for Buyer's account Orders in process may be canceled only with Seller's written consent and upon payment of Seller's cancellation charges Orders in process may not be changed except with Seller's written consent and upon agreement by the parties as to an appropriate adjustment in the purchase price therefor Credit will not be allowed for Products returned without the prior written consent of Seller

6 TITLE AND RISK OF LOSS Notwithstanding the trade terms indicated above and subject to Seller's right to stop delivery of Products in transit, title to and risk of loss of the Products will pass to Buyer upon delivery of possession of the Products by Seller to the carrier; provided, however, that title to any software incorporated within or forming a part of the Products shall at all times remain with Seller or the licensor(s) thereof, as the case may be

7 WARRANTY Seller warrants that the Products will operate or perform substantially in conformance with Seller's published specifications and be free from defects in material and workmanship, when subjected to normal, proper and intended usage by properly trained personnel, for the period of time set forth in the product documentation, published specifications or package inserts If a period of time is not specified in Seller's product documentation, published specifications or package inserts, the warranty period shall be one (1) year from the date of shipment to Buyer for equipment and ninety (90) days for all other products (the "Warranty Period") Seller agrees during the Warranty Period, to repair or replace, at Seller's option, defective Products so as to cause the same to operate in substantial conformance with said published specifications; provided that Buyer shall (a) promptly notify Seller in writing upon the discovery of any defect, which notice shall include the product model and serial number (if applicable) and details of the warranty claim; and (b) after Seller's review, Seller will provide Buyer with service data and/or a Return Material Authorization ("RMA"), which may include biohazard decontamination procedures and other product-specific handling instructions, then, if applicable, Buyer may return the defective Products to Seller with all costs prepaid by Buyer Replacement parts may be new or refurbished, at the election of Seller All replaced parts shall become the property of Seller Shipment to Buyer of repaired or replacement Products shall be made in accordance with the Delivery provisions of the Seller's Terms and Conditions of Sale Consumables are expressly excluded from this warranty

Notwithstanding the foregoing, Products supplied by Seller that are obtained by Seller from an original manufacturer or third party supplier are not warranted by Seller, but Seller agrees to assign to Buyer any warranty rights in such Product that Seller may have from the original manufacturer or third party supplier, to the extent such assignment is allowed by such original manufacturer or third party supplier

In no event shall Seller have any obligation to make repairs, replacements or corrections required, in whole or in part, as the result of (i) normal wear and tear, (ii) accident, disaster or event of force majeure, (iii) misuse, fault or negligence of or by Buyer, (iv) use of the Products in a manner for which they were not designed, (v) causes external to the Products such as, but not limited to, power failure or electrical power surges, (vi) improper storage and handling of the Products or (vii) use of the Products in combination with equipment or software not supplied by Seller If Seller determines that Products for which Buyer has requested warranty services are not covered by the warranty hereunder, Buyer shall pay or reimburse Seller for all costs of investigating and responding to such request at Seller's then prevailing time and materials rates If Seller provides repair services or replacement parts that are not covered by this warranty, Buyer shall pay Seller therefor at Seller's then prevailing time and materials rates ANY INSTALLATION, MAINTENANCE, REPAIR, SERVICE, RELOCATION OR ALTERATION TO OR OF, OR OTHER TAMPERING WITH, THE PRODUCTS PERFORMED BY ANY PERSON OR ENTITY OTHER THAN SELLER WITHOUT SELLER'S PRIOR WRITTEN APPROVAL, OR ANY USE OF REPLACEMENT PARTS NOT SUPPLIED BY SELLER, SHALL IMMEDIATELY VOID AND CANCEL ALL WARRANTIES WITH RESPECT TO THE AFFECTED PRODUCTS THE OBLIGATIONS CREATED BY THIS WARRANTY STATEMENT TO REPAIR OR REPLACE A DEFECTIVE PRODUCT SHALL BE THE SOLE REMEDY OF BUYER IN THE EVENT OF A DEFECTIVE PRODUCT EXCEPT AS EXPRESSLY PROVIDED IN THIS WARRANTY STATEMENT, SELLER DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, ORAL OR WRITTEN, WITH RESPECT TO THE PRODUCTS, INCLUDING WITHOUT LIMITATION ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE SELLER DOES NOT WARRANT THAT THE PRODUCTS ARE ERROR-FREE OR WILL ACCOMPLISH ANY PARTICULAR RESULT

8 INDEMNIFICATION

8 1 By Seller Seller agrees to indemnify, defend and save Buyer, its officer, directors, and employees from and against any and all damages, liabilities, actions, causes of action, suits, claims, demands, losses, costs and expenses (including without limitation reasonable attorney's fees) ("Indemnified Items") for (i) injury to or death of persons or damage to property to the extent caused by the negligence or willful misconduct of Seller, its employees, agents or representatives or contractors in connection with the performance of services at Buyer's premises under this Agreement and (ii) claims that a Product infringes any valid United States patent, copyright or trade secret; provided, however, Seller shall have no liability under this Section to the extent any such Indemnified items are caused by either (i) the negligence or willful misconduct of Buyer, its employees, agents or representatives or contractors, (ii) by any third party, (iii) use of a Product in combination with equipment or software not supplied by Seller where the Product would not itself be infringing, (iv) compliance with Buyer's designs, specifications or instructions, (v) use of the Product in an application or environment for which it was not designed or (vi) modifications of the Product by anyone other than Seller without Seller's prior written approval Buyer shall provide Seller prompt written notice of any third party claim covered by Seller's indemnification obligations hereunder Seller shall have the right to assume exclusive control of the defense of such claim or, at the option of the Seller, to settle the same Buyer agrees to cooperate reasonably with Seller in connection with the performance by Seller of its obligations in this Section

Notwithstanding the above, Seller's infringement related indemnification obligations shall be extinguished and relieved if Seller, at its discretion and at its own expense (a) procures for Buyer the right, at no additional expense to Buyer, to continue using the Product; (b) replaces or modifies the Product so that it becomes non-infringing, provided the modification or replacement does not adversely affect the specifications of the Product; or (c) in the event (a) and (b) are not practical, refund to Buyer the amortized amounts paid by Buyer with respect thereto, based on a five (5) year amortization schedule THE FOREGOING INDEMNIFICATION PROVISION STATES SELLER'S ENTIRE LIABILITY TO BUYER FOR THE CLAIMS DESCRIBED HEREIN

8 2 By Buyer Buyer shall indemnify, defend with competent and experienced counsel and hold harmless Seller, its parent, subsidiaries, affiliates and divisions, and their respective officers, directors, shareholders and employees, from and against any and all damages, liabilities, actions, causes of action, suits, claims, demands, losses, costs and expenses (including without limitation reasonable attorneys' fees and disbursements and court costs) to the extent arising from or in connection with (i) the negligence or willful misconduct of Buyer, its agents, employees, representatives or contractors; (ii) use of a Product in combination with equipment or software not supplied by Seller where the Product itself would not be infringing; (iii) Seller's compliance with designs, specifications or instructions supplied to Seller by Buyer; (iv) use of a Product in an application or environment for which it was not designed; or (v) modifications of a Product by anyone other than Seller without Seller's prior written approval

9 SOFTWARE With respect to any software products incorporated in or forming a part of the Products hereunder, Seller and Buyer intend and agree that such software products are being licensed and not sold, and that the words "purchase", "sell" or similar or derivative words are understood and agreed to mean "license", and that the word "Buyer" or similar or derivative words are understood and agreed to mean "licensee" Notwithstanding anything to the contrary contained herein, Seller or its licensor, as the case may be, retains all rights and interest in software products provided hereunder

Seller hereby grants to Buyer a royalty-free, non-exclusive, nontransferable license, without power to sublicense, to use software provided hereunder solely for Buyer's own internal business purposes on the hardware products provided hereunder and to use the related documentation solely for Buyer's own internal business purposes This license terminates when Buyer's lawful possession of the hardware products provided hereunder ceases, unless earlier terminated as provided herein Buyer agrees to hold in confidence and not to sell, transfer, license, loan or otherwise make available in any form to third parties the software products and related documentation provided hereunder Buyer may not disassemble, decompile or reverse engineer, copy, modify, enhance or otherwise change or supplement the software products provided hereunder without Seller's prior written consent Seller will be entitled to terminate this license if Buyer fails to comply with any term or condition herein Buyer agrees, upon termination of this license, immediately to return to Seller all software products and related documentation provided hereunder and all copies and portions thereof

Certain of the software products provided by Seller may be owned by one or more third parties and licensed to Seller Accordingly, Seller and Buyer agree that such third parties retain ownership of and title to such software products The warranty and indemnification provisions set forth herein shall not apply to software products owned by third parties and provided hereunder

10 LIMITATION OF LIABILITY NOTWITHSTANDING ANYTHING TO THE CONTRARY CONTAINED HEREIN, THE LIABILITY OF SELLER UNDER THESE TERMS AND CONDITIONS (WHETHER BY REASON OF BREACH OF CONTRACT, TORT, INDEMNIFICATION, OR OTHERWISE, BUT EXCLUDING LIABILITY OF SELLER FOR BREACH OF WARRANTY (THE SOLE REMEDY FOR WHICH SHALL BE AS PROVIDED UNDER SECTION 7 ABOVE)) SHALL NOT EXCEED AN AMOUNT EQUAL TO THE LESSER OF (A) THE TOTAL PURCHASE PRICE THERETOFORE PAID BY BUYER TO SELLER WITH RESPECT TO THE PRODUCT(S) GIVING RISE TO SUCH LIABILITY OR (B) ONE MILLION DOLLARS ($1,000,000) NOTWITHSTANDING ANYTHING TO THE CONTRARY CONTAINED HEREIN, IN NO EVENT SHALL SELLER BE LIABLE FOR ANY INDIRECT, SPECIAL, CONSEQUENTIAL OR INCIDENTAL DAMAGES (INCLUDING WITHOUT LIMITATION DAMAGES FOR LOSS OF USE OF FACILITIES OR EQUIPMENT, LOSS OF REVENUE, LOSS OF DATA, LOSS OF PROFITS OR LOSS OF GOODWILL), REGARDLESS OF WHETHER SELLER (a) HAS BEEN INFORMED OF THE POSSIBILITY OF SUCH DAMAGES OR (b) IS NEGLIGENT

11 EXPORT RESTRICTIONS Buyer acknowledges that each Product and any related software and technology, including technical information supplied by Seller or contained in documents (collectively "Items"), is subject to export controls of the U S government The export controls may include, but are not limited to, those of the Export Administration Regulations of the U S Department of Commerce (the "EAR"), which may restrict or require licenses for the export of Items from the United States and their re-export from other countries Buyer shall comply with the EAR and all other applicable laws, regulations, laws, treaties, and agreements relating to the export, re-export, and import of any Item Buyer shall not, without first obtaining the required license to do so from the appropriate U S government agency; (i) export or re-export any Item, or (ii) export, re-export, distribute or supply any Item to any restricted or embargoed country or to a person or entity whose privilege to participate in exports has been denied or restricted by the U S government Buyer shall, if requested by Seller, provide information on the end user and end use of any Item exported by the Buyer or to be exported by the Buyer Buyer shall cooperate fully with Seller in any official or unofficial audit or inspection related to applicable export or import control laws or regulations, and shall indemnify and hold Seller harmless from, or in connection with, any violation of this Section by Buyer or its employees, consultants, or agents

12 MISCELLANEOUS (a) Buyer may not delegate any duties nor assign any rights or claims hereunder without Seller's prior written consent, and any such attempted delegation or assignment shall be void (b) The rights and obligations of the parties hereunder shall be governed by and construed in accordance with the laws of the State of Seller's manufacturing location, without reference to its choice of law provisions Each party hereby irrevocably consents to the exclusive jurisdiction of the state and federal courts located in the county and state of Seller's manufacturing location, in any action arising out of or relating to this Agreement and waives any other venue to which it may be entitled by domicile or otherwise (c) In the event of any legal proceeding between the Seller and Buyer relating to this Agreement, neither party may claim the right to a trial by jury, and both parties waive any right they may have under applicable law or otherwise to a right to a trial by jury Any action arising under this Agreement must be brought within one (1) year from the date that the cause of action arose (d) The application to this Agreement of the U N Convention on Contracts for the International Sale of Goods is hereby expressly excluded (e) In the event that any one or more provisions contained herein shall be held by a court of competent jurisdiction to be invalid, illegal or unenforceable in any respect, the validity, legality and enforceability of the remaining provisions contained herein shall remain in full force and effect, unless the revision materially changes the bargain (f) Seller's failure to enforce, or Seller's waiver of a breach of, any provision contained herein shall not constitute a waiver of any other breach or of such provision (g) Unless otherwise expressly stated on the Product or in the documentation accompanying the Product, the Product is intended for research only and is not to be used for any other purpose, including without limitation, unauthorized commercial uses, in vitro diagnostic uses, ex vivo or in vivo therapeutic uses, or any type of consumption by or application to humans or animals (h) Buyer agrees that all pricing, discounts and technical information that Seller provides to Buyer are the confidential and proprietary information of Seller Buyer agrees to (1) keep such information confidential and not disclose such information to any third party, and (2) use such information solely for Buyer's internal purposes and in connection with the Products supplied hereunder Nothing herein shall restrict the use of information available to the general public (i) Any notice or communication required or permitted hereunder shall be in writing and shall be deemed received when personally delivered or three (3) business days after being sent by certified mail, postage prepaid, to a party at the address specified herein or at such other address as either party may from time to time designate to the other

Revised 5/30/08

INC 2 BRIEFING PAPER SERIES

Continuous Emission Monitoring Systems for Mercury







Continuous emission monitoring systems for mercury (Hg CEMS) are now available and have been required under recent regulations to measure mercury levels in stack gases where emission limits or control technologies requirements apply. For example, Hg CEMS have been installed at more than 600 power-plants in the US, several cement kilns in the US, and 34 cement kilns in Germany. They will soon be installed at many more cement kilns in the US as a result of new Hg emission regulations requiring their use (or equivalent methods).

The advent of continuous emissions monitoring is an important technical advancement since it provides the most direct means of monitoring compliance, and a superior method in terms of accuracy. Hg CEMS provide real time measurements of mercury (by the minute) compared to other monitoring techniques, such as sorbent traps that accumulate mercury over longer time periods, or snapshot stack tests measuring compliance at one point in time under certain conditions.

Mercury emissions from a process can change over time. Various operational factors, such changes in fuel or other feedstocks, could impact performance of mercury controls. Devising a test plan to clearly establish the performance of a mercury control under all operating parameters is difficult. Therefore, Hg CEMS are essential in demonstrating continuous compliance with emissions limits. They also provide the opportunity for the real-time transmission of data electronically to company and/or regulatory officials as needed to facilitate compliance.

How it Works

Hg CEMS rely on a special probe (shown on the left) that samples gas directly from the stack. The sample is sent to an analyzer through a heated line; there samples are measured continuously through atomic fluorescence. The analyzer is combined with a digital monitor, a calibration system and other hardware on a single rack shown below. The monitor also serves as the system controller. Control systems include standard internet connections and protocols which support remote operation and the transmission of monitoring data. The equipment rack requires a climate controlled environment.

Costs

The one-time Installation costs of Hg CEMS is roughly $ 0.5 million per site in the US. That cost includes about $200,000 for the Hg CEMS equipment including startup and training, and $200,000 to $300,000 for site preparation when retrofitting existing facilities. Costs would be lower for new facilities, and in other countries where labor and other expenses are reduced.

In the US, EPA estimates typical CEMS operations costs are roughly $20,000 per year for labor and $65,000 in annual QA/QC, reporting, parts and materials such as gas cylinders. Labor costs may be initially higher reflecting a learning curve for operating the system. Again, these are based upon US labor costs.

Implementation

Monitoring equipment should be included in the BAT guidance to be developed under the treaty, and CEMs should be included among the Best Available Techniques (BAT). By doing so, Parties can be better assured the emission reductions sought by the control measures will be achieved and applied consistently throughout the world.

Sources:

NESCAUM, Mercury Control Technologies & Measurements at U.S. Coal Power Plants, July 2010.

www.nescaum.org/documents/suggested-states-version-draft-mercury-monitoring-and-reporting-protocols/

National Emissions Standards for Hazardous Air Pollutants for Source Categories; Portland Cement Manufacturing Industry; Final Rule, 64 Fed. Reg. 31,898 (June 14, 1999). www.epa.gov/ttn/atw/pcem/fr09se10.pdf; http://www.epa.gov/ttn/atw/pcem/fr06my09.pdf

Boiler MACT Docket: Correspondence with Office of Management and Budget (OMB) Regarding Technical Memos and Regulatory Impact Analysis (RIA) (3/30/2010), EPA Doc. No. EPA-HQ-OAR-2003-0119-0041.

www.epa.gov/ttn/emc/cem.html

www.thermoscientific.com/wps/portal/ts/products/detail?navigationId=L10404&categoryId=89578&productId=11961825

Mark Calloway, Tekran Instruments Corporation, Personal Communication, 11/18/10.

www.epa.gov/ttn/emc/cem/hgpmcomp.pdf

CI Number: 42939

Title: TUC2 - Circulating Water Pump (South) Refurbishment

Start Date: 2014/05
Final Cost Date: 2014/12
Function: Generation
Forecast Amount: **$**431,536

DESCRIPTION:

This project will refurbish the South Circulating Water (CW) pump at the Tufts Cove Unit 2 (TUC2), and replace the discharge bend.

Summary of Related Cls +/- 2 years:
2013 41245 TUC2 (North) CW Pump Refurbishment $170K

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Maintenance

Why do this project?

The Circulating Water System supplies cooling water to the condensing unit. Cooling water is drawn from intakes, through a pair of traveling screens into two vertical mixed flow pumps. The salt water is then pumped through the CW piping and into the condenser inlet. These pumps also supply water to the lube oil coolers, generator seal oil coolers, closed cooling water systems, hydrogen coolers and vacuum pump heat exchangers. The performance and dependability of CW pumps are critical for plant operation.

Why do this project now?

As part of the equipment life cycle management at the Tufts Cove Generating Station, overhaul of the Unit 2 South CW Pump is due in 2014. The last refurbishment of this pump was completed in 2000, and plant experience has indicated that normal wear during this service time will result in the need for refurbishment. Also, a recent inspection completed in 2013 has revealed that a known and previously repaired crack in the pump discharge bend has propagated to the point where further repairs are not feasible. Repairs of the bend will no longer mitigate the risk of a failure, as it has been determined that further crack propagation cannot be prevented. A failure of this component would render the pump unserviceable, and could cause further damage to other components.

Why do this project this way?

Refurbishment versus replacement of the pump is the most economical option to ensure the continued availability and reliability of the unit. Individual components can be refurbished or replaced to ensure pump performance. Replacement of the complete pump assembly is not required, and would be far more costly.

Repair of the discharge bend is no longer feasible. Replacement of the discharge bend is the only technically acceptable option.

CI Number : 42939 - TUC2 - Circulating Water Pump (South) Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 318 - 318-TC Unit 2 Capital **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		7,370	0	7,370
095		095-Thermal & Hydro Contracts AO		9,672	0	9,672
095		095-Thermal Overtime Labour AO		1,479	0	1,479
095		095-Thermal Regular Labour AO		9,972	0	9,972
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	52,289	0	52,289
002	014	002 - THERMAL Overtime Labour	014 - SGP - Circ.Water Sys.	15,514	0	15,514
012	014	012 - Materials	014 - SGP - Circ.Water Sys.	236,240	0	236,240
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	99,000	0	99,000
			Total Cost:	431,536	0	431,536
			Original Cost:	77,617		

TUC2 S CW Pump Refurbishment
Summary of Alternatives

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Tufts Cove	**CI Number:**	42939
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Refurbish Pump, Replace Bend	6.49%	-474,538	337,662	1	19.87%	5.9 years
B	Replace Pump, Replace Bend	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Refurbish the CW Pump and replace the discharge bend based on current condition of the equipment and strong economic analysis results.

Notes/Comments :

Refurbish Pump, Replace Bend

A failure in the discharge bend would result in significnant downtime, assumed 40 weeks from failure to in-service. Without the pump, the unit would be de-rated by 35MW. The probability of failure based on current condition is 30%, increasing each year.

Replace Pump, Replace Bend

Full replacement of the pump assembly is not required, and would be much more costly than refurbishment which allows NS Power to address only those components requiring replacement or re-work. Therefore, this option is not evaluated further. There are no technically acceptable alternatives to replacement of the discharge bend.

Test 3

Test 4

TUC2 S CW Pump Refurbishment
Summary of Sensitivities

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Tufts Cove	**CI Number:**	42939
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Pump, Replace Bend	6.49%	-474,538	337,662	1	19.87%	5.9 years
B	Replace Pump, Replace Bend	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Pump, Replace Bend	10%	-434,302	305,789	1	17.77%	6.4 years
B	Replace Pump, Replace Bend	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
Change:	**A**		40,235	-31,873	0	-2.10%	0.4 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Pump, Replace Bend	-10%	-386,849	272,023	1	17.55%	6.4 years
B	Replace Pump, Replace Bend	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
Change:	**A**		87,689	-65,639	0	-2.31%	0.5 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement		PV of Revenue Requirement	PV of Revenue Requirement	PV of Revenue Requirement	Delay?
	Yrs Delay:	1	2	3	
	A	11,643	56,139	99,608	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

TUC2 S CW Pump Refurbishment
Avoided Cost Calculations

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Tufts Cove	**CI Number:**	42939
Originator :		**Project No. :**	

Refurbish Pump, Replace Bend

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	30%	40%	30%	40%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	35	35				
Duration (Hours)	6720	6720				
Totals	$12,548	$68,319	$0	$0	$12,548	$68,319
Total Capital Cost of Alternative						$431,536

Replace Pump, Replace Bend

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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

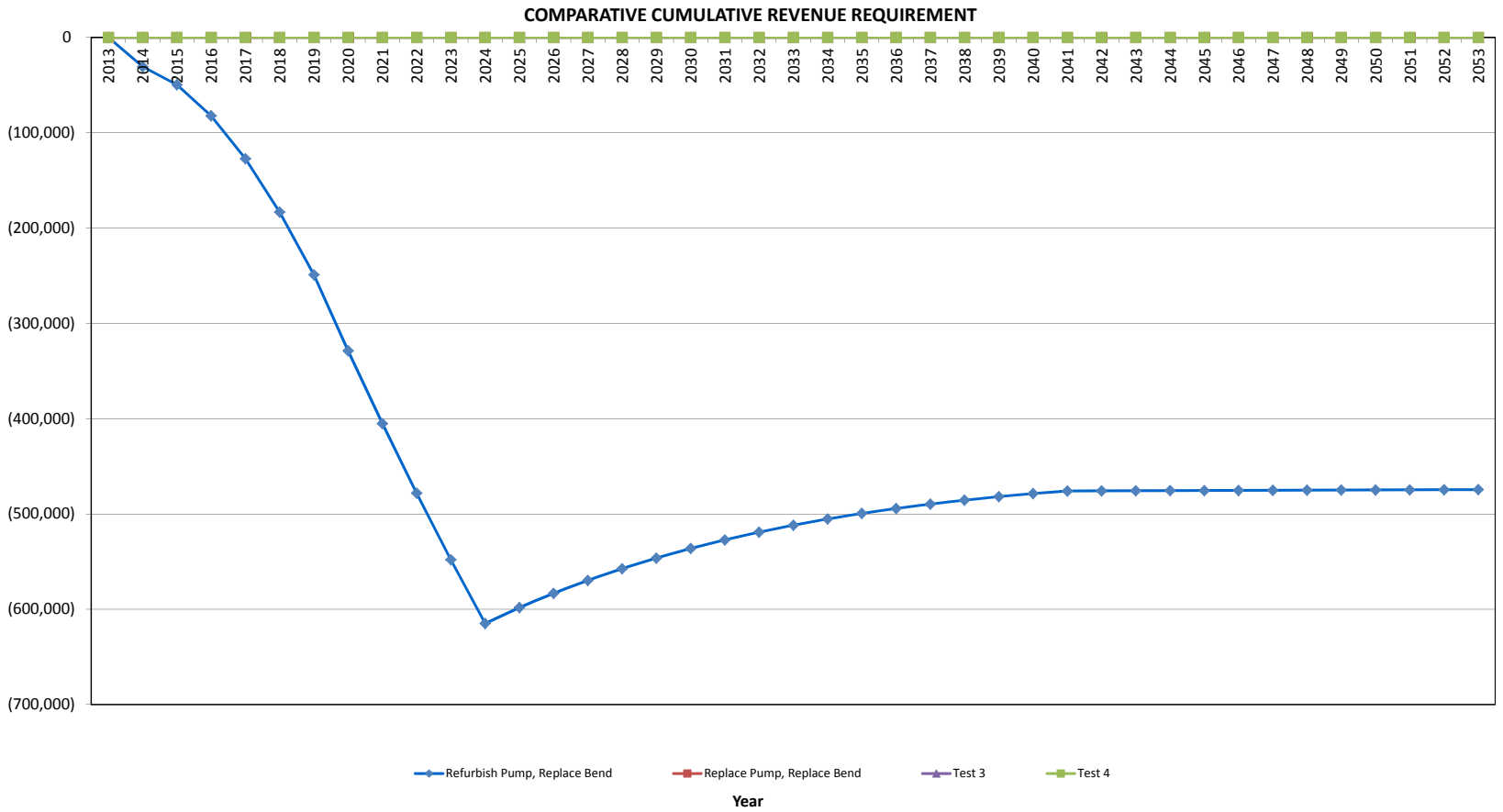
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity 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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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

TUC2 S CW Pump Refurbishment
Refurbish Pump, Replace Bend

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	12,548.4	(410,413.6)	16,121.7	392,751.6	(397,865.2)	1,107.7	(396,757.4)	(372,577.2)	0.94	(372,577.2)
2015	-	-	68,319.0	-	30,953.7	360,824.6	68,319.0	(11,583.2)	56,735.8	50,031.0	0.88	(322,546.1)
2016	-	-	87,106.7	-	28,477.4	331,451.7	87,106.7	(18,175.1)	68,931.7	57,081.1	0.83	(265,465.1)
2017	-	-	106,618.7	-	26,199.3	304,428.6	106,618.7	(24,930.0)	81,688.6	63,522.3	0.78	(201,942.7)
2018	-	-	126,876.2	-	24,103.3	279,567.4	126,876.2	(31,859.6)	95,016.6	69,383.4	0.73	(132,559.4)
2019	-	-	147,901.4	-	22,175.0	256,695.0	147,901.4	(38,975.2)	108,926.2	74,692.9	0.69	(57,866.4)
2020	-	-	179,145.6	-	20,401.0	235,652.5	179,145.6	(49,210.8)	129,934.8	83,668.8	0.64	25,802.4
2021	-	-	182,728.5	-	18,769.0	216,293.3	182,728.5	(50,827.5)	131,901.0	79,758.6	0.60	105,561.0
2022	-	-	186,383.0	-	17,267.4	198,482.9	186,383.0	(52,425.8)	133,957.2	76,065.3	0.57	181,626.3
2023	-	-	190,110.7	-	15,886.0	182,097.4	190,110.7	(54,009.6)	136,101.1	72,572.7	0.53	254,199.0
2024	-	-	193,912.9	-	14,615.2	167,022.6	193,912.9	(55,582.3)	138,330.6	69,266.2	0.50	323,465.2
2025	-	-	-	-	13,445.9	153,153.9	-	4,168.2	4,168.2	1,960.0	0.47	325,425.1
2026	-	-	-	-	12,370.3	140,394.6	-	3,834.8	3,834.8	1,693.3	0.44	327,118.4
2027	-	-	-	-	11,380.7	128,656.1	-	3,528.0	3,528.0	1,462.9	0.41	328,581.3
2028	-	-	-	-	10,470.2	117,856.7	-	3,245.8	3,245.8	1,263.8	0.39	329,845.1
2029	-	-	-	-	9,632.6	107,921.2	-	2,986.1	2,986.1	1,091.9	0.37	330,936.9
2030	-	-	-	-	8,862.0	98,780.6	-	2,747.2	2,747.2	943.3	0.34	331,880.2
2031	-	-	-	-	8,153.0	90,371.2	-	2,527.4	2,527.4	814.9	0.32	332,695.1
2032	-	-	-	-	7,500.8	82,634.6	-	2,325.2	2,325.2	704.0	0.30	333,399.2
2033	-	-	-	-	6,900.7	75,516.9	-	2,139.2	2,139.2	608.2	0.28	334,007.4
2034	-	-	-	-	6,348.7	68,968.6	-	1,968.1	1,968.1	525.5	0.27	334,532.9
2035	-	-	-	-	5,840.8	62,944.1	-	1,810.6	1,810.6	454.0	0.25	334,986.9
2036	-	-	-	-	5,373.5	57,401.7	-	1,665.8	1,665.8	392.2	0.24	335,379.1
2037	-	-	-	-	4,943.6	52,302.6	-	1,532.5	1,532.5	338.8	0.22	335,717.9
2038	-	-	-	-	4,548.1	47,611.4	-	1,409.9	1,409.9	292.7	0.21	336,010.7
2039	-	-	-	-	4,184.3	43,295.6	-	1,297.1	1,297.1	252.9	0.19	336,263.6
2040	-	-	-	-	3,849.5	39,325.0	-	1,193.4	1,193.4	218.5	0.18	336,482.1
2041	-	-	-	-	3,541.6	35,672.1	-	1,097.9	1,097.9	188.8	0.17	336,670.8
2042	-	-	-	-	3,258.3	32,311.4	-	1,010.1	1,010.1	163.1	0.16	336,833.9
2043	-	-	-	-	2,997.6	29,219.5	-	929.3	929.3	140.9	0.15	336,974.8
2044	-	-	-	-	2,757.8	26,375.0	-	854.9	854.9	121.7	0.14	337,096.5
2045	-	-	-	-	2,537.2	23,758.1	-	786.5	786.5	105.2	0.13	337,201.7
2046	-	-	-	-	2,334.2	21,350.5	-	723.6	723.6	90.8	0.13	337,292.5
2047	-	-	-	-	2,147.5	19,135.5	-	665.7	665.7	78.5	0.12	337,371.0
2048	-	-	-	-	1,975.7	17,097.7	-	612.5	612.5	67.8	0.11	337,438.8
2049	-	-	-	-	1,817.6	15,223.0	-	563.5	563.5	58.6	0.10	337,497.4
2050	-	-	-	-	1,672.2	13,498.2	-	518.4	518.4	50.6	0.10	337,548.0
2051	-	-	-	-	1,538.4	11,911.4	-	476.9	476.9	43.7	0.09	337,591.7
2052	-	-	-	-	1,415.3	10,451.5	-	438.8	438.8	37.8	0.09	337,629.5
2053	-	-	-	-	1,302.1	9,108.5	-	403.7	403.7	32.6	0.08	337,662.1
Total	**-**	**-**	**1,481,651.1**	**(410,413.6)**	**388,069.2**		**1,071,237.6**	**(339,010.4)**	**732,227.2**	**337,662.1**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(100,000)
(200,000)
(300,000)
(400,000)
(500,000)
(600,000)
(700,000)
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
2053
Refurbish Pump, Replace Bend
Replace Pump, Replace Bend
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: Tufts Cove Generating Station
CI# / FP#: 42939
Title: TUC - CW Pump Refurbishment
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	pd	5.0	$ 339	$ 1,696		
1.2	Engineering (P.Eng)	pd	11.4	$ 384	$ 4,386		
1.4	Maintenance Trades	pd	120.0	$ 345	$ 41,453		
1.1	Contingency	%	10	$ 47,536	$ 4,754		
				Sub-Total	$ 52,289		
2	**012 Materials**						
2.1	Replacement Discharge Bend	lot	1	[redacted]		Cost Support	
2.2	Miscellaneous Hardware & Materials	lot	1				
2.3	Contingency	%	[redacted]				
2.4					$ -		
2.5					$ -		
				Sub-Total	$ 236,240		
3	**013 Contracts**						
3.1	Cranes / Flatbeds	lot	1	20000	$ 20,000		
3.2	Scaffolding	lot	1	20000	$ 20,000		
3.3	Miscellaneous (Sandblasting, Coating, Machining, etc.)	lot	1	50000	$ 50,000		
3.4	Contingency	%	10	90000	$ 9,000		
				Sub-Total	$ 99,000		
4	**002 OT Labour**						
4.1	Electrician	pd	2.5	$ 679	$ 1,696		
4.2	Maintenance Trades	pd	20.0	$ 691	$ 13,818		
4.3					$ -		
				Sub-Total	$ 15,514		
5	**094 Interest Capitalized**						
5.1	AFUDC	lot	1	7370	$ 7,370		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 7,370		
6	**095 Administrative Overhead**						
6.1	Contracts AO	lot	1	9672	$ 9,672		
6.2	Regular Labour AO	lot	1	9972	$ 9,972		
6.3	Overtime AO	lot	1	1479	$ 1,479		
				Sub-Total	$ 21,123		
				SUB-TOTAL (no AO, AFUDC)	$ 403,044		
				TOTAL (AO, AFUDC included)	$ 431,536		
7	**Original Cost**						
7.1					$ 77,617		

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
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

SPX

CLYDE UNION CANADA LIMITED
4151 North Service Road
BURLINGTON, ON L7L 4X6
TELEPHONE: 905-315-3817
FAX: 905-315-3843

BC 13-03037

To:	KEVIN THOMPSON	**From:**	Christine Kacur
Company:	NOVA SCOTIA POWER-TUFTS COVE	**Fax No:**	[redacted]
Location:	NOVA SCOTIA	**EMail:**	
Phone No:	**Fax No:**	**Date:**	18-Mar-2013
Sales Rep:	CLAUDE GOULET	**Rep EMail:**	[redacted]

Subject: Your Ref: S/N PD690753 TUFTS COVE **Revised:** 19-Jul-2013
Our Ref: BC 13-03037 -- Please include this Quote # when issuing a PO.

WE HAVE A $150 MINIMUM ORDER VALUE

SPARE PARTS FOR SERIAL NUMBER PD690753, MODEL NUMBER 42" VERTICAL MIXED FLOW P

ITEM	QTY	PART NUMBER	CUSTOMER P/N	DESCRIPTION	Shp Wks	$ EA	EXTEND $
1	1	TBA	N/A	DISCHARGE BEND	38	[redacted]	

PARTS EXWORKS Glasgow, UK.

FREIGHT FROM THE UNITED KINGDOM
TOTAL PARTS EXWORKS

TOTAL: [redacted]

Estimated gross weight is lbs.
Normal shipment is 38 weeks exworks after receipt of order, subject to prior sale.
Quotation validity is 60 days from this date.

COMMENTS:
*****THIS IS QUOTED IN CANADIAN FUNDS*****

*****PLEASE NOTE SHOULD YOU WISH TO PRICE THE SHIPPING SEPARATELY THE APPROX WEIGHT OF YOUR DISCHARGE BEND IS 3850KG.*****

TERMS OF PAYMENT: Net 30

Parts Manufactured in UK.

All part numbers quoted are correct and updated for pump serial numbers provided. NO CHANGE in form, fit or function.

If you do not provide a pump serial number, we cannot guarantee parts to fit and they cannot be returned for credit.

Clyde Union Canada Limited is an ISO 9001 registered company that furnishes equipment and service to numerous markets worldwide. Its Quality Assurance System ensures the qualification of only the most capable sources for materials, parts, and services. Further, Clyde Union Canada Limited suppliers must maintain a high level of measurable quality, delivery, and service performance in order to remain on the Approved Supplier List.

Clyde Union Canada Limited reserves the right to utilize any qualified source on its Approved Supplier List.

Thank you for the above referenced inquiry.

CLYDEUNION

STANDARD TERMS AND CONDITIONS OF SALE

1. **APPLICABILITY** - These standard terms and conditions of sale (the "Terms and Conditions") are applicable to all quotations made by CLYDE UNION CANADA LIMITED ("Company"), and particularly to the Goods described on the data sheet attached hereto.

(a) All orders placed by the Buyer are subject to approval and written confirmation by the Company at its home office in Burlington, Ontario, and there shall be no contract between Buyer and the Company prior to the time of such confirmation by the Company.

(b) These Terms and Conditions supersede all prior written terms, understandings, purchase orders, assurances and offers. Buyer's acceptance of the Goods or placement of an order for Goods are subject to these Terms and Conditions and is conditioned upon consent by the Company. Company shall not be deemed to have waived the following conditions if it fails to object to the conditions appearing in or attached to a Purchase Order issued by Buyer. Buyer's acceptance of Goods or services called for in a Purchase Order shall constitute its acceptance of the Terms and Conditions.

(c) Buyer shall immediately inspect all Goods from Company upon Buyer's receipt and Buyer shall, within five (5) days of such receipt, notify Company in writing of Buyer's rejection of part or all of the Goods and the reason(s) for such rejection. In the event that such notice is not timely given, Buyer expressly waives all rights to reject or to revoke acceptance of the Goods and shall have accepted such Goods and is liable to Company for full payment of such Goods.

2. **WARRANTY** - (a) Company warrants that on the date of shipment from Buyer's facility the Goods are of the kind and quality described herein and are free of non-conformities in design, workmanship and material and meet the specifications set forth on the Purchase Order accepted by Company. Company will transfer to Buyer ownership and clear title to Goods delivered, free of all liens, encumbrances, and rights of third parties (except those created by Buyer). This warranty does not apply to Goods delivered by Company but manufactured by others.

(b) Buyer's exclusive remedy for nonconformity in any item of the Goods shall be the repair or the replacement (at Company's option) of the item and any affected part of the Goods. Company's obligation to repair or replace shall be in effect for a period of one (1) year from initial operation of the Goods but not more than eighteen (18) months from Company's delivery of the Goods, provided Buyer has sent written notice within that period of time, or within thirty (30) days after the end of the applicable warranty period to Company that the Goods do not conform to the above warranty. Repaired and replacement parts shall be warranted for the remainder of the original period of notification set forth above, but in no event less than 12 months from repair or replacement. At its expense, Buyer shall remove and ship to Company any such nonconforming items and shall reinstall the repaired or replaced parts. Buyer shall grant Company access to the Goods at all reasonable times in order for Company to determine any nonconformity in the Goods. Company shall have the right of disposal of items replaced by it. If Company is unable or unwilling to repair or replace, or if repair or replacement does not remedy the nonconformity, Company and Buyer shall negotiate an equitable adjustment in the Purchase Order price.

(c) Buyer and successors of Buyer are limited to the remedies specified in this article and shall have no others for a nonconformity in the Goods. Buyer agrees that these remedies provide Buyer and its successors with a minimum adequate remedy and are their exclusive remedies, whether Buyer's or its successors' remedies are based on contract, warranty, tort (including negligence), strict liability, indemnity, or any other legal theory, and whether arising out of warranties, representations, instructions, installations, or non-conformities from any cause.

(d) This warranty shall not apply in the event of defects caused by: (i) physical abuse of the Goods or any component, or acts of vandalism by any persons other than Company, its employees, agents, or subcontractors; (ii) alterations, modifications, additions, or repairs made during the applicable warranty period by anyone other than Company, its employees, agents or subcontractors; (iii) accidents or damage resulting from fire, water, wind, hail, lightning, electrical surge or failure, earthquake, theft or similar causes not caused or contributed to by the sole negligence of Company or its employees, agents, or subcontractors; or (iv) damage as a result of corrosion or other damage caused by Buyer's failure to protect the Goods in accordance with Company's written instructions and warnings.

(e) THE FOREGOING WARRANTIES ARE THE SOLE WARRANTIES PROVIDED BY COMPANY FOR THE GOODS AND ARE IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, ALL OF WHICH ARE HEREBY DISCLAIMED AND EXCLUDED BY COMPANY, INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE BUYER AGREES THAT ITS SOLE AND EXCLUSIVE REMEDY AGAINST COMPANY WILL BE LIMITED TO THE REPAIR AND REPLACEMENT OF NONCONFORMING OR DEFECTIVE GOODS, PROVIDED COMPANY IS PROMPTLY NOTIFIED IN WRITING OF ANY DEFECT. THIS EXCLUSIVE REMEDY WILL NOT BE DEEMED TO HAVE FAILED OF ITS ESSENTIAL PURPOSE SO LONG AS COMPANY IS WILLING TO REPAIR OR REPLACE THE NONCONFORMING OR DEFECTIVE GOODS.

3. **PATENTS AND INTELLECTUAL PROPERTY** - Company shall pay costs and damages finally awarded in any suit against Buyer to the extent based upon a finding that the design or construction of the Goods as furnished infringes a United States patent or other third party intellectual property rights (except infringement occurring as a result of incorporating a design or modification at Buyer's request), provided that Buyer promptly notifies Company of any charge of infringement, and Company is given the right at its expense to settle such charge and to defend or control the defense of any suit based upon such charge. Company shall have no obligation hereunder with respect to claims, suits or proceedings, resulting from or related to, in whole or in part, (i) the use of software or software documentation, (ii) compliance with Buyer's specifications, (iii) the combination with, or modification of, the Goods after delivery by Company, or (iv) the use of the Goods, or any part thereof, in the practice of a process. THIS ARTICLE SETS FORTH COMPANY'S ENTIRE LIABILITY WITH RESPECT TO PATENTS OR OTHER INFRINGEMENTS OF INTELLECTUAL PROPERTY.

4. **PERFORMANCE; DELAYS** - Timely performance by Company is contingent upon Buyer's supplying to Company, when needed, all required technical information and data, including drawing approvals, and all required commercial documentation. If Company suffers delay in performance due to any cause beyond its reasonable control, the time of performance shall be extended a period of time equal to the period of the delay and its consequences. Company will give to Buyer notice within a reasonable time after Company becomes aware of any such delay.

5. **DELIVERY, TITLE AND RISK OF LOSS** - The Goods will be delivered to the delivery point indicated on the Purchase Order, but if no delivery point is specified, then the Goods will be delivered F.C.A. Company's facility (in accordance with Incoterms 2000) and title will transfer upon delivery to the Incoterms delivery point. In either event, Buyer will be responsible for making appropriate shipping arrangements, and Buyer will provide sufficient notice and details of such arrangements to allow Company to prepare the Goods for delivery. Unless otherwise indicated in the Purchase Order, all delivery dates specified in this Purchase Order are estimates only and time is not of the essence in Company's performance of this Purchase Order. Risk of loss of the Goods will remain with Company and not pass to Buyer until delivery to the Incoterms delivery point.

6. **FORCE MAJEURE** - Company will not be deemed to be in default or otherwise responsible for delays or failures in performance resulting from acts of God; acts of war, or civil disturbance, terrorism, epidemics, governmental action or inaction, fires, earthquakes, tornadoes, beyond Company's reasonable control (a "Force Majeure Event"). A force majeure event affecting Company's vendors shall also be deemed as a Force Majeure Event for the Company, provided that the Company shall use commercially reasonable efforts to mitigate any delays caused by its vendor's force majeure situation. Company shall in such instances give notice of the non-performance (including its anticipated duration) to the Customer promptly after becoming aware that it has occurred or will occur. In no event shall lack of finances or ability to perform or pay as a result of the financial condition of either party be considered an event of Force Majeure.

7. **PACKING and SHIPMENT** - Buyer may specify the method of transportation and the type and number of packing slips and other documents to be provided with each shipment. Company will pack and ship Goods in accordance with Buyer's reasonable instructions, including labelling, and hazardous materials instructions. If Buyer has not provided packing or shipping instructions, Company will pack and ship Goods in accordance with sound commercial practices. No charges will be made by Company or accepted by Buyer for boxing, packaging or crating unless otherwise agreed upon.

8. **TAXES** - Any applicable duties or sales, use, excise, Goods and Services Tax, Harmonized Sales Tax or similar taxes will be added to the price and invoiced separately (unless an acceptable exemption certificate is furnished).

9. **NONCANCELLATION** - Buyer may not cancel or terminate for convenience, or direct suspension of manufacture, except with Company's written consent and then only upon terms that will compensate Company for its engineering, fabrication and purchasing charges and any other costs relating to such cancellation, termination or suspension, plus a reasonable amount for profit and overhead.

10. **LIMITATION OF LIABILITY** - NEITHER COMPANY AND ITS AFFILIATES AND THEIR RESPECTIVE OFFICERS, DIRECTORS, EMPLOYEES, AGENTS, INSURERS AND ATTORNEYS SHALL BE LIABLE, WHETHER IN CONTRACT, WARRANTY, FAILURE OF A REMEDY TO ACHIEVE ITS INTENDED OR ESSENTIAL PURPOSES, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY, INDEMNITY OR ANY OTHER LEGAL THEORY, FOR LOSS OF USE, REVENUE, PROFIT, OR FOR COSTS OF CAPITAL OR OF SUBSTITUTE USE OR PERFORMANCE, OR FOR INDIRECT, SPECIAL, LIQUIDATED, INCIDENTAL OR CONSEQUENTIAL DAMAGES, OR FOR ANY OTHER LOSS OR COST OF A SIMILAR TYPE, OR FOR CLAIMS BY BUYER FOR DAMAGES OF BUYER'S CUSTOMERS. COMPANY'S MAXIMUM LIABILITY UNDER THIS PURCHASE ORDER FOR ALL CLAIMS AND LOSSES ARISING OUT OF OR RELATED TO THIS PURCHASE ORDER OR THE MANUFACTURE OR SALE OF THE GOODS SHALL BE THE PURCHASE ORDER PRICE. BUYER AND COMPANY AGREE THAT THE EXCLUSIONS AND LIMITATIONS SET FORTH IN THIS ARTICLE ARE SEPARATE AND INDEPENDENT FROM ANY REMEDIES WHICH BUYER MAY HAVE HEREUNDER AND SHALL BE GIVEN FULL FORCE AND EFFECT WHETHER OR NOT ANY OR ALL SUCH REMEDIES SHALL BE DEEMED TO HAVE FAILED OF THEIR ESSENTIAL PURPOSE.

11. **GOVERNING LAW** - This Purchase Order shall be governed and controlled in all respects by the laws of, the Province of Ontario and all disputes, including interpretation, enforceability, validity, and construction, shall be determined under the law of the Province of Ontario without regard to any conflict of law provisions. Any dispute arising between the parties out of or in connection with this Purchase Order will be finally resolved in the provincial or federal courts of Ontario. Each party consents to personal jurisdiction in the provincial and federal courts of Ontario and Canada for the limited purposes of this section, and agrees that personal jurisdiction in any such court will be deemed proper.

12. **ATTORNEY FEES** - Buyer shall be liable to Company for any attorney fees and costs incurred by Company in enforcing any of its rights hereunder.

13. **DISPUTES** - Either party may give the other party written notice of any dispute arising out of or relating to this Purchase Order and not resolved in the normal course of business. The parties shall attempt in good faith to resolve such dispute promptly by negotiations between executives who have authority to settle the dispute. If the matter has not been resolved within 60 days of the notice, either party may initiate non-binding mediation of the dispute.

14. **STATUTE OF LIMITATIONS** - To the extent permitted by applicable law, any lawsuit for breach of contract, including breach of warranty, arising out of the transactions covered by this Purchase Order, must be commenced not later than twelve (12) months from the date the cause of action accrued.

15. **PRICES** - Prices quoted are based on anticipated receipt of full manufacturing release for the product within 30 days from the date of quotation. In the event of a price increase or decrease, the price of Goods on order will be adjusted to reflect such increase or decrease. This does not apply to a shipment held by request of Buyer. Goods already shipped are not subject to price increase or decrease. Orders on a bid or contract basis are not subject to this article.

16. **DEFERRED OR DELAYED DELIVERIES** - After Buyer's order has been accepted by the Company pursuant to paragraph 2 hereof, Goods already produced or in the process may not be deferred beyond the originally specified delivery date without the Company's consent. Any deferment in delivery date is subject to terms necessary to indemnify the Company against all loss, including, but not limited to, off-site storage charges and related expenses if any order is delayed beyond the original shipping date because of Buyer's failure to provide required instructions or equipment or for convenience of Buyer, Buyer will be immediately liable for off-site storage charges and any other expenses resulting from such delay.

17. **ADDITIONAL TERMS OF PAYMENT** - Invoice payment terms are as shown on latest discount sheets as issued from time to time. Cash discounts are not applicable to notes or trade acceptances, to prepaid transportation charges when added to Company's invoices or to discountable items if there are undisputed past due items on the account. Portions of an invoice in dispute should be deducted and the balance remitted with a detailed explanation of the deduction. Cash discounts will only be allowed on that portion of the invoice paid within the normal discount period.

18. **CHANGES IN LAWS AND REGULATIONS** - Company's prices and timely performance are based on all applicable laws, rules, regulations, orders, codes, standards or requirements of governmental authorities effective on the date of Company's proposal. Any change to any law, rule, regulation, order, code, standard or requirement which requires any change hereunder shall entitle Company to an equitable adjustment in the prices and any time of performance.

19. **COMPLIANCE WITH EXPORT LAWS AND REGULATIONS** - Products manufactured by Seller, as well as technical data related thereto, are subject to export licensing controls under the Canadian Export and Imports Permits Act, U.S. Export Administration Regulations and/or the U.S. International Traffic in Arms Regulations, which require licensing for and/or prohibit the export or diversion of the Seller's products to certain countries. If Buyer is responsible for obtaining export approvals, Buyer warrants that it will not assist or participate in any export of Seller's products or related technical data without obtaining the required export license and will not knowingly assist or participate in any such diversion or other violation of applicable Canadian and U.S. laws and regulations. If Seller is responsible for obtaining export approvals, Buyer shall assist Seller, as necessary, in obtaining such approvals. Buyer shall indemnify and hold harmless Seller for any losses or claims arising out of or related to Buyer's failure to comply with applicable export control laws and regulations.

20. **RELATIONSHIP OF THE PARTIES** - Buyer and Company are independent contractors, and nothing in the contract makes either party the agent or legal representative of the other party for any purpose. Neither party has authority to assume or to create any obligation on behalf of the other party.

21. **WAIVER** - The failure of Company to enforce any right or remedy provided in the contract or by law on a particular occasion will not be deemed a waiver of that right or remedy on a subsequent occasion or a waiver of any other right or remedy.

22. **SEVERABILITY** - A finding that any provision of the contract is invalid or unenforceable in any jurisdiction will not affect the validity or enforceability of any other provision of the contract or the validity or enforceability of that provision in any other jurisdiction.

23. **ASSIGNMENT and DELEGATION** - No right or interest in the sale of Goods hereunder shall be assigned by the Buyer without the written permission of the Company, and no delegation of any obligation owed, or the performance of any obligation by the Buyer, shall be made without the written permission of the Company. Any attempted assignment of delegation shall be wholly void and totally ineffective for all purposes unless made in conformity with this paragraph. Company shall have the right to assign this Purchase Order or its obligations hereunder to any affiliate of Company or any successor to substantially all of the assets of Company. In the event of a proper assignment, these Terms and Conditions shall be binding upon and inure to the benefit of either party's successors and assigns.

24. **THIRD PARTY RIGHTS** - Notwithstanding any provision of law, no third party (including Buyer's customer) shall have any right to enforce these Terms and Conditions or any other contractual rights against Company or its affiliates.

25. **HEADINGS** - The headings of the various paragraphs of these terms and conditions of sale have been inserted for convenient reference only and shall not to any extent have the effect of modifying, amending or changing the expressed terms and provisions hereof.

26. **ETHICAL BUSINESS PRACTICES** - Company requires manufacturing and business practices that are compliant with all applicable laws and regulations, including, the need to conduct all transactions in compliance with ethical business practices. Both the Company and the Buyer agree that neither of them nor their employees, agents, representatives or other intermediaries will engage in any activity that may be construed to be in violation of their respective codes of ethical business practices or applicable law. Buyer acknowledges and agrees that it shall not, in regards to the sale or resale of the Company's products, shall not make any payment or transfer of value to any third party (including through any or multiple intermediaries) that would cause either the Buyer, Company or and of Company's affiliates to violate either the U.S. Foreign Corrupt Practices Act or any other applicable anti-corruption laws. Buyer shall indemnify and hold Company and Company's affiliates harmless in the event of any breach of this paragraph by Buyer or any of its intermediaries.

27. **INTERPRETATION, PAROL EVIDENCE** - These Terms and Conditions are intended as a final expression of the Company's quotation and as a complete and exclusive statement of terms thereof. No course of prior dealings between the Company and Buyer, and no usage of the trade shall be relevant to supplement or explain any term used herein. Acceptance or acquiescence in a course of performance rendered hereunder shall not be relevant to determine the meaning of these Terms and Conditions even though the accepting or acquiescing party has knowledge of the performance and opportunity for objection.

28. **ENTIRE AGREEMENT** - These Terms and Conditions, including attachments hereto, constitutes the entire understanding and agreement between the parties and supersedes any prior oral or written agreements with respect to the subject matter hereof.

ACUREN

Acuren Group Inc.
170 Akerley Boulevard, Unit 6
Dartmouth, NS, Canada B3B1Z5
Phone: (902) 443-4448
Fax: (902) 445-5090

Materials Engineering and Testing
a Rockwood Company

NONDESTRUCTIVE EXAMINATION REPORT

TO: **Nova Scotia Power Inc.**
Tuft's Cove, Dartmouth, N.S.

REPORT# BM022613 PAGE: 1
DATE: Feb. 26, 2013 TIME: 8:00am
ACUREN JOB #: 9080-180
P.O.: 238805
WORK LOCATION: Unit 2

ATTENTION: **Colin Irving**
PROJECT: Unit 2, South CW Pump

ACCEPTANCE STANDARD: ASME B31.1 REV./DATE: 2012
PROCEDURE #: CAN-PT-14P001 Rev.03 REV./DATE: July/12
TECHNIQUE #: 2 REV./DATE: July/12

ITEM(S) TESTED: Pump body at crack location

PART #: ***24221200*** MATERIAL: Stainless THICKNESS: NA

SCOPE: Perform Liquid Penetrant Inspection on crack area to determine ends of crack.

TYPE(S) OF INSPECTION: Liquid Penetrant

TEST DETAILS: LIQUID PENETRANT

TYPE: Solvent Removable		METHOD: Solvent Removable	
FAMILY BRAND: Magnaflux		BLACKLIGHT S/N:	MAKE:
PENETRANT: Skl-SP1	MIN. DWELL TIME: 20 Min.	LIGHTING EQUIPMENT: Trouble Light	
PENETRANT REMOVER: SKC-S	MIN. DRY TIME: 5 Min.	OTHER: ---	
DEVELOPER: SKD-S2	MIN. DWELL TIME: 15 Min.	LIGHT METER S/N:	CAL DUE:
DEVELOPER TYPE: Non-Aqueous		LIGHT INTENSITY:	
SURFACE CONDITION: Welded		SURFACE TEMPERATURE: 10°C/50°F to 52°C/125°F	

RESULTS: (Imperial)

Liquid Penetrant Inspection was performed on the unit 2, south CW pump on an area with a visible crack to determine the ends of crack. The crack appears to start off where the previous crack repair took place and propagates under the lip of pump body, through the first gusset, but stops before the next. No additional cracks were noted. See pictures on following pages of this report.

NSPI WO # 183591

DTR # E-110182

SCOPE OF SERVICES: The agreement of Acuren Group Inc. to perform services extends only to those services provided for in writing. Under no circumstances shall such services extend beyond the performance of the requested services. It is expressly understood that all descriptions, comments and expressions of opinion reflect the opinions or observations of Acuren based on information and assumptions supplied by the owner/operator and are not intended nor can they be construed as representations or warranties. Acuren is not assuming any responsibilities of the owner/operator and the owner/operator retains complete responsibility for the engineering, manufacture, repair and use decisions as a result of the data or other information provided by Acuren. In no event shall Acuren's liability in respect of the services referred to herein exceed the amount paid for such services.
STANDARD OF CARE: In performing the services provided, Acuren uses the degree, care, and skill ordinarily exercised under similar circumstances by others performing such services in the same or similar locality. No other warranty, expressed or implied, is made or intended by Acuren.

CLIENT REPRESENTATIVE:
TECHNICIAN:
PRINT NAME: B. MacNeil
1st Technician
CGSB,SNT,BINDT Level II
CGSB Registration No 4780
2nd Technician

	TOTAL HOURS	S.T.	O.T.	SHIFT
1ST TECHNICIAN:				Day ☐
2ND TECHNICIAN:				PM ☐

KILOMETRES: OTHER CHARGES: YES ☐ NO ☐

BM-022613

ACUREN
NOVA SCOTIA POWER Inc.

Photo 1: Unit 2, South CW Pump Crack. Starting at previous repair.

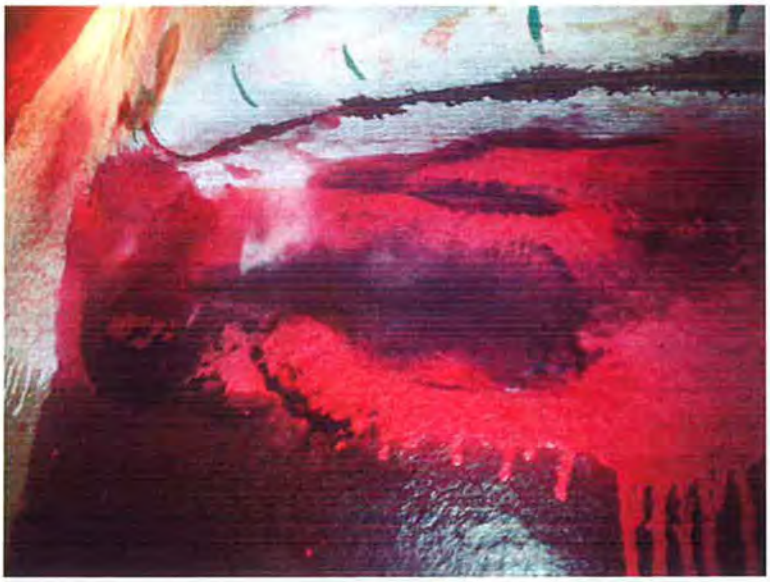
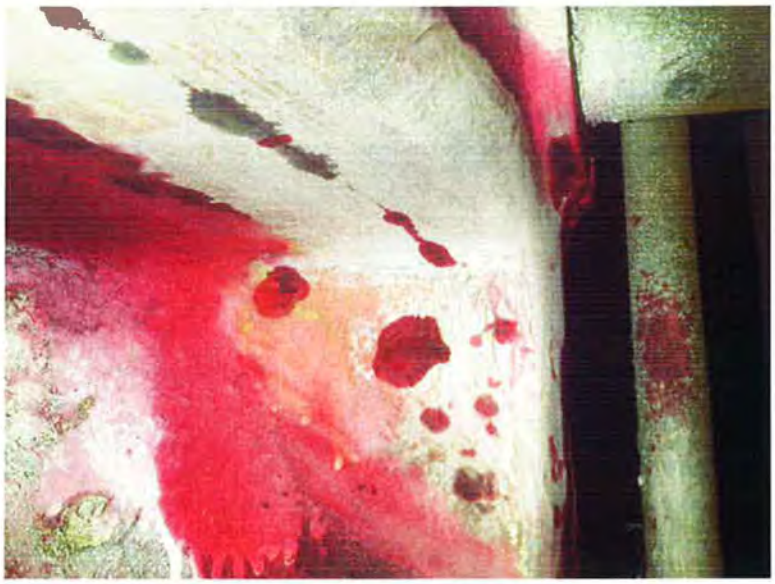


Photo 2: Unit 2, South CW Pump Crack. Crack stops before second gusset.



BM-022613

ACUREN
NOVA SCOTIA POWER Inc.

Photo 3: Unit 2, South CW Pump Crack. Crack runs through first gusset.



Photo 4: Unit 2, South CW Pump Crack. View of entire crack.



BM-022613

ACUREN

Acuren Group Inc.
170 Akerley Boulevard, Unit 6
Dartmouth, NS, Canada B3B1Z5
Phone: (902) 443-4448
Fax: (902) 445-5090

Materials Engineering and Testing
a Rockwood Company

NONDESTRUCTIVE EXAMINATION REPORT

TO: **Nova Scotia Power Inc.**
Tufts Cove, Dartmouth, N.S.

REPORT # **BM-022713** PAGE: 1
DATE: Feb. 25, 2013 TIME: 8:00 AM
ACUREN JOB #: 9080-180
P.O.: **238805**
WORK LOCATION: Unit 2

ATTENTION: **Colin Irving/Kevin Thompson**
PROJECT: Unit 2, Hot Reheat Warming Valve.

ACCEPTANCE
STANDARD: ASME B31.1 REV./DATE: 2012
PROCEDURE: CAN-UT-14T001 Rev.03 REV./DATE: August, 2012
TECHNIQUE: CAN-UT-14T001 REV./DATE: August, 2012

ITEM(S) TESTED: **Pipe on either side of valve**

ITEM # ***24221200*** MATERIAL: NA THICKNESS: NA

SCOPE: Perform a UT thickness on south CW pump at crack area for repair information.

TYPE(S) OF INSPECTION: Ultrasonic thickness

TEST DETAILS: ULTRASONIC

TYPE: Straight Beam			METHOD: Contact		
INSTRUMENT:	Panametrics	MODEL: Epoch IV	S/N: 051381811	CAL DUE: May 02, 2013	
CAL. BLOCK:	Step wedge	S/N: 64388-1D703	CABLE-TYPE: Coaxial	LENGTH: 6'	
CAL. BLOCK:	IIW Block	S/N: 015290	COUPLANT: Sonoglide		
CAL. BLOCK:		S/N:	SPECIAL EQUIP.: ---		

TRANSDUCER MANUFACTURER & TECHNIQUE DETAILS: SONATEST DEV5050

	TEST ANGLE	PROBE TYPE	FREQUENCY (MHz)	SERIAL NUMBER	PROBE Ø	TRANSFER VALUE	TEST FROM	REFERENCE REFLECTOR	REFERENCE dB	REFERENCE % FSH	SCAN SENSITIVITY	RANGE
1	0°	Single	5MHz	O1JLOF	1/2"	0	Surface	BW	50	80	+6	0.5 "

SURFACE CONDITION: Clean Bare SURFACE TEMPERATURE: 0°C/32°F to 120°C/250°F

RESULTS Ultrasonic thickness was carried out on the Unit 2, south CW pump adjacent to crack. This was done to try and determine material thickness to assist with the repair procedure. Material thickness varied from approximately half an inch (1/2"), where crack ties into previous repair, to three quarters of an inch (3/4") closer to the second gusset. See pictures on following pages.

DTR's: E-110183

W.O. # 183591

SCOPE OF SERVICES: The agreement of Acuren Group Inc. to perform services extends only to those services provided for in writing. Under no circumstances shall such services extend beyond the performance of the requested services. It is expressly understood that all descriptions, comments and expressions of opinion reflect the opinions or observations of Acuren based on information and assumptions supplied by the owner/operator and are not intended nor can they be construed as representations or warranties. Acuren is not assuming any responsibilities of the owner/operator and the owner/operator retains complete responsibility for the engineering, manufacture, repair and use decisions as a result of the data or other information provided by Acuren. In no event shall Acuren's liability in respect of the services referred to herein exceed the amount paid for such services.
STANDARD OF CARE: In performing the services provided, Acuren uses the degree of care and skill ordinarily exercised under similar circumstances by others performing such services in the same or similar locality. No other warranty, expressed or implied, is made or intended by Acuren.

CLIENT REPRESENTATIVE:
TECHNICIAN:
PRINT NAME: Barry MacNeil
1st Technician
CGSB Level II SNT Level II
CGSB Registration No. 4780
2nd Technician

	TOTAL HOURS	S.T.	O.T.	SHIFT
1ST TECHNICIAN:				Day ☐
2ND TECHNICIAN:				PM ☐

KILOMETRES: OTHER CHARGES: YES ☐ NO ☐

BM-022713

ACUREN

NOVA SCOTIA POWER
Ultrasonic Inspection

Photo 1: UT performed on the Unit 2 South CW pipe adjacent to crack. Thicknesses written on pump in green marker above where readings were taken.



Photo 2: UT performed on the Unit 2 South CW pipe adjacent to crack. Thicknesses written on pump in green marker above where readings were taken.



BM-022713

CI Number: 44717

Title: TUC2 - Condenser Vacuum Pump Replacement

Start Date: 2014/05
Final Cost Date: 2015/01
Function: Generation
Forecast Amount: $428,783

DESCRIPTION:

This project is for the replacement of the Tufts Cove Unit 2 (TUC2) North Condenser Vacuum Pump. TUC2 is equipped with 2 x 100 percent vacuum pumps. They are critical to the operation of the unit. These vacuum pumps remove non-condensables from the steam condenser. If sufficient vacuum cannot be achieved in the condenser, the unit would suffer higher heat rates, or could be de-rated or experience a forced outage.

Summary of Related CIs +/- 2 years: None

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

TUC2 was originally designed with two 100 percent vacuum pumps. Performance issues associated with the North pump were identified during operation. The pump was taken out of service to investigate the cause of the performance issues. Disassembly of the pump revealed significant indication of erosion and corrosion such as pitting and loss of allowable tolerances. Through time pump components have worn and deteriorated to the point that refurbishment is not practical or cost-efficient due to the extent of pump components requiring replacement.

Why do this project now?

The North vacuum pump has been taken out of service, and is therefore not supporting the operation of the unit. The South vacuum pump is of similar vintage and operating hours. Replacing the North pump now mitigates the risk of de-rating or forced outage of the unit due to the inability to maintain vacuum. It would also restore the original design redundancy to the unit.

Why do this project this way?

The existing North vacuum pump cannot be repaired to a reliable state. Replacement is the only option that will restore reliability and redundancy to the vacuum system of TUC2.

CI Number : 44717 - TUC2 - Condenser Vacuum Pump Replacement **Project Number**

Parent CI Number : -

Cost Centre : 318 - 318-TC Unit 2 Capital **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		9,755	0	9,755
095		095-Thermal & Hydro Contracts AO		4,397	0	4,397
095		095-Thermal Regular Labour AO		13,042	0	13,042
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	68,389	0	68,389
012	014	012 - Materials	014 - SGP - Circ.Water Sys.	263,200	0	263,200
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	45,000	0	45,000
028	014	028 - Consulting	014 - SGP - Circ.Water Sys.	25,000	0	25,000
			Total Cost:	428,783	0	428,783
			Original Cost:	77,004		

Tufts Cove Unit 2 North Vacuum Pump Replacement
Summary of Alternatives

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Tufts Cove Maintenance	**CI Number:**	44717
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	North Vacuum Pump Replacement	6.49%	-1,408,735	1,095,998	1	28.84%	5.1 years
B	North Vacuum Pump Refurbishment	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Replace the North Condenser Vacuum Pump to mitigate the risk of a forced outage on TUC2 due to vacuum pump failure. This is supported by favorable economic analysis results.

Notes/Comments :

North Vacuum Pump Replacement

The North Vacuum Pump is currently out of service. Its mating pump, the South Vacuum pump, is of the same vintage and is assumed to have a 15% chance of failure. Without a vacuum pump, TUC2 would not be operable.

North Vacuum Pump Refurbishment

The vacuum pump cannot be refurbished cost-effectively. The number of components requiring replacement would result in the pump being completely disassembled, and re-assembled, at a cost greater than the new pump. As this would not create any additional benefits, and is known to be more expensive, it was not evaluated further here.

Test 3

Test 4

Tufts Cove Unit 2 North Vacuum Pump Replacement
Summary of Sensitivities

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Tufts Cove Maintenance	**CI Number:**	44717
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	North Vacuum Pump Replacement	6.49%	-1,408,735	1,095,998	1	28.84%	5.1 years
B	North Vacuum Pump Refurbishment	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	North Vacuum Pump Replacement	10%	-1,368,231	1,064,014	1	26.70%	5.5 years
B	North Vacuum Pump Refurbishment	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
Change:	**A**		40,504	-31,984	0	-2.14%	0.4 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	North Vacuum Pump Replacement	-10%	-1,227,357	954,414	1	26.48%	5.6 years
B	North Vacuum Pump Refurbishment	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
Change:	**A**		181,377	-141,584	0	-2.35%	0.5 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement		PV of Revenue Requirement	PV of Revenue Requirement	PV of Revenue Requirement	Delay?
	Yrs Delay:	1	2	3	
	A	20,597	94,865	162,601	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

Tufts Cove Unit 2 North Vacuum Pump Replacement
Avoided Cost Calculations

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Tufts Cove Maintenance	**CI Number:**	44717
Originator :		**Project No. :**	

North Vacuum Pump Replacement

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	15%	17%	15%	17%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	95	95				
Duration (Hours)	8760	8760				
Totals	$22,200	$102,736	$0	$0	$22,200	$102,736
Total Capital Cost of Alternative						$428,783

North Vacuum Pump Refurbishment

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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

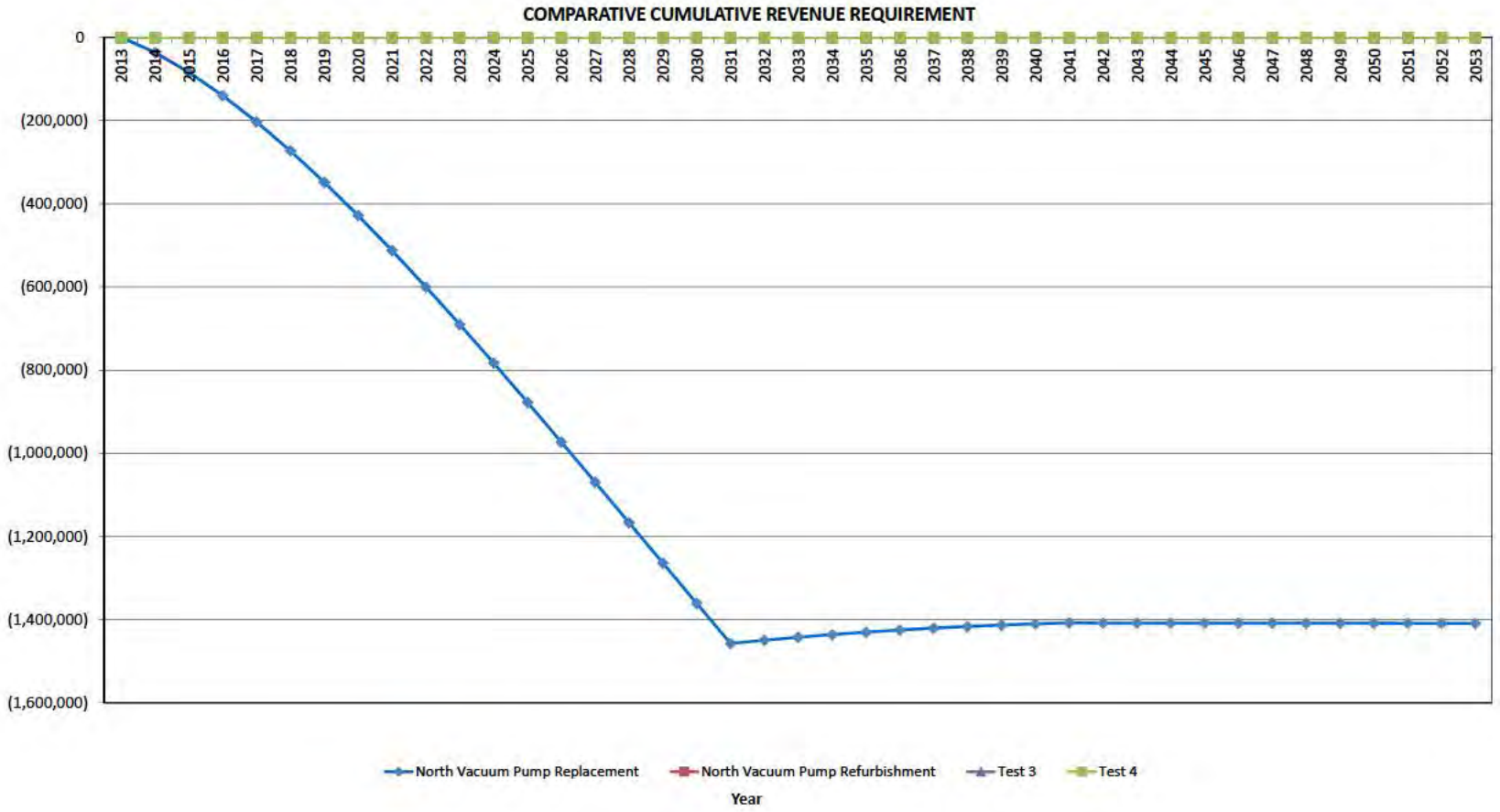
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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

Tufts Cove Unit 2 North Vacuum Pump Replacement

North Vacuum Pump Replacement

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	22,199.8	(411,344.7)	16,063.6	390,338.6	(389,144.9)	(1,902.2)	(391,047.1)	(367,214.9)	0.94	(367,214.9)
2015	-	-	102,735.6	-	30,842.1	358,693.0	102,735.6	(22,287.0)	80,448.6	70,941.6	0.88	(296,273.3)
2016	-	-	117,118.6	-	28,374.7	329,579.0	117,118.6	(27,510.6)	89,608.0	74,202.8	0.83	(222,070.5)
2017	-	-	132,035.8	-	26,104.7	302,794.2	132,035.8	(32,838.6)	99,197.1	77,137.2	0.78	(144,933.3)
2018	-	-	147,502.8	-	24,016.3	278,152.1	147,502.8	(38,280.8)	109,222.0	79,756.5	0.73	(65,176.8)
2019	-	-	163,535.7	-	22,095.0	255,481.5	163,535.7	(43,846.6)	119,689.1	82,073.3	0.69	16,896.4
2020	-	-	180,151.0	-	20,327.4	234,624.4	180,151.0	(49,545.3)	130,605.7	84,100.8	0.64	100,997.3
2021	-	-	197,365.4	-	18,701.2	215,435.9	197,365.4	(55,385.9)	141,979.5	85,852.9	0.60	186,850.2
2022	-	-	215,196.3	-	17,205.1	197,782.5	215,196.3	(61,377.3)	153,819.1	87,343.5	0.57	274,193.7
2023	-	-	233,661.6	-	15,828.7	181,541.4	233,661.6	(67,528.2)	166,133.4	88,586.7	0.53	362,780.4
2024	-	-	252,779.3	-	14,562.4	166,599.6	252,779.3	(73,847.2)	178,932.1	89,596.5	0.50	452,377.0
2025	-	-	272,568.4	-	13,397.4	152,853.1	272,568.4	(80,343.0)	192,225.4	90,386.8	0.47	542,763.7
2026	-	-	293,047.8	-	12,325.6	140,206.3	293,047.8	(87,023.9)	206,023.9	90,971.0	0.44	633,734.7
2027	-	-	314,237.4	-	11,339.6	128,571.3	314,237.4	(93,898.3)	220,339.1	91,362.5	0.41	725,097.2
2028	-	-	336,157.4	-	10,432.4	117,867.1	336,157.4	(100,974.7)	235,182.7	91,574.1	0.39	816,671.4
2029	-	-	358,828.5	-	9,597.8	108,019.2	358,828.5	(108,261.5)	250,567.0	91,618.4	0.37	908,289.7
2030	-	-	382,271.9	-	8,830.0	98,959.1	382,271.9	(115,767.0)	266,504.9	91,507.2	0.34	999,796.9
2031	-	-	406,509.6	-	8,123.6	90,623.9	406,509.6	(123,499.7)	283,010.0	91,252.1	0.32	1,091,049.0
2032	-	-	-	-	7,473.7	82,955.5	-	2,316.9	2,316.9	701.5	0.30	1,091,750.5
2033	-	-	-	-	6,875.8	75,900.5	-	2,131.5	2,131.5	606.1	0.28	1,092,356.6
2034	-	-	-	-	6,325.7	69,409.9	-	1,961.0	1,961.0	523.6	0.27	1,092,880.2
2035	-	-	-	-	5,819.7	63,438.6	-	1,804.1	1,804.1	452.3	0.25	1,093,332.5
2036	-	-	-	-	5,354.1	57,945.0	-	1,659.8	1,659.8	390.8	0.24	1,093,723.3
2037	-	-	-	-	4,925.8	52,890.9	-	1,527.0	1,527.0	337.6	0.22	1,094,060.9
2038	-	-	-	-	4,531.7	48,241.1	-	1,404.8	1,404.8	291.7	0.21	1,094,352.6
2039	-	-	-	-	4,169.2	43,963.3	-	1,292.4	1,292.4	252.0	0.19	1,094,604.6
2040	-	-	-	-	3,835.6	40,027.7	-	1,189.1	1,189.1	217.7	0.18	1,094,822.3
2041	-	-	-	-	3,528.8	36,407.0	-	1,093.9	1,093.9	188.1	0.17	1,095,010.4
2042	-	-	-	-	3,246.5	33,075.9	-	1,006.4	1,006.4	162.5	0.16	1,095,172.8
2043	-	-	-	-	2,986.8	30,011.3	-	925.9	925.9	140.4	0.15	1,095,313.2
2044	-	-	-	-	2,747.8	27,191.9	-	851.8	851.8	121.3	0.14	1,095,434.5
2045	-	-	-	-	2,528.0	24,598.0	-	783.7	783.7	104.8	0.13	1,095,539.3
2046	-	-	-	-	2,325.8	22,211.7	-	721.0	721.0	90.5	0.13	1,095,629.8
2047	-	-	-	-	2,139.7	20,016.2	-	663.3	663.3	78.2	0.12	1,095,708.0
2048	-	-	-	-	1,968.5	17,996.4	-	610.2	610.2	67.6	0.11	1,095,775.6
2049	-	-	-	-	1,811.0	16,138.2	-	561.4	561.4	58.4	0.10	1,095,833.9
2050	-	-	-	-	1,666.2	14,428.6	-	516.5	516.5	50.4	0.10	1,095,884.4
2051	-	-	-	-	1,532.9	12,855.8	-	475.2	475.2	43.6	0.09	1,095,927.9
2052	-	-	-	-	1,410.2	11,408.8	-	437.2	437.2	37.6	0.09	1,095,965.6
2053	-	-	-	-	1,297.4	10,077.6	-	402.2	402.2	32.5	0.08	1,095,998.1
Total	**-**	**-**	**4,127,903.0**	**(411,344.7)**	**386,668.9**		**3,716,558.3**	**(1,159,782.6)**	**2,556,775.8**	**1,095,998.1**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(200,000)
(400,000)
(600,000)
(800,000)
(1,000,000)
(1,200,000)
(1,400,000)
(1,600,000)
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
2053
North Vacuum Pump Replacement
North Vacuum Pump Refurbishment
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: Tufts Cove
CI# / FP#: 44717
Title: TUC2 - Vacuum Pump Replacement
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	pd	60.0	$ 339	$ 20,357		
1.2	Engineering (P.Eng)	pd	17.1	$ 384	$ 6,580		
1.3	Maintenance Trades	pd	120.0	$ 345	$ 41,453		
1.4							
				Sub-Total	$ 68,389		
2	**012 Materials**						
2.1	Vacuum Pump System	lot	1	[redacted]		Cost Support 1	
2.2	Contingency	%	[redacted]			includes currency risk	
2.3	Miscellaneous Mechanical	lot	1	$ 20,000.00	$ 20,000		
2.4	Miscellaneous Electrical	lot	1	$ 20,000.00	$ 20,000		
2.5					$ -		
				Sub-Total	$ 263,200		
3	**013 Contracts**						
3.1	Field Engineering Support	lot	1	20000	$ 20,000		
3.2	Miscellanous Mechanical	lot	1	25000	$ 25,000		
3.3							
3.4							
				Sub-Total	$ 45,000		
4	**028 Consulting**						
4.1	Engineering Consultants	lot	1	25000	$ 25,000		
4.2							
4.3					$ -		
				Sub-Total	$ 25,000		
5	**094 Interest Capitalized**						
5.1	AFUDC	lot	1	9755.46	$ 9,755		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 9,755		
6	**095 Administrative Overhead**						
6.1	Contracts AO	lot	1	4396.5	$ 4,397		
6.2	Regular Labour AO	lot	1	13041.82	$ 13,042		
				Sub-Total	$ 17,438		
				SUB-TOTAL (no AO, AFUDC)	$ 401,589		
				TOTAL (AO, AFUDC included)	$ 428,783		
7	**Original Cost**						
7.1					$ 77,004		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

PROPOSAL

Submitted by: Gardner Denver Nash LLC, 700 McKeesport Road, Elizabeth, PA 15037-1864
Telephone: 412-382-6800 Fax: 412-382-4880

To:	Nova Scotia Power Inc. Tufts Cove Generating Station Dartmouth, NS **Att: Grayson Swan and Warren Rodgers**	**Phone Number:** **Fax Number:** **e-mail:**	**902-428-7619** **902-428-7699** Grayson.Swan@nspower.ca
From:	Mark Savage Gardner Denver Nash, LLC.	**Phone Number:** **Fax Number:** **e-mail:**	514-381-7291 X 226 514-381-2339 msavage@samclernon.com
Reference:	Nova Scotia Power TUC2 AT2006E Vacuum System	**Pages:**	4 + Attachments
Quote #:	X09-0062	**Date:**	8/25/09

This proposal is submitted on behalf of Gardner Denver Nash LLC, as seller, and is subject to the attached Terms and Conditions.

Gentlemen,

Gardner Denver Nash is pleased to provide you with a detailed proposal for the custom designed liquid ring vacuum pump system as described herein. The air removal equipment supplied under this proposal shall consist of one 100% AT2006E Air Removal system for condenser exhauster service for the above referenced jobsite.

All pricing is quoted Ex-works Elizabeth, PA and assumes acceptance of Gardner Denver Nash LLC standard Terms and Conditions of Sale (attached).

Please do not hesitate to contact me directly with questions regarding this proposal. For immediate assistance, please contact the sales representative in your area.

Very Truly Yours,

Mark Savage

Gardner Denver Nash LLC

c/o S.A. McLernon Inc.

AIR REMOVAL SCOPE OF SUPPLY

Each Gardner Denver Nash AT2006E Condenser Exhaust Unit will include the following:

One (1) Nash Model AT2006 two-stage rotary liquid ring vacuum pump with fully shrouded rotors and conical ports as manufactured by Gardner Denver Nash. The pump is cast iron with a ductile iron rotor and carbon steel shaft

One (1) inlet manifold

One (1) system inlet valve, pneumatically actuated butterfly valve with limitswitches

One (1) inlet vacuum gauge with isolation valve

One (1) flexible coupling and guard

One (1) 100 HP / 514 RPM TEFC motor 575/3/60 with 1.15 SF

One (1) cylindrical separator with gauge glass and overflow loop with check valve

One (1) balanced check valve for separator discharge (close (manually) for leakage readings)

One (1) low level switch

One (1) flow indicator for air leakage rate

One (1) make-up line strainer, make-up solenoid valve, and isolation and bypass valves

One (1) seal water recirc pump, 575V

One (1) plate & frame heat exchanger with titanium plates

One (1) control panel with interconnecting wiring, NEMA 4 carbon steel enclosure

One (1) complete set of accessories for seal water system including strainer, temperature indicator, orifice unions, pressure gauge, spray nozzles, and spray nozzle isolation valve

One (1) set of interconnecting piping and fittings as described below

One (1) fabricated steel base to accommodate the entire unit

Testing Included:
1. Non-witnessed performance test of bare shaft vacuum pump.
2. Hydrostatic test of welded pipe spools.
3. Non-witnessed mechanical run of vacuum pump package.

Wiring of all electrical instruments and devices to the junction box described above is included in our scope of supply.
All interconnecting piping between skid-mounted components shall be accomplished using ANSI Power Piping standards (ANSI B31.1) and is included in the proposed scope of supply.

COMMERCIAL PROPOSAL

System Pricing

PRICE FOR ONE (1) AT2006E VACUUM PUMP PACKAGE.....US $ [redacted] ✓
One (1) AT2006 Air Removal Systems w/ Plate & Frame Seal Cooler, Shipped Ex-works Elizabeth, PA.

All pricing is quoted in U.S. Dollars and assumes acceptance of Gardner Denver Nash LLC standard Terms and Conditions of Sale (attached).

Validity of Proposal: 30 days from date of proposal for delivery within one year of quotation.

Terms of Payment: Progressive. No taxes are included. Tax-exempt certificate, if applicable, is required with purchase order.

Shipment:
Drawings will be submitted 4 to 6 weeks after receipt of order.

Shipment will be made from Gardner Denver Nash - Elizabeth, PA in 26 to 28 weeks after final drawing approval if drawing approval is required.

Note: No sizing data or specifications were provided with this request for quotation.

Attachments:

AT2006E Capability Curve and Hogging Curve

Typical Outline and P&ID for Condenser Exhauster Package.

MISCELLANEOUS NOTES

Testing of Vacuum Pumps:

Gardner Denver Nash pumps are manufactured to the highest standards. Every pump must pass a sequence of tests for certification. The design and performance of the vacuum pumps meets the requirements of DIN (ANSI), VDE and PNEUROP. This includes a complete performance test conducted to a Standard procedure that uses dry air at 20°C and water as operating liquid at 15°C.

During the test the following data are measured:

- Suction and Discharge pressures
- Power requirements,
- Operating liquid flow and pressure,
- Relevant temperatures, etc.

A report of the test is provided for free. For a small charge the customer or their representative can witness the test. The standard notice is five (5) days.

Instruments are tested in our assembly shop in accordance with specifications.

Each completed assembly is given a functional run test, when within limits of shop floor capabilities.

Each pump is hydrostatically tested, WELDED SPOOLS ONLY.

Each vacuum pump can be noise tested for an additional charge.

Field Services and Training:

Field services are available in technical and advisory capacity for the installation, start-up, operation and maintenance of Gardner Denver Nash equipment. This service excludes management regulation, arbitration and measurement or purchasers' personnel, agents or contractors actually performing work and excludes responsibility for planning, scheduling or managing the work.

Warranty

Warranty period is two years after shipment of the vacuum pump system.

CI Number: 43168

Title: LIN CW Pump Refurbish and Upgrade

Start Date: 2014/09
Final Cost Date: 2015/03
Function: Generation
Forecast Amount: $417,461

DESCRIPTION:

The Lingan 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.

This project is for refurbishment of one of eight CW pumps at the Lingan Generating Station. Refurbishment of Pump 4A is planned for 2014. Pump 4A is selected based on predictive maintenance data (shaft deflection). The CW pumps are routinely inspected for running shaft misalignment / whipping but developing failures are not always indicated in advance as monitoring of the submersed lower pump shaft is not feasible while the pump is in service.

The refurbishment includes re-surfacing / re-building and coating of worn, corroded and damaged surfaces and components, a new sleeveless, chromed stainless pump shaft, new marine bearings, and verification of all mating fits and alignments. The refurbishment project also includes the installation of an additional bearing on the pump shaft. This bearing will help to maintain alignment and will reduce the movement of the pump shaft if misalignment occurs, protecting related bearings and running surfaces. This bearing modification has been completed on a number of pumps in recent years, and has demonstrated successful operation.

Summary of Related CI's +/- 2 years:
2012 CI 41121 LIN – CW Pump Refurbish $479K

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Maintenance

Why do this project?

Each operating unit is equipped with two 50% duty CW pumps, which supply cooling water to each Unit's condenser and various smaller heat exchangers serving the Unit. Adequate condenser cooling is necessary to ensure sufficient condenser vacuum, which is a major contributor to Unit efficiency. During the cooler months, one CW pump per operating unit is capable of providing adequate condenser cooling. During warmer months, both pumps must operate at the same time to maintain condenser vacuum. If one of a Unit’s two CW pumps is unavailable during the warmer months, the Unit's heat rate and/or ability to generate full load will be restricted. The loss of both pumps would lead to an unplanned unit outage. The availability of these pumps is critical to ensure reliable unit operation. The CW pumps range in age from 18 to 23 years. Over the years, these pumps have developed normal operating wear and component erosion and corrosion due to solid particle and salt water exposure which has been managed through periodic overhauls.

Why do this project now?

The station's CW pumps are currently exhibiting wear profiles that indicate rebuilds are required. Regular maintenance has extended the life of the pumps but does not address the age-related refurbishment work to be completed under this project. Completing this project now will mitigate the risk of an unplanned pump failure, unit de-rating or forced outage.

Why do this project this way?

The most economic and efficient solution is to rebuild deteriorated CW pumps. Condition assessments from recent failed pumps indicate pump refurbishment for normal wear is required every 7 years to reduce potential for shaft misalignment. Repair and balancing facilities are not available on site or locally; the plant proposes to have restorations done at an ISO 9002 repair facility ensuring an effective overhaul. New pumps have an 11 month lead time and cost approximately 50% greater than refurbishment.

CI Number : 43168 - LIN CW Pump Refurbish and Upgrade **Project Number**

Parent CI Number : -

Cost Centre : 305 - 305-Lingan 3&4 Prod.Unit **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
095		095-Thermal & Hydro Contracts AO		31,235	0	31,235
095		095-Thermal Regular Labour AO		8,653	0	8,653
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	45,373	0	45,373
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.	12,500	0	12,500
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	319,700	0	319,700
			Total Cost:	417,461	0	417,461
			Original Cost:	172,439		

43168 LIN CW Pump Refurbish
Summary of Alternatives

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Lingan	**CI Number:**	43168
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Refurbish Pump	6.49%	-2,482,927	1,783,452	1	171.60%	1.0 years
B	Replace Pump	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Refurbishment the CW pump to greatly improve unit reliability and efficiency in the summer / late fall months when both CW pumps are required on a unit to maintain proper condenser function.

Notes/Comments :

Refurbish Pump

Expected life of 7 years. Under a do nothing scenario, the failure mode results in an increasing probability of an extended forced outage due to a failed CW pump with no back-up available. The risk of a CW pump failing or having to be taken out of service for any reason is estimated at 30% in year 1, escalating to 90% percent in year 6 if no action is taken. In the event of a forced outage it is assumed that it will take 21 weeks to enact a repair (extract pump, ship, outsource, ship, install). The cost for an emergency repair is estimated at an additional $50,000 in labor OT and expediated materials and subcontracts.

Replace Pump

The purchase cost of a replacement pump is 50% greater than refurbishment. The lead time for this pump is 11 months. Replacement is not seen as a viable or cost effective option, and is therefore not evaluated further here.

Test 3

Test 4

43168 LIN CW Pump Refurbish
Summary of Sensitivities

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Lingan	**CI Number:**	43168
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Pump	6.49%	-2,482,927	1,783,452	1	171.60%	1.0 years
B	Replace Pump	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Pump	10%	-2,446,251	1,754,242	1	143.60%	1.1 years
B	Replace Pump	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
Change:	**A**		36,676	-29,210	0	-28.01%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Pump	-10%	-2,197,958	1,575,896	1	141.09%	1.2 years
B	Replace Pump	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
Change:	**A**		284,969	-207,555	0	-30.52%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement		PV of Revenue Requirement	PV of Revenue Requirement	PV of Revenue Requirement	Delay?
	Yrs Delay:	1	2	3	
	A	282,398	556,304	873,514	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

43168 LIN CW Pump Refurbish
Avoided Cost Calculations

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Lingan	**CI Number:**	43168
Originator :		**Project No. :**	

Refurbish Pump

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			110,000	117,200		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	30%	40%	30%	40%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	60	60				
Duration (Hours)	3528	3528				
Totals	$271,369	$287,437	$33,000	$46,880	$304,369	$334,317

Total Capital Cost of Alternative **$417,461**

Replace Pump

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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**

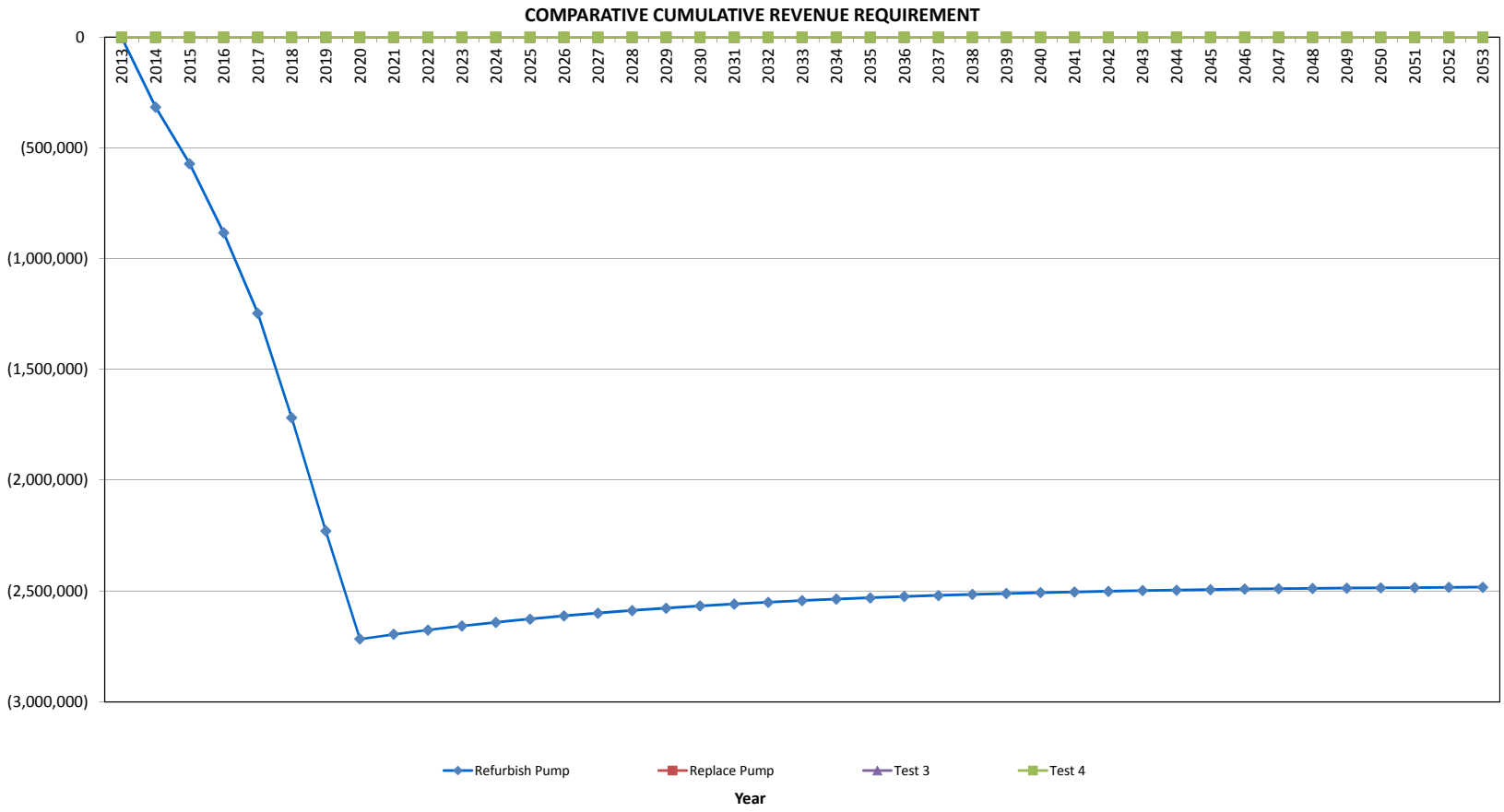
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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**

43168 LIN CW Pump Refurbish
Refurbish Pump

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	304,369.1	(377,573.2)	15,102.9	373,479.2	(73,204.1)	(89,672.5)	(162,876.6)	(152,950.1)	0.94	(152,950.1)
2015	-	-	334,316.9	-	28,997.6	342,643.6	334,316.9	(94,649.0)	239,667.9	211,345.1	0.88	58,395.0
2016	-	-	429,054.0	-	26,677.8	314,274.8	429,054.0	(124,736.6)	304,317.4	251,999.9	0.83	310,394.8
2017	-	-	528,925.3	-	24,543.6	288,175.5	528,925.3	(156,358.3)	372,567.0	289,713.7	0.78	600,108.6
2018	-	-	724,958.2	-	22,580.1	264,164.2	724,958.2	(217,737.2)	507,221.0	370,384.7	0.73	970,493.3
2019	-	-	838,970.3	-	20,773.7	242,073.7	838,970.3	(253,641.0)	585,329.4	401,372.3	0.69	1,371,865.5
2020	-	-	863,680.3	-	19,111.8	221,750.5	863,680.3	(261,816.2)	601,864.0	387,557.9	0.64	1,759,423.5
2021	-	-	-	-	17,582.9	203,053.2	-	5,450.7	5,450.7	3,295.9	0.60	1,762,719.4
2022	-	-	-	-	16,176.2	185,851.6	-	5,014.6	5,014.6	2,847.5	0.57	1,765,566.9
2023	-	-	-	-	14,882.1	170,026.2	-	4,613.5	4,613.5	2,460.0	0.53	1,768,026.9
2024	-	-	-	-	13,691.6	155,466.8	-	4,244.4	4,244.4	2,125.3	0.50	1,770,152.2
2025	-	-	-	-	12,596.2	142,072.2	-	3,904.8	3,904.8	1,836.1	0.47	1,771,988.3
2026	-	-	-	-	11,588.5	129,749.1	-	3,592.4	3,592.4	1,586.3	0.44	1,773,574.5
2027	-	-	-	-	10,661.5	118,411.9	-	3,305.0	3,305.0	1,370.4	0.41	1,774,945.0
2028	-	-	-	-	9,808.5	107,981.6	-	3,040.6	3,040.6	1,184.0	0.39	1,776,128.9
2029	-	-	-	-	9,023.9	98,385.8	-	2,797.4	2,797.4	1,022.9	0.37	1,777,151.8
2030	-	-	-	-	8,301.9	89,557.6	-	2,573.6	2,573.6	883.7	0.34	1,778,035.4
2031	-	-	-	-	7,637.8	81,435.7	-	2,367.7	2,367.7	763.4	0.32	1,778,798.9
2032	-	-	-	-	7,026.8	73,963.6	-	2,178.3	2,178.3	659.6	0.30	1,779,458.4
2033	-	-	-	-	6,464.6	67,089.2	-	2,004.0	2,004.0	569.8	0.28	1,780,028.2
2034	-	-	-	-	5,947.5	60,764.8	-	1,843.7	1,843.7	492.3	0.27	1,780,520.5
2035	-	-	-	-	5,471.7	54,946.3	-	1,696.2	1,696.2	425.3	0.25	1,780,945.8
2036	-	-	-	-	5,033.9	49,593.3	-	1,560.5	1,560.5	367.4	0.24	1,781,313.2
2037	-	-	-	-	4,631.2	44,668.5	-	1,435.7	1,435.7	317.4	0.22	1,781,630.7
2038	-	-	-	-	4,260.7	40,137.7	-	1,320.8	1,320.8	274.2	0.21	1,781,904.9
2039	-	-	-	-	3,919.9	35,969.4	-	1,215.2	1,215.2	236.9	0.19	1,782,141.8
2040	-	-	-	-	3,606.3	32,134.6	-	1,117.9	1,117.9	204.7	0.18	1,782,346.5
2041	-	-	-	-	3,317.8	28,606.5	-	1,028.5	1,028.5	176.8	0.17	1,782,523.3
2042	-	-	-	-	3,052.3	25,360.7	-	946.2	946.2	152.8	0.16	1,782,676.1
2043	-	-	-	-	2,808.2	22,374.5	-	870.5	870.5	132.0	0.15	1,782,808.1
2044	-	-	-	-	2,583.5	19,627.3	-	800.9	800.9	114.0	0.14	1,782,922.1
2045	-	-	-	-	2,376.8	17,099.8	-	736.8	736.8	98.5	0.13	1,783,020.6
2046	-	-	-	-	2,186.7	14,774.5	-	677.9	677.9	85.1	0.13	1,783,105.7
2047	-	-	-	-	2,011.7	12,635.3	-	623.6	623.6	73.5	0.12	1,783,179.2
2048	-	-	-	-	1,850.8	10,667.1	-	573.7	573.7	63.5	0.11	1,783,242.8
2049	-	-	-	-	1,702.7	8,856.5	-	527.8	527.8	54.9	0.10	1,783,297.6
2050	-	-	-	-	1,566.5	7,190.7	-	485.6	485.6	47.4	0.10	1,783,345.0
2051	-	-	-	-	1,441.2	5,658.1	-	446.8	446.8	41.0	0.09	1,783,386.0
2052	-	-	-	-	1,325.9	4,248.2	-	411.0	411.0	35.4	0.09	1,783,421.4
2053	-	-	-	-	1,219.8	2,951.0	-	378.1	378.1	30.6	0.08	1,783,452.0
Total	**-**	**-**	**4,024,274.1**	**(377,573.2)**	**363,545.1**		**3,646,700.9**	**(1,134,826.0)**	**2,511,874.9**	**1,783,452.0**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(500,000)
(1,000,000)
(1,500,000)
(2,000,000)
(2,500,000)
(3,000,000)
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
2053
Refurbish Pump
Replace Pump
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: LINGAN
CI# / FP#: 43168
Title: LIN - CW Pump Refurbish & Upgrade
Execution Year: 2014

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)	pd	5.7	$ 384	$ 2,193		
1.2	Maintenance Trades	pd	62.5	$ 345	$ 21,590		
1.3	Maintenance Trades (removal)	pd	62.5	$ 345	$ 21,590		
1.4				$ -	$ -		
				Sub-Total	$ 45,373		41121
2	**012 Materials**						
2.1	Piping Replacement	lot	1	$ 5,000.00	$ 5,000		
2.2	Miscellaneous Consumables	lot	1	$ 7,500.00	$ 7,500		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 12,500		41121
3	**013 Power Production Contracts**						
3.1	CW Pump Refurbishment	lot	1	[redacted]		Cost Support 1	
3.2	Contingency on Refurbishment	%	[redacted]				
3.3	Machining and Mechanical work	lot	1	$ 26,000.00	$ 26,000		
3.4	Transportation and Loading	lot	1	$ 20,000.00	$ 20,000		
				Sub-Total	$ 319,700		41121
4	**095 Administrative Overhead**						
4.1	Contracts AO	lot	1	$ 31,234.69	$ 31,235		
4.2	Regular Labour AO	lot	1	$ 8,652.67	$ 8,653		
4.3							
				Sub-Total	$ 39,887		
				SUB-TOTAL (no AO, AFUDC)	$ 377,573		
				TOTAL (AO, AFUDC included)	$ 417,461		
5	**Original Cost**						
5.1					$ 172,439		

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
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

SULZER

SPCAN Toronto SC
1851 Albion Road
Toronto ON M9W 5S8
Phone: 416-675-2470
FAX:416-675-2174

Equipment Location
NOVA SCOTIA POWER INC
LINGHAM GENERATING STATION
2599 HICHY AVENUE LINGAN
NOVA SCOTIA NS B1H 5E6

Customer RFQ # :TBD
Customer Contact: MR. BILL DELANY
Phone: 902-862-6422 EXT:3224
Fax:
Email: bill.delaney@nspower.ca

Sulzer Quote#:Q100113311
Project Manager: David Veselinovski
Phone: [redacted]
Fax: [redacted]
Email: [redacted]

Customer PO#: TBD

Sulzer Sales Order#: 100113311

Subject: Repair of your model 48SP-1STG

Serial No.:08JK8-3 Equipment Nr.100194427

Dear Bill,

Thank you for the opportunity to provide our services in the repair of your Pump: **48SP-1STG.**

The attached work scope and proposal is based on the results of a complete "As Found" inspection applied to this unit upon its arrival at Sulzer's. For your convenience, we have divided this proposal to include the following sections; we believe that you will find this format to be helpful in reviewing our proposal.

Section No. 1 Detailed Recondition Requirements
Section No. 2 Pricing Summary and Commercial Terms

If you have any questions or need any additional information regarding this proposal, please feel free to contact us at any time. We look forward to your advisements.

Delivery is 16 to1 8 weeks from receipt of approval to proceed.

SULZER

OPTION 1

Section 1:

Detailed Recondition Requirements

SULZER

Date:	Nov-05-2012	Manufacturer:	
Job#	100113311	Size & Type:	48SP-1STG.
Customer:	NOVA SCOTIA POWER INC.	Serial NO:	08JK8-3

As Found

- Suction Liner is worn from the Impeller rubbing against it once the bowl and retainer bearings failed.
- Impeller is worn from coming into contact with the suction liner.
  Impeller integrity will be verified by use of LPI.
- Inter Bowl ring is worn and scored oversized and the bowl bearings (marine style) are worn.
- Line Shaft Bearing was severely worn, whipping of the shaft once the bearing was gone, resulted in the retainer being worn by the shaft.
- Pump Shaft is badly worn close to the coupling.

Job Scope

- The suction liner will be skim machined to remove scoring and ensure proper contour with the Impeller.
- The impeller is worn on the vane tips and will be built up with weld and re machined.
  Hand polished, under filed and balanced to G 2.5 as an assembly with the shaft.
  The Impeller ring will be replaced and machine to proper clearances with the bowl ring.
- The bowl will be modified to accept a new additional bearing at the top side and have the bowl ring machine to remove scoring and re-qualify the concentricity.
- The shaft retainer will be machined to achieve proper alignment and the bore will be sleeved in order to accept standard dual bearing suitable for product flush operation.
- The unit will be full sandblasted inside and out and painted with a Devoe (2 part epoxy) suitable for potable water and your sea water service.
- The bowl cavities will be repaired with replacement liner and fitted into bowl (316 s.s.material) and belzona coat internal passages
- All spigots / mating fits of columns, retainer, bowl and suction Bell will be prequalified.
- Manufacture new shaft from 304SS. Manufacture shaft will be a sleeveless design and chromed on bearing areas.
- Supply all new 316SS hardware and O rings, 2 new flange type marine bearings with naval bronze backing and 2 new straight marine bearings with naval bronze backing
- Supply new coupling 304 s.s. c/w wedges.
- Assembly of the **48SP-1STG.**
- Return pump to customer

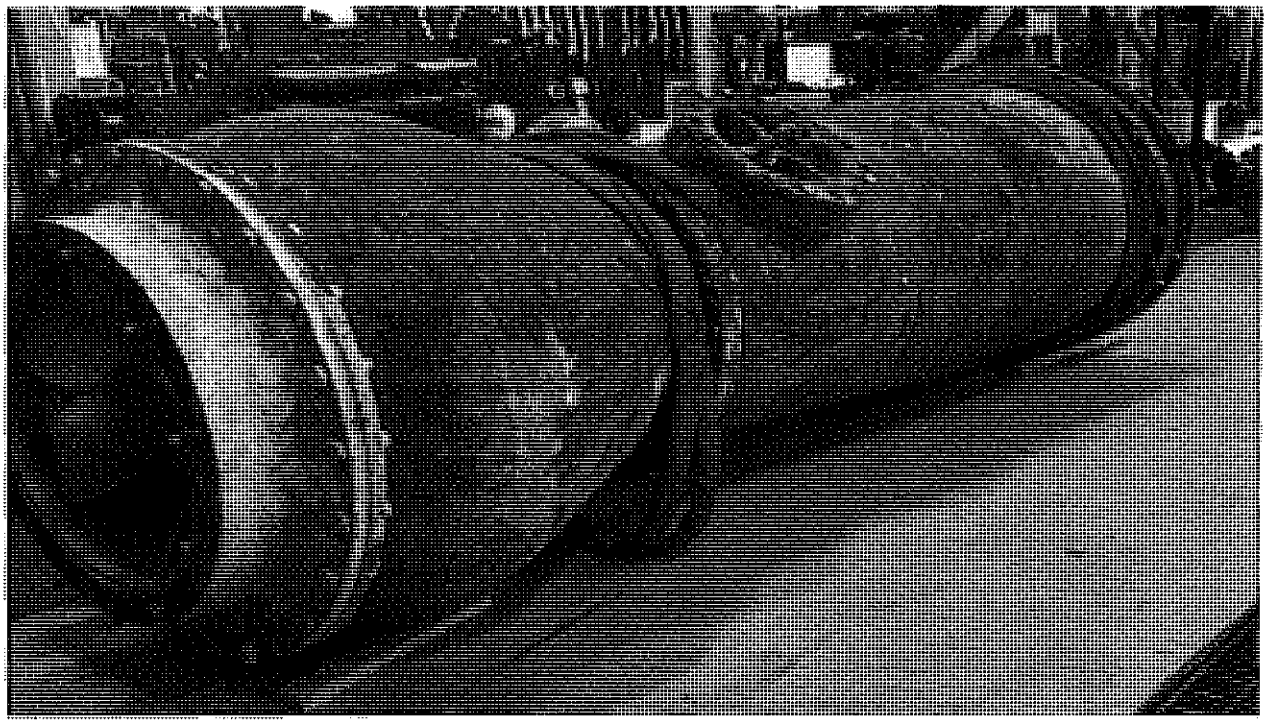
TOTAL RECONDITIONING: $[redacted]

SULZER

Section 2:

Pricing Summary:	
Total Cost for Recondition Requirements:	[redacted]
Total Freight:	$0.00 CAD
Expedite Fee:	$0.00 CAD
Total Repair Cost:	[redacted]

Unless otherwise agreed in writing, our delivery is subject to our General Terms and Conditions of Supply which can be found on www.sulzerpumps.com if not attached hereto. At your request, we will send you a copy thereof.



HITACHI CIRC.PUMP MODEL 48SP-1STG

SULZER



Re-machine bearing pocket to receive dual bearing

Machine bowl to accept additional bearing

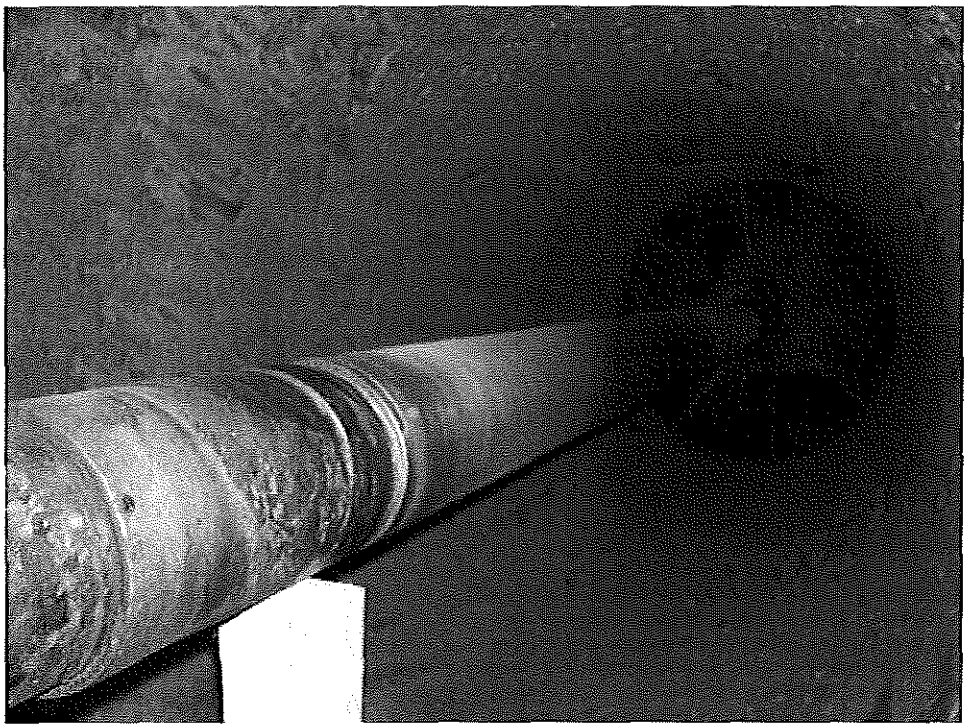


SULZER

Replace Bowl Ring



Install Liner in 316SS Material



Replace Shaft 304SS Material

CI Number: 44731

Title: TRE5 Coal System Upgrades

Start Date: 2014/04
Final Cost Date: 2015/03
Function: Generation
Forecast Amount: $413,416

DESCRIPTION:

The purpose of this project is to improve the safety of the Trenton Unit 5 (TRE5) coal delivery system, in particular on the 5D conveyor and transfer points. The scope of the project includes:

- Replacement of belt scrapers and skirt boards, which will reduce accumulations of dust and spilled coal build-up in the conveying processes. This will improve performance, improve equipment life, reduce maintenance and housekeeping requirements and mitigate the risks associated with combustible dust accumulation.
- Replacement of corroded fire suppression piping.
- Replacement of deficient electrical components including lighting fixtures and junction boxes.
- Installation of 'grizzly' bars on hoppers.

Summary of Related CIs +/- 2 years:
2013 CI 44733 TRE6 Coal System Upgrades ($166K)

JUSTIFICATION:

Justification Criteria: Health & Safety

Sub Criteria: Maintenance

Why do this project?

The TRE5 coal delivery system was commissioned in 1969. The system is designed to deliver 200 tonnes/hour, and currently operates anywhere between 150 and 180 tonnes/hour at full load. Normal wear and tear on various components over the years, combined with a complicated transfer point design, generates a high level of everyday housekeeping to maintain a safe, clean environment. Excessive coal dust is an explosion hazard, and is minimized through the proper use of belt scrapers and skirt boards at the belt transfer areas. This equipment requires replacement as it has worn past the point of repair. Corrosion is also evident in fire suppression piping, which will be replaced as required. As part of this effort, electrical deficiencies will also be addressed.

Why do this project now?

The project is planned for execution during the TRE5 planned outage in 2014 to minimize future safety risk in the coal delivery system. Future replacement energy costs associated with an unplanned outage will be avoided by completing this project. In the interim, housekeeping and inspection efforts have been increased to address short term risk.

Why do this project this way?

The modifications proposed would bring this conveyor system in line with normal industry practice. This project will focus on items/components which present the highest risk to safety and reliability within the coal delivery system.

CI Number : 44731 - TRE5 Coal System Upgrades **Project Number**

Parent CI Number : -

Cost Centre : 340 - 340-Trenton Unit 5 Capital **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		5,223	0	5,223
095		095-Thermal Regular Labour AO		15,662	0	15,662
095		095-Thermal & Hydro Contracts AO		6,888	0	6,888
095		095-Thermal Overtime Labour AO		1,617	0	1,617
095		095-Thermal Term Labour AO		2,264	0	2,264
001	018	001 - THERMAL Regular Labour	018 - SGP - Fuel Hndlg.Coal	82,131	0	82,131
002	018	002 - THERMAL Overtime Labour	018 - SGP - Fuel Hndlg.Coal	16,957	0	16,957
004	018	004 - THERMAL Term Labour	018 - SGP - Fuel Hndlg.Coal	11,874	0	11,874
012	018	012 - Materials	018 - SGP - Fuel Hndlg.Coal	179,000	0	179,000
013	018	013 - POWER PRODUCTION Contracts	018 - SGP - Fuel Hndlg.Coal	70,500	0	70,500
028	085	028 - Consulting	085 Design	12,000	0	12,000
011	087	011 - Travel Expense	087 Field Super.& Ops.	100	0	100
021	087	021 - Telephones	087 Field Super.& Ops.	100	0	100
028	087	028 - Consulting	087 Field Super.& Ops.	9,000	0	9,000
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	100	0	100
			Total Cost:	413,416	0	413,416
			Original Cost:	67,786		

Capital Project Detailed Estimate

Location: Trenton Generating Station
CI# / FP#: 44731
Title: TRE5 Coal System Upgrades
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Mechanic	pd	100.0	$ 345	$ 34,544		
1.2	Welder	pd	52.5	$ 345	$ 18,136		
1.3	Electrician	pd	60.0	$ 339	$ 20,357		
1.4	Utility	pd	40.0	$ 227	$ 9,094		
1.5					$ -		
				Sub-Total	$ 82,131		
2	**002 Overtime Labour**						
2.1	Mechanic	pd	10.0	$ 691	$ 6,909		
2.2	Welder	pd	7.0	$ 691	$ 4,836		
2.3	Electrician	pd	5.0	$ 679	$ 3,393		
2.4	Utility	pd	4.0	$ 455	$ 1,819		
2.5					$ -		
				Sub-Total	$ 16,957		
3	**004 Term Labour**						
3.1	Mechanic	pd	15.0	$ 345	$ 5,182		
3.2	Welder	pd	7.0	$ 345	$ 2,418		
3.3	Electrician	pd	10.0	$ 339	$ 3,393		
3.4	Utility	pd	3.9	$ 227	$ 881		
				Sub-Total	$ 11,874		
4	**012 Materials**						
4.1	Belt Cleaner	each	2	$ 2,500.00	$ 5,000		
4.2	Conveyor Skirtboards	ft	300	$ 100.00	$ 30,000		
4.3	Reclaim Feeder Skirtboards	ft	60	$ 100.00	$ 6,000		
4.4	Reclaim Hopper Gates	each	3	$ 6,000.00	$ 18,000		
4.5	Electrical Materials	lot	1	$ 30,000.00	$ 30,000		
4.6	Reclaim Hopper Grizzly	each	2	$ 40,000.00	$ 80,000		
4.7	Misc Materials	lot	1	$ 10,000.00	$ 10,000		
				Sub-Total	$ 179,000		
5	**013 Contracts/Contract Labour**						
5.1	Crane Rental	lot	1	[redacted]			
5.2	Sprinkler Pipe Replacements	lot	1	[redacted]		Cost Support 1, 50% of cost assumed as quotation includes both TRE5 and TRE6 work	
5.3					$ -		
5.4					$ -		
5.5					$ -		
				Sub-Total	$ 70,500		
6	**028 Consultants**						
6.1	Design Services	lot	1	$ 12,000.00	$ 12,000		
6.2	Project Management	hr	120	$ 75.00	$ 9,000		
6.3					$ -		
				Sub-Total	$ 21,000		
7	**Travel/Meals/Phones**						
7.1	Travel	lot	1	$ 100.00	$ 100		
7.2	Meals	lot	1	$ 100.00	$ 100		
7.3	Phone	lot	1	$ 100.00	$ 100		
				Sub-Total	$ 300		
8	**094 Interest Capitalized**						
8.1	Interest Capitalized	lot	1	$ 5,223.44	$ 5,223		
				Sub-Total	$ 5,223		
9	**095 Administrative Overhead**						
9.1	Regular	lot	1	$ 15,662.35	$ 15,662		
9.2	OT	lot	1	$ 1,616.82	$ 1,617		
9.3	Term	lot	1	$ 2,264.28	$ 2,264		
9.4	Contracts	lot	1	$ 6,887.86	$ 6,888		
				Sub-Total	$ 26,431		
				SUB-TOTAL (no AO, AFUDC)	$ 381,761		
				TOTAL (AO, AFUDC included)	$ 413,416		
10	**Original Cost**						
10.1					$ 67,786		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

Troy
Life & Fire Safety Ltd.

September 16, 2013

Nova Scotia Power
Trenton, Nova Scotia
Phone (902) 872-1957

Attention: Jason Tait / Dion Antle

Re: Sprinkler pipe replacement
Conveyors A and A-1, transfer house building #6, Crusher Building Unit 5, sampler building and lower level of Track Hopper House.
Troy Quotation # T-1355 Rev 1

Troy Life & Fire Safety Ltd. is pleased to submit for your review our quotation for the above referenced project. Our price is based upon our site visit of September 4, 2013. It should be noted while reviewing the system in question we found the control room and all high piping of the track hopper house appeared to be fine from the 4" flange located in the conveyor. As well one of the 2 ½" looped areas around the lower hopper level appears to have been replaced and good condition.

Total Price to complete this work, excluding all applicable taxes: $[redacted]

Scope of Work (Goods or Services included in this price):

- Starting from above the dry valve located in the sprinkler room.
- Design and Engineering as required
- All installation labour to be performed by CASA qualified sprinkler fitters
- All labor based on work being done after 4:00 PM Monday to Friday
- Removal of existing piping
- All and material to make for a complete installation
- Site preparation and clean up throughout the construction process
- One year warranty on workmanship & materials from date of substantial completion.
- Painting of pipe.

The following Items are excluded in our quotation:

- Any permits and all permits pertaining to the prescribed work
- All electrical work including Fire Alarm and or Sprinkler Devices
- Coring & Drilling
- Fire-stopping and smoke-sealing
- Adequate water supply
- Fire Extinguishers
- Fire Watch
- Removal of scrapped materials from site

Pricing on this quotation has been prepared based on standard sales and payment terms of NET 30 days from date of invoice, on approved credit. Troy Life & Fire Safety Ltd., will not agree to a contract that contains "paid when paid"/"paid if paid" payment terms without commercially reasonable limitations that are mutually acceptable to both parties. The foregoing is a condition of a provision of Services at the price quoted.

This quotation for delivery of Goods or Services described herein is subject to Troy Life & Fire Safety Ltd.'s General Terms and Conditions attached hereto and pricing shall remain in effect for a period of 30 days unless

Fire Alarm • Sprinkler • Fire Pumps • Hydrants • Foam Systems • Special Hazards • Standpipe • Fire Hose • 24 hr. Service
Security • Communications • Signaling Devices • Exit Signs • Nurse Call • Green Solutions www.troylfs.com
CASA MEMBER MEMBER

Troy
Life & Fire Safety Ltd.

extended by formal request. To proceed with this work, please complete the "Customer Authorization" section at the bottom of this document and return to me at your earliest convenience.

Thank you for the opportunity to provide this proposal. Should you require any clarification or additional information, please contact me at your convenience.

Respectfully Yours,

Ted Martin
Special Hazards Project Manager
Troy Life & Fire Safety Ltd.
www.troylfs.com

Fire Alarm • Sprinkler • Fire Pumps • Hydrants • Foam Systems • Special Hazards • Standpipe • Fire Hose • 24 hr. Service
Security • Communications • Signaling Devices • Exit Signs • Nurse Call • Green Solutions www.troylfs.com
CASA MEMBER

Troy
Life & Fire Safety Ltd.

General Terms and Conditions.

For the purposes of construction projects, items not specifically addressed within Troy Life & Fire Safety Ltd., General Terms and Conditions and where Seller is providing Goods and Services as subcontract work, such work shall be governed by CCA 1 Stipulated Price Subcontract in its most recent form. Where Seller is providing Goods and Services direct with a Customer who is the owner of the project, such items not specifically addressed herein shall be governed by CCDC 2 Stipulated Price Contract in its most recent form.

The Customer and Troy Life & Fire Safety Ltd. ("Seller") have entered into an binding quotation for the provision of the "Goods" or "Services" described therein and is expressly conditioned on Customer's assent to the following General Terms and Conditions that will take priority over and exclude any terms and conditions proposed by Customer dealing with the same or similar subject matter, including but not limited to any pre-printed terms and conditions on the Customer's purchase order.

Sales and payment terms. Terms are net 30 days from date of invoice, unless mutually agreed otherwise in writing. If payment is not received when due, Customer will be responsible for all collection and legal fees and Seller shall be entitled to charge interest at a rate of the lesser of **[eighteen percent (18%)]** per annum, and the highest rate permissible by applicable law. Customer may not retain payment on account of any claim that it may have against Seller or offset any such claim against the invoiced price. Nothing shall serve to void Seller's construction lien and/or bonding claim rights in accordance with provincial law. If Customer has an account in arrears with Seller, Seller reserves the right to withhold documentation including verification reports and/or inspection certificates until such time account is current.

Delivery, title, and risk of loss. All shipments of Goods will be FOB shipping point. Delivery, shipment, and installation dates are estimated dates only, and unless otherwise specified are figured from date of receipt of complete technical data and approved drawings as such may be necessary. Seller will ship via its preferred carrier. Seller reserves the right to make partial shipments unless specifically stated otherwise on Customer's purchase order. Freight charges will be prepaid by Seller and invoiced to Customer unless mutually agreed otherwise in writing. Customer must promptly file claims for damaged items with the freight carrier. Seller will determine the point of shipment and Goods may be shipped from multiple locations. All Services will be FOB destination.

Force Majeure. Seller shall not be liable, directly or indirectly, for non-delivery, delays in performance, or any other failure to comply with our obligations under these terms and conditions if same is due to labour difficulties, inability to secure transportation, shortages, lockouts, strikes or stoppages of any sort, fires, floods, accidents (in manufacture or otherwise), failure or delay in obtaining materials or manufacturing facilities, acts of government, weather, embargoes, civil unrest, terrorism, war, invasion, riots, acts (or omissions) of Customer or Customer's suppliers or agents including (but not limited to) Customer's failure to promptly supply all necessary documentation or acts of God or any other cause beyond our reasonable control, and, when such delays arise, all of our obligations and estimated dates shall be extended for a period equal to the time lost by reason of delay, plus such additional time as may be reasonably necessary to overcome the effect of the delay. Seller will be entitled to an equitable price and performance adjustment.

Cancellation and Return of Goods. Goods may be cancelled only with Seller's written consent and upon payment of reasonable and proper cancellation charges. Goods may be returned only when specifically authorized by Seller in writing. Customer may be required to pay reasonable charges including cost of placing returned Goods in saleable condition, sales expenses further incurred, a restocking charge and transportation costs (incoming and outgoing) which Seller pays.

Governing law. This Agreement shall be governed by the laws of the jurisdiction in which the Goods and Services are provided and performed.

WARRANTY. SELLER WARRANTS TO CUSTOMER THAT (I) THE GOODS WILL BE SHIPPED FREE FROM DEFECTS IN MATERIAL, WORKMANSHIP AND TITLE AND THAT(II) THE SERVICES WILL BE PERFORMED IN A COMPETENT AND REASONABLE MANNER IN ACCORDANCE WITH ANY MUTUALLY DETERMINED SPECIFICATIONS IN WRITING. ALL GOODS (INCLUDING INCIDENTAL MATERIALS AND CONSUMABLES USED IN THE SERVICES AND SOFTWARE) WILL CARRY ONLY THE WARRANTY OF THEIR ORIGINAL MANUFACTURER OR SOFTWARE PROVIDER. Unless otherwise stated in the binding quotation, the warranty period for Goods and Services is one year from substantial completion of Sellers work. If Goods or Services do not meet the above warranties, Customer will promptly notify Seller in writing within the warranty period. Seller will thereupon (i) at Seller's option, repair or replace the defective Goods, or (ii) re-perform or correct the defective Services. Where a failure cannot be corrected by Seller's reasonable efforts, the parties will negotiate an equitable adjustment in price. Any repair, replacement, modification or reperformance by Seller hereunder will not extend the applicable warranty period. Customer will bear the costs of access (including removal and replacement of systems, structures or other parts of Customer's facility), de-installation, decontamination, re-installation and transportation of Goods to Seller and back to Customer. These warranties and remedies are conditioned upon (a) the proper storage, installation, operation, and maintenance of the Goods and conformance with the proper operation instruction manuals provided by Seller or its suppliers or subcontractors, (b) Customer keeping proper records of operation and maintenance during the warranty period and providing Seller access to those records, and (c) modification or repair of the Goods only as authorized by Seller in writing. Seller does not warrant the Goods or any repaired or replacement parts against normal wear and tear or damage caused by misuse, accident, or use against the advice of Seller. Any modification or repair of any of the Goods not authorized by Seller including any third party repair or attempted repair will render the warranty null and void. This clause provides the exclusive remedies for all claims based on breach or a failure of or defect in Goods and Services, whether the breach, failure or defect arises before or during the applicable warranty period and whether a claim, however described, is based on contract, warranty, indemnity, tort/extracontractual liability (including negligence), strict liability or otherwise. THE WARRANTIES PROVIDED IN THIS CLAUSE ARE

Troy
Life & Fire Safety Ltd.

EXCLUSIVE AND IN LIEU OF, AND SELLER EXPRESSLY EXCLUDES ANY AND ALL OTHER WARRANTIES, GUARANTEES, OBLIGATIONS, LIABILITIES, REPRESENTATIONS (INNOCENT OR NEGLIGENT) OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABLE QUALITY, FITNESS FOR A PARTICULAR PURPOSE, DURABILITY, SUITABILITY, QUALITY OR CONDITION OR ANY CONDITION OR WARRANTY ARISING BY STATUTE OR OTHERWISE IN LAW OR IN EQUITY OR FROM A COURSE OF DEALING OR USAGE OF TRADE.

Limitation of Liability. Seller is not an insurer, and payments for Seller's Goods and Services are based solely on the value of the Goods and Services provided and are unrelated to the value of the Customer's premises, its contents or occupants. SELLER SHALL NOT BE LIABLE TO CUSTOMER OR ANY PERSON WHETHER IN CONTRACT, TORT, EQUITY OR OTHERWISE, OR UNDER ANY STATUTE OR REGULATION, FOR ANY COST OR EXPENSE, NOR FOR ANY CLAIMS ARISING OUT OF THE SERVICES PROVIDED BY SELLER, THE SUPPLY OR USE OF THE GOODS FURNISHED BY SELLER, NOR FOR ANY PENALTY, EXPENSE, LOSS OR DAMAGE OF ANY KIND OR NATURE WHATSOEVER IN ANY MANNER RESULTING FROM ANY BREACH OR FAILURE IN PERFORMANCE BY SELLER HEREUNDER, WHETHER OR NOT FROM NEGLIGENCE, FUNDAMENTAL BREACH OR BREACH OF A FUNDAMENTAL TERM OTHER THAN FOR CUSTOMER"S ACTUAL DIRECT DAMAGES WHICH IN NO EVENT SHALL EXCEED THE INVOICE PRICE PAID TO SELLER FOR THE GOODS THAT ARE THE SUBJECT OF CUSTOMER"S CLAIM, OR THE PRICE PAID DURING THE YEAR IN WHICH THE SERVICES WERE PERFORMED. IN NO EVENT AND UNDER NO CIRCUMSTANCES SHALL SELLER BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT, PUNITIVE, CONSEQUENTIAL (INCLUDING LOSS OF PROFITS) OR OTHER SIMILAR DAMAGES, REGARDLESS OF THE LEGAL THEORY OF ANY CLAIM, EVEN IF ADVISED OF THE POSSIBILITY THEREOF. The foregoing limitation of liability is a condition of sale of the Goods and provision of Services at the price quoted and shall apply notwithstanding any defect in or failure of, including total failure of any Goods. If Customer is supplying the Goods to a third party, Customer will require the third party to agree to be bound by this clause and will indemnify, defend and hold Seller harmless from and against any and all claims made by the third party in excess of the limitations and exclusions of this clause. Seller will not be liable for any advice or assistance that is not required under the Agreement.

Hazardous Substances. Customer shall be responsible for all costs, expenses, damages, fines, penalties, claims and liabilities associated with or incurred in connection with any hazardous materials or substances, including but not limited to asbestos, upon, beneath, about or inside customer's equipment , facility or property. Title to, ownership of, and legal responsibility and liability for any and all such hazardous materials or substances, shall at all times remain with Customer. Customer shall be responsible for the removal, handling and disposal of all hazardous materials or substances in accordance with all applicable governmental regulations. Customer shall defend, indemnify, reimburse and hold harmless Seller and its officers, directors, agents, and employees from and against any and all claims, damages, costs, expenses, liabilities, actions, suits, fines, and penalties (including without limitation, attorneys' fees and expenses) suffered or incurred by any of such indemnified parties, based upon arising out of or in any way relating to exposure to, handling of, or disposal of any hazardous materials or substances in connection with the Services performed hereunder. Seller shall have the right to suspend its work with no penalty to Seller until such hazardous materials or substances are removed. The time for completion of the work shall be extended to the extent caused by the suspension and the Service price equitably adjusted.

Entire Agreement. This Agreement and provisions of the binding quotation made in respect of the Goods and Services represents the entire agreement between the parties for the purchase of the Goods or Services. Notwithstanding any negotiations or discussions or any provision to the contrary in any purchase order or other document, all terms and conditions in any document which modify, add to or are at variance with the provisions in this Agreement will be binding only if Seller expressly accepts them in writing.

Language. It has been agreed between the parties hereto that this Agreement and all related documents thereto be drawn in the English language. Il a été convenu entre les parties aux présentes que ce Contrat ainsi que tous les documents y afférents soient rédigés en langue anglaise.

Miscellaneous. This Agreement cannot be waived, varied, modified or amended in any manner (including subsequent conduct between the parties) unless agreed upon in writing by both parties. Seller reserves the right to terminate this Agreement for Customer's failure to pay when due or Customer's insolvency. If any provision of this Agreement is found by a court of competent jurisdiction to be illegal, invalid or unenforceable, that provision shall be severed from this Agreement to the extent of its illegality, invalidity or unenforceability and the remaining provisions of this Agreement shall continue in full force and effect.

In consideration of mutual agreement, Troy Life & Fire Safety Ltd. and the Customer agree that the quotation for services and/or type of equipment coverage to be supplied or performed herein at the above-mentioned project location(s) will be provided in accordance with the terms of this quotation.

Authorization

Name of Customer: ***PO Number:***

Name and Title of Person Signing:

Signature: ***Date:***

Fire Alarm • Sprinkler • Fire Pumps • Hydrants • Foam Systems • Special Hazards • Standpipe • Fire Hose • 24 hr. Service
Security • Communications • Signaling Devices • Exit Signs • Nurse Call • Green Solutions www.troylfs.com
CASA MEMBER

CI Number: 43424

Title: TRE5 Analytical Panel

Start Date: 2014/06
Final Cost Date: 2015/02
Function: Generation
Forecast Amount: $393,825

DESCRIPTION:

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.

A 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 is critical for corrosion prevention and is highly 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.

Summary of Related CIs +/- 2 years: None

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 to an analytical panel for feedwater sampling on Unit 5.

While feedwater analysis does not directly cause outage events, it contributes to the promptness and the ability to respond to issues when they do occur.

Currently, there is insufficient cooling water supply to cool boiler, steam and feedwater samples to the standard water sample temperature of 25C. Elevated sample temperatures can affect the accuracy of sample testing, and may result in damage to analytical sensors. The dissolved oxygen meters are currently located in a hot environment and do not function properly. There are currently no sodium analyzers on the steam or extraction pump samples. These samples must also be cooled properly. Sodium is a core parameter as recommended by the Electric Power Research Institute (EPRI). Upgrading the analytical panel will ensure standard flow controls, and adequate cooling for accurate sample analysis.

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?

Installation of an analytical panel and sample cooling system is an industry standard, effective 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** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		6,133	0	6,133
095		095-Thermal Regular Labour AO		5,116	0	5,116
001	011	001 - THERMAL Regular Labour	011 - SGP - Plant Control and Inst	21,344	0	21,344
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	[redacted]	0	[redacted]
015	011	015 - Frt, Post & Delivery	011 - SGP - Plant Control and Inst	[redacted]	0	[redacted]
001	085	001 - THERMAL Regular Labour	085 Design	2,193	0	2,193
001	087	001 - THERMAL Regular Labour	087 Field Super.& Ops.	3,290	0	3,290
011	087	011 - Travel Expense	087 Field Super.& Ops.	1,000	0	1,000
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:	393,825	0	393,825
			Original Cost:	30,000		

TRE5 Analytical Panel
Summary of Alternatives

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Trenton Generating Station	**CI Number:**	43424
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Analytical Panel Installation	6.49%	-1,903,693	1,418,615	1	73.25%	1.8 years
B	Test 2	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Based on favorable economic analysis, it is recommended to fund installation of a new analytical panel on Unit 5.

Notes/Comments :

Analytical Panel Installation

This analysis compared the cost of installing an analytical panel on Trenton Unit 5 versus the avoided cost of returning the unit to service 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. This type of failure would bring the unit down unless a significant capital investment were made to return it to service.

Test 2

Test 3

Test 4

TRE5 Analytical Panel
Summary of Sensitivities

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Trenton Generating Station	**CI Number:**	43424
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Analytical Panel Installation	6.49%	-1,903,693	1,418,615	1	73.25%	1.8 years
B	Test 2	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Analytical Panel Installation	10%	-1,865,407	1,388,442	1	63.84%	2.0 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
	Change: **A**		38,286	-30,173	0	-9.41%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Analytical Panel Installation	-10%	-1,675,037	1,246,580	1	62.95%	2.0 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
	Change: **A**		228,655	-172,035	0	-10.30%	0.3 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement		PV of Revenue Requirement	PV of Revenue Requirement	PV of Revenue Requirement	Delay?
	Yrs Delay:	1	2	3	
	A	184,293	380,864	555,384	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

TRE5 Analytical Panel
Avoided Cost Calculations

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Trenton Generating Station	**CI Number:**	43424
Originator :		**Project No. :**	

Analytical Panel Installation

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	3%	3%	3%	3%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	155	155				
Duration (Hours)	8760	8760				
Totals	$198,631	$243,537	$0	$0	$198,631	$243,537
Total Capital Cost of Alternative						$393,825

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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

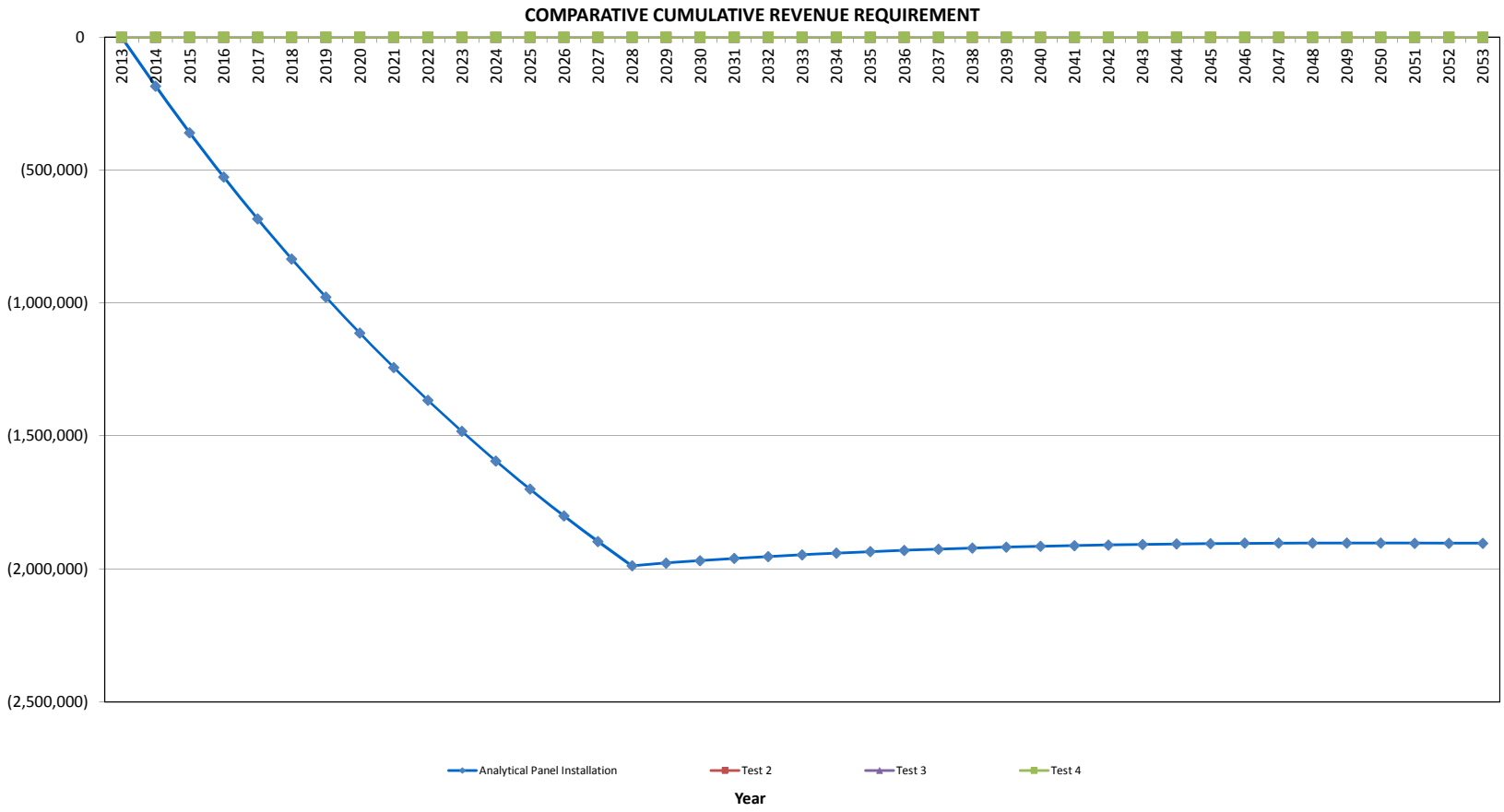
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity 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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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
Analytical Panel Installation

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	198,631.2	(388,709.6)	15,303.1	368,685.9	(190,078.4)	(56,831.7)	(246,910.1)	(231,862.2)	0.94	(231,862.2)
2015	-	-	243,536.8	-	29,381.9	339,068.2	243,536.8	(66,388.0)	177,148.8	156,214.2	0.88	(75,648.0)
2016	-	-	248,407.5	-	27,031.4	311,820.0	248,407.5	(68,626.6)	179,780.9	148,873.4	0.83	73,225.4
2017	-	-	253,375.7	-	24,868.9	286,751.6	253,375.7	(70,837.1)	182,538.5	141,944.7	0.78	215,170.1
2018	-	-	258,443.2	-	22,879.3	263,688.7	258,443.2	(73,024.8)	185,418.4	135,396.9	0.73	350,567.0
2019	-	-	263,612.0	-	21,049.0	242,470.8	263,612.0	(75,194.5)	188,417.5	129,201.7	0.69	479,768.7
2020	-	-	268,884.3	-	19,365.1	222,950.4	268,884.3	(77,351.0)	191,533.3	123,333.9	0.64	603,102.6
2021	-	-	274,262.0	-	17,815.9	204,991.6	274,262.0	(79,498.3)	194,763.7	117,770.7	0.60	720,873.3
2022	-	-	279,747.2	-	16,390.6	188,469.5	279,747.2	(81,640.5)	198,106.7	112,491.5	0.57	833,364.8
2023	-	-	285,342.1	-	15,079.4	173,269.1	285,342.1	(83,781.5)	201,560.7	107,477.5	0.53	940,842.3
2024	-	-	291,049.0	-	13,873.0	159,284.8	291,049.0	(85,924.6)	205,124.4	102,711.8	0.50	1,043,554.1
2025	-	-	296,870.0	-	12,763.2	146,419.3	296,870.0	(88,073.1)	208,796.9	98,178.9	0.47	1,141,733.0
2026	-	-	302,807.4	-	11,742.1	134,582.9	302,807.4	(90,230.2)	212,577.1	93,864.6	0.44	1,235,597.6
2027	-	-	308,863.5	-	10,802.7	123,693.5	308,863.5	(92,398.8)	216,464.7	89,756.0	0.41	1,325,353.5
2028	-	-	315,040.8	-	9,938.5	113,675.3	315,040.8	(94,581.7)	220,459.1	85,841.2	0.39	1,411,194.7
2029	-	-	-	-	9,143.4	104,458.5	-	2,834.5	2,834.5	1,036.4	0.37	1,412,231.1
2030	-	-	-	-	8,412.0	95,979.0	-	2,607.7	2,607.7	895.4	0.34	1,413,126.5
2031	-	-	-	-	7,739.0	88,177.9	-	2,399.1	2,399.1	773.5	0.32	1,413,900.0
2032	-	-	-	-	7,119.9	81,000.9	-	2,207.2	2,207.2	668.3	0.30	1,414,568.3
2033	-	-	-	-	6,550.3	74,398.0	-	2,030.6	2,030.6	577.4	0.28	1,415,145.7
2034	-	-	-	-	6,026.3	68,323.4	-	1,868.1	1,868.1	498.8	0.27	1,415,644.5
2035	-	-	-	-	5,544.2	62,734.8	-	1,718.7	1,718.7	430.9	0.25	1,416,075.4
2036	-	-	-	-	5,100.6	57,593.2	-	1,581.2	1,581.2	372.3	0.24	1,416,447.7
2037	-	-	-	-	4,692.6	52,863.0	-	1,454.7	1,454.7	321.6	0.22	1,416,769.4
2038	-	-	-	-	4,317.2	48,511.2	-	1,338.3	1,338.3	277.9	0.21	1,417,047.2
2039	-	-	-	-	3,971.8	44,507.5	-	1,231.3	1,231.3	240.1	0.19	1,417,287.3
2040	-	-	-	-	3,654.1	40,824.1	-	1,132.8	1,132.8	207.4	0.18	1,417,494.7
2041	-	-	-	-	3,361.7	37,435.4	-	1,042.1	1,042.1	179.2	0.17	1,417,673.9
2042	-	-	-	-	3,092.8	34,317.8	-	958.8	958.8	154.8	0.16	1,417,828.6
2043	-	-	-	-	2,845.4	31,449.6	-	882.1	882.1	133.7	0.15	1,417,962.4
2044	-	-	-	-	2,617.7	28,810.8	-	811.5	811.5	115.5	0.14	1,418,077.9
2045	-	-	-	-	2,408.3	26,383.2	-	746.6	746.6	99.8	0.13	1,418,177.7
2046	-	-	-	-	2,215.7	24,149.8	-	686.9	686.9	86.2	0.13	1,418,264.0
2047	-	-	-	-	2,038.4	22,095.0	-	631.9	631.9	74.5	0.12	1,418,338.5
2048	-	-	-	-	1,875.3	20,204.6	-	581.4	581.4	64.4	0.11	1,418,402.8
2049	-	-	-	-	1,725.3	18,465.5	-	534.8	534.8	55.6	0.10	1,418,458.4
2050	-	-	-	-	1,587.3	16,865.4	-	492.1	492.1	48.0	0.10	1,418,506.5
2051	-	-	-	-	1,460.3	15,393.4	-	452.7	452.7	41.5	0.09	1,418,548.0
2052	-	-	-	-	1,343.5	14,039.2	-	416.5	416.5	35.9	0.09	1,418,583.8
2053	-	-	-	-	1,236.0	12,793.3	-	383.2	383.2	31.0	0.08	1,418,614.8
Total	**-**	**-**	**4,088,872.6**	**(388,709.6)**	**368,363.0**		**3,700,163.0**	**(1,153,358.0)**	**2,546,805.0**	**1,418,614.8**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(500,000)
(1,000,000)
(1,500,000)
(2,000,000)
(2,500,000)
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
2053
Analytical Panel Installation
Test 2
Test 3
Test 4
Year

Location: Trenton Generating Station
CI# / FP#: 43424
Title: TRE5 Analytical Panel
Execution Year: 2014

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	pd	10.0	$ 339	$ 3,393		
1.2	Reg Instr	pd	30.0	$ 339	$ 10,178		
1.3	Reg Mech - Piping	pd	22.5	$ 345	$ 7,772		
1.4	Internal Engineering	pd	5.7	$ 384	$ 2,193		
1.5	Internal Supervision	pd	8.6	$ 384	$ 3,290		
1.6					$ -		
Totals may appear incorrect due to rounding.				Sub-Total	$ 26,827		
2	**012 Materials**						
2.1	Analytical Panel	lot	1	[redacted]		Cost Support 1, 15% escalation	28554
2.2	Piping, valves, fittings	lot	1				
2.3							
2.4							
				Sub-Total	[redacted]		
3	**015 Freight**						
3.1	Freight/Shipping	lot	1	[redacted]			
3.2					$ -		
				Sub-Total	[redacted]		
4	**011 Travel**						
4.1	Travel	lot	1	$ 1,000.00	$ 1,000		
				Sub-Total	$ 1,000		
5	**021 Telephones**						
5.1	Telephones	lot	1	$ 250.00	$ 250		
				Sub-Total	$ 250		
6	**041 Meals and Entertainment**						
6.1	Meals	lot	1	$ 250.00	$ 250		
				Sub-Total	$ 250		
7	**094 Interest Capitalized**						
7.1	Interest Capitalized	lot	1	$ 6,132.57	$ 6,133		
				Sub-Total	$ 6,133		
8	**095 Administrative Overhead**						
8.1	Thermal Regular Labour AO	lot	1	$ 5,115.82	$ 5,116		
8.2					$ -		
				Sub-Total	$ 5,116		
				SUB-TOTAL (no AO, AFUDC)	$ 382,577		
				TOTAL (AO, AFUDC included)	$ 393,825		
9	**Original Cost**						
9.1	Retirement				$ 30,000		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

ABB Inc.

WATER STEAM SAMPLING BUDGETARY PROPOSAL

Revised for Point Tupper Power Station June 30, 2009

INTRODUCTION

The proposed sampling system is based upon sampling systems supplied to ABB Limited standards and design and the detail included on the completed questionnaires.

SYSTEM DESCRIPTION

The proposal is based on the supply of one four and a half meter double sided rack for Point Tupper. The coolers are mounted on one side along with some of the analysers. The other side has the balance of the analysers plus the electrical connection box.

Primary coolers have been based on cooling water at supply temperatures of between 5°C and 30°C, and sample flow rates at a nominal 1 l/min

All sample lines, valves and compression fitting are of stainless steel, the cooling water pipework and rack are painted carbon steel as standard.

Water / Steam Sampling System

The Sample conditioning equipment will be installed on one side of the rack, and comprises the primary sample coolers, sample inlet / isolating valves, pressure regulating valves with filters and pressure relief, and temperature indicators. The cooling line comprises a coolant inlet and outlet header with 2" ASA 150# flanged interfaces, a coolant regulating valve on each line, flow indicators and a system pressure relief valve.

Thermal protection is fitted to each line that requires cooling. The solenoid valves that form part of the thermal protection can be remotely opened or closed from the DCS if required or maintained as "local" operation only by simple removal of a link within the control box. Each sample line that is cooled has a 3 wire PT100 fitted and a digital controller to continuously monitor the sample temperatures downstream of the coolers. Temperatures above the adjustable set point (factory set at 50°C) generate an alarm that is sent to the DCS via a grouped signal alarm. The solenoid valve is then closed which stops the sample flow.

This system is also linked with a cooling water flow switch, located in the cooling water inlet header pipe. The switch activates when the cooling water flow is dramatically reduced. When activated the sample line solenoid valves close. The system will automatically reset when the sample temperature falls below 50°C or the cooling water flow is restored.

A three-position switch is provided on the front of the control cubicle to give various options during commissioning and maintenance periods. During normal operation the switch should always be set to "AUTO", this allows the system to function as detailed above. If the switch is set to "Open" or "Close" (local control) the system alarms are overridden and the solenoid valves are permanently open or closed.

The analysers are mounted on the part of the cooler side of the rack plus all of the other side complete with the signal connection box and the electrical isolation (mcb) box.

Each sample line will consist of flow regulating valves, flow indicator on lines other than manual samples only, manual grab valves and the analyser flowcells / sensors and transmitters.

Wherever possible Conductivity and Cation Conductivity cells on the same sample line are installed in series and used in conjunction with a dual channel transmitter. Also, where Conductivity and pH are on the same sample, these will also be installed in series and use a dual channel transmitter. All transmitters are wall mounted style with easy access to all parts for simple maintenance/calibration etc.

The analysers comprise both Conductivity and Cation Conductivity, pH, Dissolved Oxygen, Silica, Sodium and Hydrazine. The Cation Conductivity and Dissolved Oxygen are available with Bi-linear analog output.
Dual input AX series electronics will be used wherever possible for pH and Conductivity measurements.

Site Process Connections

PROCESS	TYPE OF CONNECTION	SIZE	MATERIAL
Sample Inlet	Compression fitting	3/8"	SS316
Sample outlet	Compression fitting	3/8" and 1/4"	SS316
Coolant Inlet	Flanged	2" ASA 150#	Carbon steel
Coolant outlet	Flanged	2" ASA 150#	Carbon steel
Drains	Flanged	2" ASA 150#	Carbon steel

Utility Requirements per unit (estimated values only)

Cooling Water (Pressure drop ≅ 0.5 bar.)	6000 l/hr
	Approx. Consumption
Power Supply (UPS or service) 110V/1ph/ 60/60Hz Point Tupper	400VA

Other features include an MCB box, power isolator and the 4-20mA signals box. Volt free binary and 4-20mA analogue outputs will be wired to terminals, for retransmission to the DCS, by others.

PACKING / DESPATCH

Sea worthy Packing for the racks is included.

QUALITY ASSURANCE

ABB Limited operate a quality assurance management system accredited to ISO 9001.

PROPOSED MANUFACTURING SCHEDULE

Manufacturing schedule is approximately 24 weeks from Contract award.

PRICING SUMMARY

Basic Sampling System as described above based on **Ex Works** delivery.

Budget total for Pt. Tupper $[redacted]

Terms and Conditions
ABB Inc. Standard Terms and Conditions of Sale (attached)

Terms of Payment 100% within 30 days after availability for despatch.

Warranties.....The warranty shall be 18 months from date of despatch or 12 months from commissioning whichever is the sooner. Warranty on exchanged or repaired parts shall be 12 months from the repair or exchange.

System basic details:

Coolers
Have "316" stainless steel coils with an outer "304" stainless steel shell. If the cooling water medium is not "closed circuit" demineralised water and there is a risk of Chlorides present in the cooling water coolers with Inconel coils are recommended to ensure a long service life. These are available as a cost option. Each cooler has a relief valve fitted to protect the cooler shell in the event that the cooler water is isolated and the sample left running. This would result in a rapid overpressure of the cooler. All coolers are sized on the basis of a sample flowrate of 1l/min.

Pressure regulating valve
Sample pressure reducers with relief valves are fitted to lines with an operating pressure above 20bar.

Temperature Indicators
ABB standard temperature indicators are a surface contact type and have an overall diameter of 50mm to provide a visual indication of sample temperature on the outlet of the cooler.

Sample Line Tubing & Accessories
ABB standard tubing- ASTM A213-94B, A269-94A (W Number 1.4436) This is grade 316/316L.

Sample Line Valves and Fittings
Double ferule compression type Stainless steel valves, solenoid valves and fittings are used and manufactured by "Parker". All sample interface points are also compression fitting as standard. Alternative interface connections, for example, socket weld, are available as an option

Drain trough
The sample drain trough is manufactured from stainless steel grade 304.

Cooling Water Headers
Cooling water pipe will be carbon steel painted green (RAL6010). The inlet and outlet headers are fitted with an auto vent valve. A manual grab sample valve is fitted to the inlet header.

Equipment Identification
The identification of the equipment will be by tag numbers only. The label size 15mm x 50mm (approximately), and manufactured from 2 ply white on black plastic and secured to the panel with plastic push-fit rivets.

Sample Probes
The sample probes are excluded from this proposal.

List of Accessories
Holding down equipment and fixing bolts excluded from this proposal.

As Built Documentation
Will include two sets of ABB standard system operating manuals.
Quality Dossier will include ABB limited standard quality plan,
Certificate of conformance, final test procedure, supplier's certificate of conformance for racks and coolers only
All documents and drawings in English language only
Also supplied is one CD-ROM containing all as build drawing and system operating manual.

We trust the above meets your approval. Please do not hesitate to contact us for further information.

[redacted]
Analytical Product Manager
ABB Canada.
3450 Harvester Road
Burlington, Ontario
L7N 3W6

"**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

2.0 Purpose and Scope

3.0 Organization of Report

4.0 Standards Comparison

5.0 General Findings

6.0 Plant Specific Findings:

- Pt. Tupper, Tuft's Cove, Lingan, Trenton, Pt. Aconi.

6.01 Water Treatment Plant
6.02 Condensate polishers
6.03 Boiler/Feedwater Cycle Chemistry
6.04 General Service Cooling Water
6.05 Monitoring and Instrumentation
6.06 Procedures/Chemical Control Records/Tasks
6.07 General Condition of Chemical Tanks & Piping.

7.0 Laboratory Staffing & Apprenticeship

8.0 Boiler Tube Deposits and Acid Cleaning

8.01 Introduction
8.02 Boiler Tube Failure Risk Factors
8.03 Plant Tube Samples Acid Clean history

9.0 Report Summary

"**FINAL REPORT"**

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.

"**FINAL REPORT"**

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.

"FINAL REPORT"

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.

Maintenance and Equipment:

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.

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 N2H4. 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.

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 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 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.

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.

"**FINAL REPORT"**

NSPI Thermal Station Chemical Asset Gap Analysis Report – 2010
Tuft's Cove Plant Specific Findings.

"**FINAL REPORT"**

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.

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.

Maintenance and Equipment:

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.

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 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 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.

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.

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.

"**FINAL REPORT"**

NSPI Thermal Station Chemical Asset Gap Analysis Report – 2010
Lingan Plant Specific Findings.

"**FINAL REPORT"**

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.

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

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.

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.

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

"**FINAL REPORT"**

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.

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.

"**FINAL REPORT"**

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.

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.

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.

(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

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.

"**FINAL REPORT"**

NSPI Thermal Station Chemical Asset Gap Analysis Report – 2010
Pt. Aconi Plant Specific Findings.

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.

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.

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.

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.

"**FINAL REPORT"**

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.

(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.

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.

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

	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.

CI Number: 44350

Title: LIN4 Boiler Refurbish 2014

Start Date: 2014/07
Final Cost Date: 2014/12
Function: Generation
Forecast Amount: $382,503

DESCRIPTION:

The scope of work for this project is to refurbish and replace tubes, tube bends and shields on the Lingan Unit 4 (LIN4) boiler as part of a planned maintenance outage in 2014. Protective erosion shields identified as missing or degraded will be replaced with new shields. Tubes and tube bends will be replaced in the areas where the thickness readings are below American Society of Mechanical Engineers (ASME) specifications. Replacement of shields will protect the tubes from further ash erosion. Finalized scope is determined as part of boiler condition data collected during the 2013 boiler assessment and on inspection, evaluation and prioritization activities undertaken during the 2014 planned outage.

NS Power has standardized repair/replacement practices for boiler tubing based on engineering tube thickness calculations required for the service conditions. Tube repair or replacement is required when the wall thickness remaining is 70 percent of the original minimum tube wall thickness in accordance with the ASME Boiler Code. This tolerance maximizes the economic tube life while maintaining boiler reliability.

The service conditions of the tube (for example the fuel quality, water chemistry and metal temperatures) can affect the life of the tubes. Routine annual condition assessments, based on tube thickness surveys, are the primary tool for evaluating remaining tube life.

NS Power employs comprehensive boiler tube inspection surveys, metallurgical analysis of boiler tube failures, industry experience with boiler tube failure mechanisms and engineering best practices. This approach serves to selectively identify weak and degraded boiler tubes that require replacement before they fail, which would result in unplanned forced outages of the generating unit and extra operating costs.

Summary of Related CIs +/- 2 years:
2012 CI 41234 LIN4 Boiler Refurbish $415K
2013 CI 43165 LIN4 Boiler Refurbish $450K
2015 CI TBD LIN4 Boiler Refurbishment $400K (est.)
2016 CI TBD LIN4 Boiler Refurbishment $600K (est.)

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Maintenance

Why do this project?

Ongoing asset management activities have identified the requirement for boiler component replacement to maintain the long term reliability of the boiler and mitigate the risk of unplanned outages due to tube leaks.

Why do this project now?

Some of the tubes to be inspected and replaced are difficult to access and sufficient time during a planned outage is required to complete repairs or replacements. The planned outage of Unit 4 in 2014 will be of sufficient duration to complete the work.

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 tubes, tube bends and shields, the risk of tube leaks and unplanned outages to the Unit 4 boiler will be reduced. Based on boiler life cycle assessments, these upgrades are necessary to maintain reliable operation of the boiler. This method of refurbishment is the standard procedure.

CI Number : 44350 - LIN4 Boiler Refurbish 2014 **Project Number**

Parent CI Number : -

Cost Centre : 305 - 305-Lingan 3&4 Prod.Unit **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
095		095-Thermal Regular Labour AO		987	0	987
095		095-Thermal & Hydro Contracts AO		32,339	0	32,339
001	013	001 - THERMAL Regular Labour	013 - SGP - Boiler	5,177	0	5,177
012	013	012 - Materials	013 - SGP - Boiler	13,000	0	13,000
013	013	013 - POWER PRODUCTION Contracts	013 - SGP - Boiler	331,000	0	331,000
			Total Cost:	382,503	0	382,503
			Original Cost:	165,910		

44350 LIN4 Refurbish Boiler
Summary of Alternatives

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Lingan	**CI Number:**	44350
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Refurbish Boiler	6.49%	-514,500	350,917	1	33.98%	3.5 years
B	Test 2	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Refurbish Boiler to avoid unplanned outages and related repair and replacement energy costs

Notes/Comments :

Refurbish Boiler

Assume 1 tube failure per year - escalating to 4 per year after 5 years under do nothing as erosion continue under high ash conditions. Each failure results in 160 man hours of labour for cleaning, hole watch, staging, etc., as well as Contractor costs to execute the repair. The outage would cause loss of full generation of the unit for an estimated 80 hours.

Test 2

Test 3

Test 4

44350 LIN4 Refurbish Boiler
Summary of Sensitivities

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Lingan	**CI Number:**	44350
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Boiler	6.49%	-514,500	350,917	1	33.98%	3.5 years
B	Test 2	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Boiler	10%	-480,515	323,903	1	29.90%	3.7 years
B	Test 2	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
	Change: **A**		33,985	-27,013	0	-4.08%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Boiler	-10%	-429,065	288,812	1	29.48%	3.7 years
B	Test 2	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
	Change: **A**		85,435	-62,105	0	-4.49%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement		PV of Revenue Requirement	PV of Revenue Requirement	PV of Revenue Requirement	Delay?
	Yrs Delay:	1	2	3	
	A	34,012	98,992	213,536	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

44350 LIN4 Refurbish Boiler
Avoided Cost Calculations

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Lingan	**CI Number:**	44350
Originator :		**Project No. :**	

Refurbish Boiler

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			69,549	70,940		
Events/Outages (#)	1	2	1	2		
Probability of Occurance (%)	30%	40%	30%	40%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	154	154				
Duration (Hours)	80	80				
Totals	$15,794	$33,458	$20,865	$56,752	$36,659	$90,210

Total Capital Cost of Alternative **$382,503**

Test 2

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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

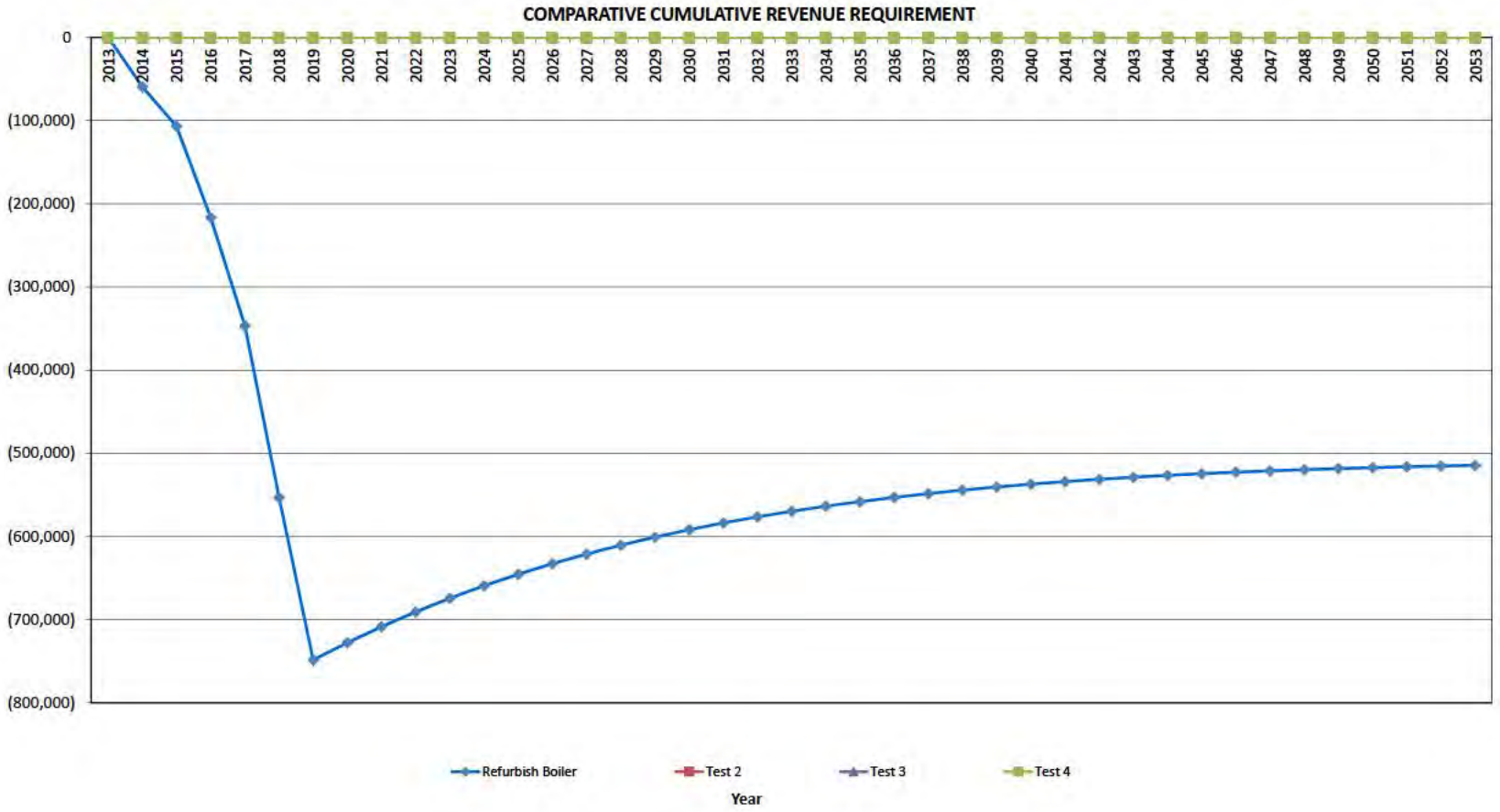
	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			0	0		
Events/Outages (#)	0	0	0	0		
Probability of Occurance (%)	0%	0%	0%	0%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	0	0				
Duration (Hours)	0	0				
Totals	$0	$0	$0	$0	$0	$0

Total Capital Cost of Alternative **$0**

44350 LIN4 Refurbish Boiler

Refurbish Boiler

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	36,658.6	(349,176.8)	13,967.1	344,407.6	(312,518.1)	(7,034.4)	(319,552.5)	(300,077.5)	0.94	(300,077.5)
2015	-	-	90,210.1	-	26,816.8	316,055 2	90,210.1	(19,651.9)	70,558.2	62,219.9	0.88	(237,857.6)
2016	-	-	172,526.8	-	24,671.4	289,971 0	172,526.8	(45,835.2)	126,691.6	104,911.1	0.83	(132,946.5)
2017	-	-	211,172.8	-	22,697.7	265,973 5	211,172.8	(58,427.3)	152,745.5	118,777.2	0.78	(14,169.2)
2018	-	-	335,060.8	-	20,881.9	243,895 8	335,060.8	(97,395.5)	237,665.4	173,548.8	0.73	159,379.6
2019	-	-	341,762.0	-	19,211.3	223,584 3	341,762.0	(99,990.7)	241,771.3	165,787.5	0.69	325,167.1
2020	-	-	-	-	17,674.4	204,897.7	-	5,479.1	5,479.1	3,528.1	0.64	328,695.3
2021	-	-	-	-	16,260.5	187,706.1	-	5,040.8	5,040.8	3,048.1	0.60	331,743.3
2022	-	-	-	-	14,959.6	171,889 8	-	4,637.5	4,637.5	2,633.3	0.57	334,376.7
2023	-	-	-	-	13,762.9	157,338 8	-	4,266.5	4,266.5	2,275.0	0.53	336,651.7
2024	-	-	-	-	12,661.8	143,951 8	-	3,925.2	3,925.2	1,965.4	0.50	338,617.1
2025	-	-	-	-	11,648.9	131,635 9	-	3,611.2	3,611.2	1,698.0	0.47	340,315.1
2026	-	-	-	-	10,717.0	120,305 2	-	3,322.3	3,322.3	1,467.0	0.44	341,782.1
2027	-	-	-	-	9,859.6	109,880 9	-	3,056.5	3,056.5	1,267.4	0.41	343,049.4
2028	-	-	-	-	9,070.9	100,290.6	-	2,812.0	2,812.0	1,094.9	0.39	344,144.3
2029	-	-	-	-	8,345.2	91,467.6	-	2,587.0	2,587.0	945.9	0.37	345,090.3
2030	-	-	-	-	7,677.6	83,350 3	-	2,380.0	2,380.0	817.2	0.34	345,907.5
2031	-	-	-	-	7,063.4	75,882 5	-	2,189.6	2,189.6	706.0	0.32	346,613 5
2032	-	-	-	-	6,498.3	69,012.1	-	2,014.5	2,014.5	609.9	0.30	347,223.4
2033	-	-	-	-	5,978.4	62,691 3	-	1,853.3	1,853.3	527.0	0.28	347,750.4
2034	-	-	-	-	5,500.2	56,876 2	-	1,705.0	1,705.0	455.3	0.27	348,205.7
2035	-	-	-	-	5,060.1	51,526 2	-	1,568.6	1,568.6	393.3	0.25	348,599.0
2036	-	-	-	-	4,655.3	46,604 3	-	1,443.2	1,443.2	339.8	0.24	348,938.7
2037	-	-	-	-	4,282.9	42,076 2	-	1,327.7	1,327.7	293.6	0.22	349,232.3
2038	-	-	-	-	3,940.3	37,910 2	-	1,221.5	1,221.5	253.6	0.21	349,485.9
2039	-	-	-	-	3,625.1	34,077.6	-	1,123.8	1,123.8	219.1	0.19	349,705.0
2040	-	-	-	-	3,335.0	30,551.6	-	1,033.9	1,033.9	189.3	0.18	349,894.3
2041	-	-	-	-	3,068.2	27,307.6	-	951.2	951.2	163.5	0.17	350,057.8
2042	-	-	-	-	2,822.8	24,323 2	-	875.1	875.1	141.3	0.16	350,199.1
2043	-	-	-	-	2,597.0	21,577 5	-	805.1	805.1	122.1	0.15	350,321.2
2044	-	-	-	-	2,389.2	19,051 5	-	740.7	740.7	105.4	0.14	350,426.6
2045	-	-	-	-	2,198.1	16,727 5	-	681.4	681.4	91.1	0.13	350,517.7
2046	-	-	-	-	2,022.2	14,589 5	-	626.9	626.9	78.7	0.13	350,596.4
2047	-	-	-	-	1,860.4	12,622 5	-	576.7	576.7	68.0	0.12	350,664.4
2048	-	-	-	-	1,711.6	10,812 9	-	530.6	530.6	58.7	0.11	350,723.2
2049	-	-	-	-	1,574.7	9,148.1	-	488.2	488.2	50.8	0.10	350,773.9
2050	-	-	-	-	1,448.7	7,616.4	-	449.1	449.1	43.8	0.10	350,817.8
2051	-	-	-	-	1,332.8	6,207 3	-	413.2	413.2	37.9	0.09	350,855.6
2052	-	-	-	-	1,226.2	4,910 9	-	380.1	380.1	32.7	0.09	350,888.4
2053	-	-	-	-	1,128.1	3,718 2	-	349.7	349.7	28.3	0.08	350,916.6
Total	**-**	**-**	**1,187,391.1**	**(349,176.8)**	**336,203.7**		**838,214.4**	**(263,868.1)**	**574,346.3**	**350,916.6**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(100,000)
(200,000)
(300,000)
(400,000)
(500,000)
(600,000)
(700,000)
(800,000)
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
2053
Refurbish Boiler
Test 2
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: Lingan
CI# / FP#: 44350
Title: L N4 Boiler Refurbishment 2014
Execution Year: 2014

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)	pd	2.1	$ 384	$ 822		
1.2	Maintenance Trades	pd	4.4	$ 345	$ 1,511		
1.3	Utility	pd	12.5	$ 227	$ 2,843		
1.4							
				Sub-Total	$ 5,177		41234, 43165
2	**012 Materials**						
2.1	Replacement Tubes, bends, shields	lot	1	$ 13,000.00	$ 13,000		
				Sub-Total	$ 13,000		41234, 43165
3	**013 Contracts**						
3.1	Boiler Inspection and Refurbishment	lot	1	$ 331,000.00	$ 331,000		
				Sub-Total	$ 331,000		41234, 43165
4	**095 Administrative Overhead**						
4.1	Thermal& Hydro Contracts	lot	$ 1	$ 32,339	$ 32,339		
4.2	Thermal Regular Labour	lot	$ 1	$ 987	$ 987		
4.3							
				Sub-Total	$ 33,326		
				SUB-TOTAL (no AO, AFUDC)	$ 349,177		
				TOTAL (AO, AFUDC included)	$ 382,503		
5	**Original Cost**						
5.1					$ 165,910		

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
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 44590

Title: POT - Water Treatment Plant Siding Replacement

Start Date: 2014/04
Final Cost Date: 2015/01
Function: Generation
Forecast Amount: $360,523

DESCRIPTION:

As part of life cycle management at the Point Tupper Generating Station, the condition of buildings, pipe bridges, walkways, and other structural components are regularly assessed. Several areas of the plant siding have been identified as requiring replacement.

This project includes replacement of deteriorated exterior plant siding, fasteners, and structural components in various areas of the water treatment plant (WTP). Siding replacement will be executed in phases. In 2014, the North and West walls of the WTP will be addressed, as well as the pedway to Unit 1. The majority of the siding to be replaced is original to the plant (installed in 1973) and has reached the end of its useful life. Newer siding that may be replaced as part of this project is 20 to 30 years old.

Summary of Related CIs +/- 2 years:
2011 CI 40256 POT Plant Siding Replacement $475K
2015 CI TBD POT Plant Siding Replacement $350K (est)

JUSTIFICATION:

Justification Criteria: Health & Safety

Sub Criteria: Buildings

Why do this project?

Replacing the siding will mitigate the risk of further deterioration of the siding and prevent separation from the building structure. Replacing the siding will also ensure the building envelope is adequately sealed, prevent premature damage to the building's interior structural components, and ensure equipment inside the plant is protected.

Why do this project now?

The siding to be replaced under this project has reached or is about to reach the end of its useful life and must be replaced. Some repairs have been completed in recent years, but the degree of deterioration of both the siding and some of the support structure no longer allows for repairs to be completed. In recent years, siding materials have become detached from station buildings. As the siding contains asbestos, it requires careful handling and precaution in order for it to be safely disposed of, and repairs completed.

Why do this project this way?

The siding can no longer be repaired. Replacing the siding will ensure the long-term integrity of the building, and the safety of equipment and personnel working in the vicinity of the WTP.

CI Number : 44590 - POT - Water Treatment Plant Siding Replacement **Project Number**

Parent CI Number : -

Cost Centre : 351 - 351-Pt.Tupper Admin./Capital **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		2,584	0	2,584
095		095-Thermal & Hydro Contracts AO		26,965	0	26,965
095		095-Thermal Regular Labour AO		540	0	540
001	003	001 - THERMAL Regular Labour	003 - SGP - Bldg.,Struct.Grnd.	2,834	0	2,834
012	003	012 - Materials	003 - SGP - Bldg.,Struct.Grnd.	50,600	0	50,600
013	003	013 - POWER PRODUCTION Contracts	003 - SGP - Bldg.,Struct.Grnd.	276,000	0	276,000
011	085	011 - Travel Expense	085 Design	500	0	500
041	085	041 - Meals & Entertainment	085 Design	500	0	500
			Total Cost:	360,523	0	360,523
			Original Cost:	20,000		

Capital Project Detailed Estimate

Location: Point Tupper
CI# / FP#: 44590
Title: POT - Water Treatment Plant Siding Replacement
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	pd	5	$ 339.28	$ 1,696		
1.2	Utility	pd	5	$ 227.44	$ 1,137		
1.3				$ -	$ -		
				Sub-Total	$ 2,834		
2	**012 Materials**						
2.1	Siding and flashing	lot	1	44000	$ 44,000		
2.2	Contingency	%	15	$ 44,000.00	$ 6,600		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 50,600		
3	**013 Power Production Contracts**						
3.1	Siding removal	lot	1	90000	$ 90,000		
3.2	Siding installation	lot	1	150000	$ 150,000		
3.3	Contingency	%	15	$ 240,000.00	$ 36,000		
				Sub-Total	$ 276,000		
4	**011 Travel Expenses**						
4.1	Travel	lot	1	500	$ 500		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 500		
5	**041 Meals and Entertainment**						
5.1	Meals and expenses	lot	1	500	$ 500		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 500		
6	**094 Interest Capitalized**						
6.1	Interest	lot	1	2583.75	$ 2,584		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 2,584		
7	**095 Administrative Overhead**						
7.1	Contracts AO	lot	1	26965.2	$ 26,965		
7.2	Regular Labour AO	lot	1	540.44	$ 540		
7.3					$ -		
				Sub-Total	$ 27,506		
				SUB-TOTAL (no AO, AFUDC)	$ 330,434		
				TOTAL (AO, AFUDC included)	$ 360,523		
8	**Original Cost**						
8.1					$ 20,000		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.










15
KM/HR



CI Number: 37885

Title: POT – Lubrication and Chemical Storage Facility

Start Date: 2013/01
Final Cost Date: 2015/02
Function: Generation
Forecast Amount: $343,763

DESCRIPTION:

This project is to construct a new storage building on the Point Tupper Generating Station (POT) property. The existing Unit 1 storage area, currently being used for Unit 2, is undersized for the lubrication and chemical storage requirements of Unit 2 and does not meet the National Fire Code standards for storage of flammable liquids.

Ensuring there is adequate storage for lubricating oil and non-hazardous chemicals is an important component of safety and environmental management. 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.

Summary of Related Cls +/- 2 years: None

JUSTIFICATION:

Justification Criteria: Health & Safety

Sub Criteria: Buildings

Why do this project?

Proper storage of lubricating oil is required to maintain environmental management practices and fire safety standards. The existing petroleum storage area is undersized and a new location is required. The new storage area will also include storage for other non-hazardous chemicals, salt and sand. The existing storage area is considered temporary as it was not intended to support current operation of Unit 2, and a permanent storage area is required.

Why do this project now?

The lubricating oil and chemicals are currently stored in a temporary storage area that was intended for decommissioned Unit 1, and is therefore not located close to plant operations or in compliance with current industry standards for flammable liquid storage. Some materials are also being stored in areas that are not adequately contained and protected from fire. Completing this project will provide the benefits of a permanent storage area that is located in proximity to current plant operations for Unit 2. The area being utilized is not an appropriate long-term solution, and does not meet criteria of the National Fire Code.

Why do this project this way?

The lubricating oil and chemicals are currently stored in temporary storage areas that are not compliant with the National Fire Code, and were not intended to support current operations of Unit 2. An appropriate location within existing facilities is not available, so a new building is required.

CI Number : 37885-SB31 - POT - Lubrication and Chemical Storage Facility **Project Number** SB31

Parent CI Number : -

Cost Centre : 351 - 351-Pt.Tupper Admin./Capital **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
028		028 - Consulting		6,537	0	6,537
094		094 - Interest Capitalized		1,457	0	1,457
095		095 - T&CS Regular Labour AO		[redacted]	0	[redacted]
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
095		095-Thermal Regular Labour AO		[redacted]	0	[redacted]
001	003	001 - T&CS Regular Labour	003 - SGP - Bldg.,Struct.Grnd.	1,386	0	1,386
001	003	001 - THERMAL Regular Labour	003 - SGP - Bldg.,Struct.Grnd.	9,774	0	9,774
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.	179,728	0	179,728
013	003	013 - POWER PRODUCTION Contracts	003 - SGP - Bldg.,Struct.Grnd.	[redacted]	0	[redacted]
011	085	011 - Travel Expense	085 Design	1,000	0	1,000
028	085	028 - Consulting	085 Design	8,463	0	8,463
041	085	041 - Meals & Entertainment	085 Design	2,000	0	2,000
			Total Cost:	343,763	0	343,763
			Original Cost:			

Capital Project Detailed Estimate

Location: POT
CI# / FP#: 37885-SB31
Title: POT Lubrication and Chemical Storage Facility
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	pd	10 0	$ 339	$ 3,393		
1 2	Engineering (P Eng)	pd	5.7	$ 384	$ 2 193		
1 3	Maintenance Trades	pd	5 0	$ 345	$ 1,727		
1.4	Utility & Unskilled	pd	10 0	$ 227	$ 2,274		
1 5	Technologists	pd	5.7	$ 275	$ 1,572		
1 6				$ -	$ -		
				Sub-Total	$ 11,160		
2	**012 Materials**						
2.1	New steel building, foundation, etc.	lot	1	[redacted]		Attachment 1: line items 2,3,4,5,6,7,8	
2 2	Misc. and consumables	lot	1				
2 3	Contingency on New Building	%	[redacted]				
2.4					$ -		
2 5					$ -		
				Sub-Total	$ 179,728		
3	**013 Power Production Contracts**						
3.1	Construction of new building	lot	1	[redacted]		Attachment 1: 1,9. 1,9. 2,9 3,9.4,10,11,12,credit - pollution coverage	
3 2	Contingency	%	[redacted]				
3 3					$ -		
				Sub-Total	[redacted]		
4	**028 Consulting**						
4.1	Construction Supervision	lot	1	15000	$ 15,000		
4 2					$ -		
4 3					$ -		
				Sub-Total	$ 15,000		
5	**011 Travel Expenses**						
5.1	Travel	lot	1	1000	$ 1,000		
5 2					$ -		
5.3					$ -		
				Sub-Total	$ 1,000		
6	**041 Meals and Entertainment**						
6.1	Meals and expenses	lot	1	2000	$ 2 000		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 2,000		
7	**094 Interest Capitalized**						
7.1	Interest	lot	1	1456.6	$ 1,457		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 1,457		
8	**095 Administrative Overhead**						
8.1	Regular Labour AO	lot	1	[redacted]			
8.2	Contracts AO	lot	1				
8.3					$ -		
				Sub-Total	[redacted]		
				SUB-TOTAL (no AO, AFUDC)	$ 328,339		
				TOTAL (AO, AFUDC included)	$ 343,763		
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
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

Nova Scotia POWER
An Emera Company

GOODS & SERVICES TRAVEL SHEET (P-13-081)

SUPPLY INITIATIVE DATE: July 16, 2013

Scope: ☒NSPI ☐Emera ☐Affiliate:_____

Supply Line Needed: *Lube Oil & Miscellaneous Storage Bldg - POT*

Initiator: Mary Louise Mills Sponsor: Brent MacLeod Stakeholders: NSPI

Sourcing Strategy: ☐Competitive Bid ☒RFP ☐Sole Source ☐Other:_____

OPERATIONAL APPROVALS (Recommendation with signature page attached: ☒Yes ☐No)
(Include Director of IT for Computer Software and Hardware Purchases)

Approver	Title	Reviewed	Date
Jeffrey Campbell	Plant Manager, POT Generating Station	☐	
Craig Sutherland	Director, Procurement & Real Estate	☑	16-JUL-13
David Pickles	Director, Power Production	☐	
		☐	

INTERNAL OPERATING AUTHORITY

Internal Operating Authority is required from the following Approver Category: **Vice-President**

Approver	Reviewed	Date
Mark Sidebottom	☐	

CONTRACT DOCUMENT EXECUTION & EXTERNAL COMMITMENT

Supplier:_____

Term:_____ Value:_____ Committed Volume of Spend: Y☐ N☐

Agreement Type: ☐Partial Supply ☒Supplier of Choice ☐Exclusive ☐Other:_____

Review Required →	Y	N	Reviewer Name	Signature	Date
Public Relations	☐	☐			
Environmental	☐	☐			
Safety	☐	☐			
Security	☐	☐			
Finance/Treasury	☐	☐			
Code of Conduct	☐	☐			
Procurement	☐	☐			
Operational	☐	☐			
Legal	☐	☐			
Document Executors:	☐	☐			
	☐	☐			

Please return to Tracie Speichts (L4A), Procurement & Real Estate, upon completion

Lube Oil & Miscellaneous Storage Building
Point Tupper Generating Station
Recommendation – P-13-081
July 2013

Submitted to:

- Craig Sutherland Director, Procurement & Real Estate
- Jeffrey Campbell Plant Manager, Point Tupper Generating Station
- Dave Pickles Director, Power Production
- Mark Sidebottom VP Power Generation & Delivery

The following Recommendation is being presented on behalf of the Lube Oil & Miscellaneous Storage Building evaluation team, which is made up of:

- Brent MacLeod Sr. Plant Engineer
- Michel Larade Consultant
- Mary-Louise Mills Procurement Manager

This initiative was under taken to enter into a supply arrangement for a Lube Oil & Miscellaneous Storage Building at the Point Tupper Generating Station.

NSPI's objective is to select a Supplier who is competitive from a quality and cost perspective, has the ability to meet the required construction schedule and is able to meet the project specification.

Lube Oil & Miscellaneous Storage Building
Point Tupper Generating Station
Recommendation – P-13-081
July 2013

Background / Scope of Project:

This scope of this project is to include the construction of a storage building for lubricating oils, chemicals, salt for winter usage and auxiliary equipment such as hoses and storage containers.

Recommendation:

The evaluation team recommends NSPI awards the Lube Oil & Miscellaneous Storage Building at Point Tupper to **Form Tech Construction Ltd (Form Tech).**

Upon approval of this Recommendation, NSPI will issue a Purchase Order to **Form Tech.**

Total expenditure from this Recommendation:

$ [redacted] CND Lube Oil and Miscellaneous Storage Building
$ [redacted] CND Contingency
$ [redacted] CND Total Recommended Expenditure

Process Overview:

On May 6, 2013, a Request for Proposal for the Lube Oil and Miscellaneous Storage Building at Point Tupper was issued to the following companies:

- Form Tech Construction Ltd.
- [redacted]

A Site Visit held on May 16, 2013 was attended by the following companies:

- Form Tech Construction Ltd.
- [redacted]

By the Close Date, May 23, 2013, 5 proponents decided to bid this project and the team began the process of reviewing and evaluating the proposals.

Lube Oil & Miscellaneous Storage Building
Point Tupper Generating Station
Recommendation – P-13-081
July 2013

The evaluation of the bids focused on the following Key Selection Criteria, in no particular order of importance:

- Pricing
- Speed and efficiency of project plan and availability
- Experience in Industry and relevant and specific expertise and competence of proposed project team / key personnel
- Understanding and ability to meet Specification
- Safety performance record
- Reputation of Service Provider
- Insurability
- Adherence to RFP Requirements

Technical and Commercial Evaluation:

The following 5 companies submitted bids for the project:

- Form Tech Construction Ltd.
- [redacted]

Pricing Overview – (Attachment A)
Commercial Overview – (Attachment B)

[redacted] As a result they were not evaluated any further.

[redacted] As a result they were not evaluated any further.

[redacted] they were not considered any further for this project.

[redacted]

Lube Oil & Miscellaneous Storage Building
Point Tupper Generating Station
Recommendation – P-13-081
July 2013

[redacted] was not considered any further for this project.

Form Tech: [redacted] their reputation within NSPI, particularly jobs they have performed at Point Tupper is extremely good. Form Tech's project schedule with a 13 week duration is consistent with the required project timelines. Form Tech was unable to provide bonding in time for their proposal submission as they have not been required to provide it for past projects, however, they are actively pursuing bonding prior to the start of this project. Should bonding not be in place by the start of the project, the project team is comfortable enough with Form Tech's past reputation within NSPI to continue with them without bonding in place.

[redacted] Commercial negotiations focused on removal of post-disaster designation, slab on grade option, insurance and price.

Removal of post-disaster designation:

Upon technical review of the initial specification for the project, it was discovered that post-disaster building designation is not a requirement and reduced the wind loading frequency to 1/50 from 1/100 to correspond to the Climatic Values listed in the National Building Code of Canada 2010.
Savings of $[redacted]

Slab on Grade Option:

Form Tech initially offered NSPI a [redacted] Form Tech agreed [redacted]
Savings of $[redacted]

Insurance:

[redacted]
Savings of $[redacted]

Price:

Pricing negotiations on several items in Form Tech's proposal resulted in a cost reduction from $[redacted] to $[redacted]
Savings of $[redacted]

Total Negotiated Savings:

Total cost before negotiations	$[redacted]
Total negotiated savings	$[redacted] ([redacted])
Final project cost	$[redacted]

Lube Oil & Miscellaneous Storage Building
Point Tupper Generating Station
Recommendation – P-13-081
July 2013

As reflected in the following project team scorecard, although Form Tech's final negotiated price [redacted] the project team is confident they are the right choice for this project.

Evaluation Scorecard
P-13-081 - Lube Oil & Miscellaneous Storage Building

Review Criteria	Weighting	Formtech	[redacted]			[redacted]
Speed and efficiency of Project Plan and Availability / Understanding and Ability to meet Specification	**20%**	3.00	3.33	2.00	2.00	0.00
Reputation of Service Provider / Experience in industry and relevant and specific exepertise and competence of proposed project team / key personnel	**20%**	3.67	4.00	3.00	2.33	0.00
Safety performance record	**10%**	3.00	4.00	0.67	0.67	0.00
Insurability	**5%**	2.00	3.33	2.00	2.00	0.00
Adherence to RFP requirements	**5%**	2.00	3.00	2.00	1.67	0.00
Total non-price evaluation:	**60%**	36.67%	43.67%	25.33%	22.33%	0.00%
Pricing - Total	**40%**	3	1	4	2	0
		30.00%	10.00%	40.00%	20.00%	0.00%
Grand Total:	**100%**	**66.67%**	**53.67%**	**65.33%**	**42.33%**	**0.00%**

Price - Complete Project $2[redacted] $[redacted] $[redacted] $[redacted]
Price - Building Suppy and Erect Only $[redacted]

Non Financial Scale	**5**
0 - Does not meet requirement	
1 - Response deficient in most areas	
2 - Deficient in some areas	
3 - Meets expectations	
4 - Exceeds expectations in some areas	
5 - Meets and Exceeds expectations	

Financial Scale	**4**
The rating is based on giving the lowest price a 3 and using this price as a denominator to determine the prorated score based on the difference between the vendor price and the lowest price	

[redacted]

Lube Oil & Miscellaneous Storage Building
Point Tupper Generating Station
Recommendation – P-13-081
July 2013

Nova Scotia POWER An Emera Company

Recommendation:

The evaluation team confidently presents this Recommendation and believes the process was both competitive and transparent and requests your approval.

Prepared by:

Mary-Louise Mills,
Procurement Manager

Reviewed by:

Brent MacLeod,
Sr. Plant Engineer

Michel Larade,
Consultant

Approved by:

Craig Sutherland,
Director, Procurement & Real Estate

Jeffrey Campbell,
Plant Manager, Point Tupper Generating Station

Dave Pickles,
Director, Power Production Station

Mark Sidebottom,
VP, Power Production & Delivery

Lube Oil & Miscellaneous Storage Building
Point Tupper Generating Station
Recommendation – P-13-081
July 2013

Nova Scotia POWER An Emera Company

ATTACHMENT "A"

					Form Tech Construction																			
Item No.	Section	Description	Approx. Quantities	Unit	Unit Price	Total Price	Negotiated Price	Subcontract Y/N	Subcontractor	Unit Price	Total Price	Subcontract Y/N	Subcontractor	Unit Price	Total Price	Subcontract Y/N	Subcontractor	Unit Price	Total Price	Subcontract Y/N	Subcontractor	Unit Price	Total Price	Subcontract Y/N	Subcontractor
1		Overhead and General Conditions	1	LS																			$ -		
2	2201	Class A Excavation (Common)	1	LS				Y	Norvon			N											$ -		
3	2201	Class B Excavation (Rock)	2	YD^3				Y	Norvon			N											$ -		
4	2204	Common Backfill	1	LS				Y	Norvon			N											$ -		
5	2203	Pervious Fill – Type 1	70	TON				Y	Norvon			N											$ -		
6	2203	Pervious Fill – Type 2	32	TON				Y	Norvon			N											$ -		
7	3000	Concrete Foundation – includes formwork, reinforcing steel, anchor bolts, concrete, floor finishing, etc.	63.5	YD^3				N				Y											$ -		
8	13600	Pre-Engineered Steel Building – Supply and Erect	1	LS				Y	Timberlake			Y													
9	10000	Miscellaneous Items																							
9.1		Drainage Pipe Installation Trench	1	LS				Y	Norvon			Y/N											$ -		
9.2		Concrete Curb Removal	1	LS				Y	Norvon			N											$ -		
9.3		Concrete Apron Removal	1	LS				Y	Norvon			N											$ -		
9.4		Vent Pipe Relocation	1	LS				Y	AB Mechanical			Y											$ -		
10	15500	Supply and Install Plumbing & Buried Piping	1	LS				Y	AB Mechanical			Y/N											$ -		
11	16500	Supply and Install Primary Grounding	1	LS				Y	K&A Electric			Y/N											$ -		
12	16500	Supply and Install Electrical Services	1	LS				Y	K&A Electric			Y											$ -		
13				TOTAL:																					
		Credit for removal of post-disaster designation	1	LS																					
		Sudden and Accidental Pollution coverage	1	LS																					
				REVISED TOTAL:																					

Total $ value reduction from original proposal	$
Total % reduction from original proposal	
Difference between Form Tech and	$
Difference between Form Tech and	$ (

CI Number: 44729

Title: TUC – Station & Unit Transformer Connection Cable Replacement

Start Date: 2014/04
Final Cost Date: 2014/12
Function: Generation
Forecast Amount: $313,042

DESCRIPTION:

This project is for the replacement of the 5kV cables that run from Unit Transformer #1 (UT1) and its associated switchgear, along with the 5kV cables that run from Station Transformer #12 (ST12) and its associated switchgear. While completing an inspection in the East Tunnel, the physical condition of these cables was noted as being deteriorated. The cables are frequently submerged in water.

The cables were installed in 1966 and they have reached the end of their useful life. This project includes the replacement of the cables, associated switchgear, termination kits and any modifications necessary to the transformer termination box, switchgear enclosure and supports.

Summary of Related CIs +/- 2 years: None

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

The cables are showing their age and are bloated in some areas, likely due to water ingress as the cables are frequently submerged underwater. The cables and the associated switchgear are past their expected life and their condition makes it difficult to accurately assess their remaining safe and reliable operation. The cables should be replaced before an unexpected failure occurs which could impact plant production by causing a unit trip. In addition, the physical support structure has deteriorated such that they also need refurbishment or repair.

Why do this project now?

An electrical fault in the cable tray area of the East Tunnel could result in significant damage to cables and support structures, potentially causing a unit trip or fire. In the interim, the plant has implemented preventative measures to remove and reduce the amount of water present in the tunnel to mitigate the risk of a cable shorting out, but this does not address the age of the equipment. The cables and associated equipment require replacement as they have reached the end of their useful life. Some of the work associated with cable replacement must take place during a unit outage. There is sufficient outage time planned in 2014 to complete the necessary work.

Why do this project this way?

The cables cannot be repaired. Replacement is the only option to eliminate the risk to the plant and personnel. The operating conditions for the cable will be evaluated, and cable routing and specification will be examined and optimized to maximize asset life.

CI Number : 44729 - TUC - Station & Unit Transformer Connection Cable Replacement **Project Number**

Parent CI Number : -

Cost Centre : 311 - 311-Tufts Cove Admin./Common Capita **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		1,724	0	1,724
095		095-Thermal & Hydro Contracts AO		8,717	0	8,717
095		095-Thermal Regular Labour AO		2,340	0	2,340
001	023	001 - THERMAL Regular Labour	023 - SGP - Power Equip.-Station S	12,269	0	12,269
012	023	012 - Materials	023 - SGP - Power Equip.-Station S	198,769	0	198,769
013	023	013 - POWER PRODUCTION Contracts	023 - SGP - Power Equip.-Station S	89,224	0	89,224
			Total Cost:	313,042	0	313,042
			Original Cost:	44,750		

TUC – Station & Unit Transformer Connection Cable Replacement
Summary of Alternatives

Division :	Nova Scotia Power Inc.	**Date :**	**19-Nov-13**
Department :	Tufts Cove	**CI Number:**	44729
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Replace Cables	6.49%	-5,127,634	4,619,346	1	55.56%	2.8 years
B	Repair Cables	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

It is recommended to replace the cables. The cables are past their useful life.

Notes/Comments :

Replace Cables

It is estimated that there is a 20% probability of each of these cables failing, increasing over time. Failure of one of these cables would result in a forced outage of TUC1 for an estimated six weeks while sourcing material. An estimated 160 hours of labour would also be required to execute the repair, and $200K in materials and start-up costs.

Repair Cables

Repair of the cables is not feasible. No other technically-feasible alternatives were identified.

Test 3

Test 4

TUC – Station & Unit Transformer Connection Cable Replacemen
Summary of Sensitivities

Division :	Nova Scotia Power Inc.	**Date :**	**19-Nov-13**
Department :	Tufts Cove	**CI Number:**	44729
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Cables	6.49%	-5,127,634	4,619,346	1	55.56%	2.8 years
B	Repair Cables	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Cables	10%	-5,096,970	4,595,955	1	50.38%	3.1 years
B	Repair Cables	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
Change:	**A**		30,663	-23,391	0	-5.18%	0.3 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replace Cables	-10%	-4,584,207	4,134,020	1	49.88%	3.1 years
B	Repair Cables	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
Change:	**A**		543,426	-485,326	0	-5.68%	0.3 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement		PV of Revenue Requirement	PV of Revenue Requirement	PV of Revenue Requirement	Delay?
	Yrs Delay:	1	2	3	
	A	87,195	209,622	320,203	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

TUC – Station & Unit Transformer Connection Cable Replacement
Avoided Cost Calculations

Division :	Nova Scotia Power Inc.	**Date :**	**19-Nov-13**
Department :	Tufts Cove	**CI Number:**	44729
Originator :		**Project No. :**	

Replace Cables

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			210,179	224,902		
Events/Outages (#)	2	2	2	2		
Probability of Occurance (%)	20%	20%	20%	20%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	100	100				
Duration (Hours)	1176	1176				
Totals	$9,907	$64,124	$84,072	$89,961	$93,978	$154,085

Total Capital Cost of Alternative **$313,042**

Repair Cables

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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**

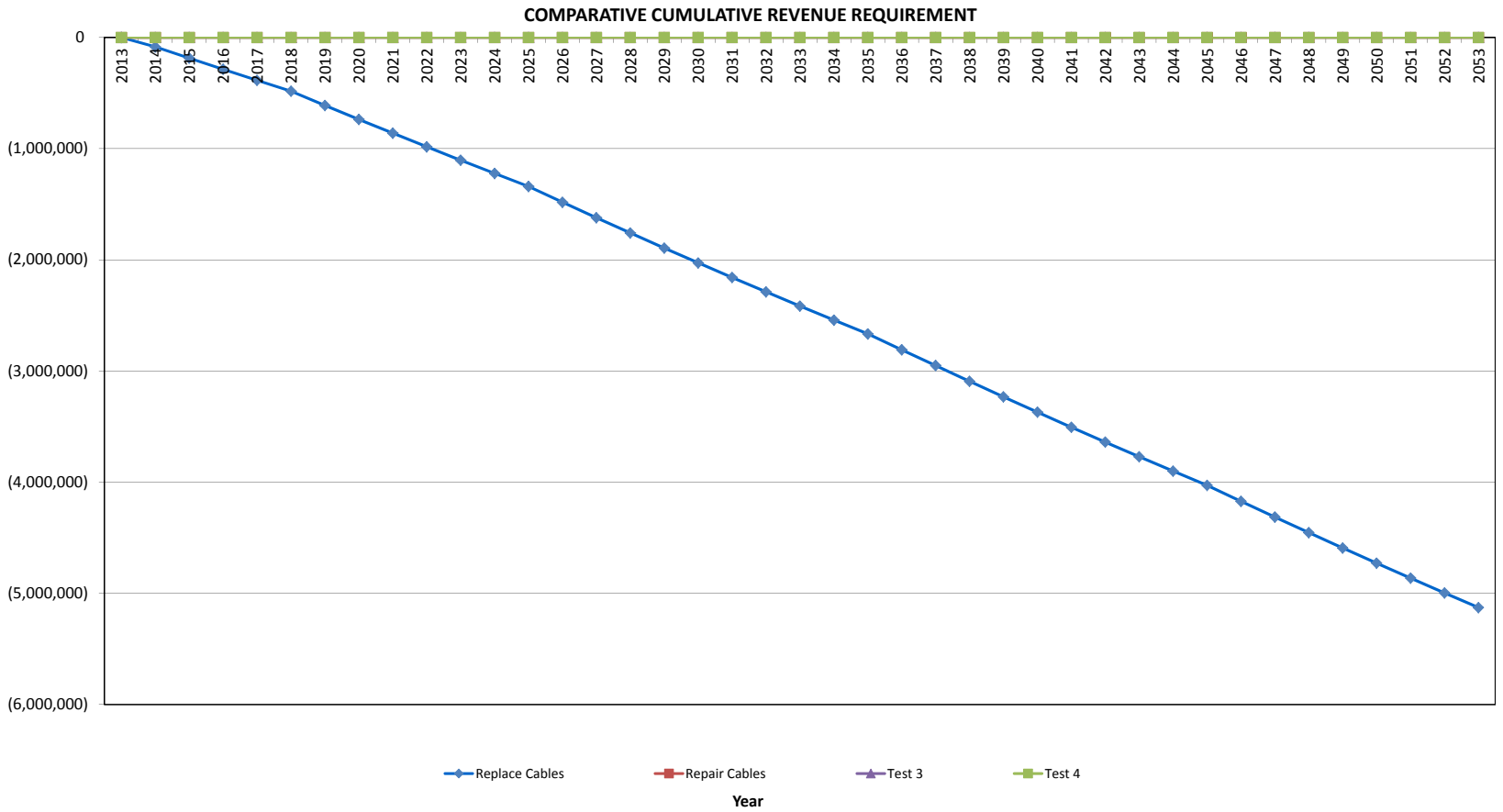
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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**

TUC – Station & Unit Transformer Connection Cable Replacement
Replace Cables

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	93,978.3	(301,985.0)	12,010.5	291,302.5	(208,006.6)	(25,410.0)	(233,416.7)	(219,191.2)	0.94	(219,191.2)
2015	-	-	154,084.8	-	23,060.1	267,733.0	154,084.8	(40,617.7)	113,467.1	100,058.1	0.88	(119,133.1)
2016	-	-	161,668.9	-	21,215.3	246,049.0	161,668.9	(43,540.6)	118,128.2	97,819.9	0.83	(21,313.2)
2017	-	-	169,720.0	-	19,518.0	226,099.7	169,720.0	(46,562.6)	123,157.4	95,769.1	0.78	74,455.9
2018	-	-	178,269.7	-	17,956.6	207,746.3	178,269.7	(49,697.1)	128,572.6	93,886.8	0.73	168,342.7
2019	-	-	234,189.4	-	16,520.1	190,861.3	234,189.4	(67,477.5)	166,711.9	114,317.7	0.69	282,660.4
2020	-	-	246,251.7	-	15,198.5	175,327.0	246,251.7	(71,626.5)	174,625.2	112,446.3	0.64	395,106.7
2021	-	-	259,072.1	-	13,982.6	161,035.5	259,072.1	(75,977.7)	183,094.3	110,714.4	0.60	505,821.1
2022	-	-	272,702.0	-	12,864.0	147,887.3	272,702.0	(80,549.8)	192,152.2	109,110.3	0.57	614,931.5
2023	-	-	287,196.3	-	11,834.9	135,790.9	287,196.3	(85,362.0)	201,834.2	107,623.4	0.53	722,554.8
2024	-	-	302,613.7	-	10,888.1	124,662.3	302,613.7	(90,435.0)	212,178.8	106,244.1	0.50	828,798.9
2025	-	-	319,017.2	-	10,017.0	114,423.9	319,017.2	(95,790.0)	223,227.1	104,964.2	0.47	933,763.1
2026	-	-	403,768.5	-	9,215.7	105,004.7	403,768.5	(122,311.4)	281,457.1	124,278.9	0.44	1,058,042.0
2027	-	-	426,066.5	-	8,478.4	96,338.9	426,066.5	(129,452.3)	296,614.2	122,989.6	0.41	1,181,031.6
2028	-	-	449,806.7	-	7,800.1	88,366.5	449,806.7	(137,022.0)	312,784.7	121,790.4	0.39	1,302,822.0
2029	-	-	475,087.8	-	7,176.1	81,031.8	475,087.8	(145,052.6)	330,035.2	120,675.5	0.37	1,423,497.5
2030	-	-	502,015.2	-	6,602.0	74,283.9	502,015.2	(153,578.1)	348,437.1	119,639.4	0.34	1,543,136.9
2031	-	-	530,701.9	-	6,073.9	68,075.8	530,701.9	(162,634.7)	368,067.2	118,677.5	0.32	1,661,814.4
2032	-	-	561,268.5	-	5,588.0	62,364.4	561,268.5	(172,261.0)	389,007.5	117,785.1	0.30	1,779,599.5
2033	-	-	593,844.1	-	5,140.9	57,109.9	593,844.1	(182,498.0)	411,346.1	116,958.3	0.28	1,896,557.7
2034	-	-	628,566.8	-	4,729.7	52,275.7	628,566.8	(193,389.5)	435,177.3	116,193.2	0.27	2,012,751.0
2035	-	-	665,584.3	-	4,351.3	47,828.3	665,584.3	(204,982.2)	460,602.1	115,486.6	0.25	2,128,237.6
2036	-	-	822,563.8	-	4,003.2	43,736.7	822,563.8	(253,753.8)	568,810.0	133,925.8	0.24	2,262,163.4
2037	-	-	871,671.3	-	3,682.9	39,972.4	871,671.3	(269,076.4)	602,594.9	133,233.6	0.22	2,395,396.9
2038	-	-	924,048.5	-	3,388.3	36,509.2	924,048.5	(285,404.7)	638,643.9	132,598.3	0.21	2,527,995.3
2039	-	-	979,921.2	-	3,117.2	33,323.1	979,921.2	(302,809.2)	677,111.9	132,017.3	0.19	2,660,012.6
2040	-	-	1,039,530.5	-	2,867.8	30,391.9	1,039,530.5	(321,365.4)	718,165.1	131,488.0	0.18	2,791,500.6
2041	-	-	1,103,134.9	-	2,638.4	27,695.2	1,103,134.9	(341,153.9)	761,981.0	131,007.7	0.17	2,922,508.3
2042	-	-	1,171,010.4	-	2,427.3	25,214.2	1,171,010.4	(362,260.8)	808,749.7	130,574.4	0.16	3,053,082.7
2043	-	-	1,243,452.7	-	2,233.2	22,931.7	1,243,452.7	(384,778.1)	858,674.6	130,185.9	0.15	3,183,268.6
2044	-	-	1,320,777.9	-	2,054.5	20,831.8	1,320,777.9	(408,804.2)	911,973.6	129,840.0	0.14	3,313,108.6
2045	-	-	1,403,324.1	-	1,890.1	18,899.9	1,403,324.1	(434,444.5)	968,879.6	129,535.1	0.13	3,442,643.7
2046	-	-	1,704,518.0	-	1,738.9	17,122.5	1,704,518.0	(527,861.5)	1,176,656.5	147,726.5	0.13	3,590,370.2
2047	-	-	1,812,059.9	-	1,599.8	15,487.4	1,812,059.9	(561,242.6)	1,250,817.3	147,466.6	0.12	3,737,836.8
2048	-	-	1,926,898.0	-	1,471.8	13,983.0	1,926,898.0	(596,882.1)	1,330,015.9	147,247.5	0.11	3,885,084.3
2049	-	-	2,049,538.6	-	1,354.1	12,599.0	2,049,538.6	(634,937.2)	1,414,601.4	147,067.4	0.10	4,032,151.7
2050	-	-	2,180,523.5	-	1,245.8	11,325.7	2,180,523.5	(675,576.1)	1,504,947.4	146,924.7	0.10	4,179,076.3
2051	-	-	2,320,432.3	-	1,146.1	10,154.3	2,320,432.3	(718,978.7)	1,601,453.6	146,817.9	0.09	4,325,894.2
2052	-	-	2,469,885.0	-	1,054.4	9,076.6	2,469,885.0	(765,337.5)	1,704,547.5	146,745.5	0.09	4,472,639.7
2053	-	-	2,629,545.1	-	970.1	8,085.1	2,629,545.1	(814,858.3)	1,814,686.9	146,706.2	0.08	4,619,346.0
Total	**-**	**-**	**35,888,309.9**	**(301,985.0)**	**289,105.6**		**35,586,325.0**	**(11,035,753.3)**	**24,550,571.6**	**4,619,346.0**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(1,000,000)
(2,000,000)
(3,000,000)
(4,000,000)
(5,000,000)
(6,000,000)
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
2053
Replace Cables
Repair Cables
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: Tufts Cove
CI# / FP#: 44729
Title: TUC Station Unit Cable Replacement
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	pd	20.0	$ 339	$ 6,786		
1.2	Engineering (P.Eng)	pd	14.3	$ 384	$ 5,483		
1.3							
				Sub-Total	$ 12,269		
2	**012 Materials**						
2.1	Cable Materials	lot	1	[redacted]		Cost Support 1	
2.2	Contingency on Cable Materials	%	[redacted]				
2.3	Cable Tray & Support Structure	lot	1	$ 20,000.00	$ 20,000		
2.4					$ -		
2.5					$ -		
				Sub-Total	$ 198,769		
3	**013 Contracts**						
3.1	Project Engineering Support	hr	200	$ 120.00	$ 24,000		
3.2	Contract Trades for Installation	lot	1	$ 42,900.00	$ 42,900		
3.3	Contract Trades for Removal	lot	1	$ 17,100.00	$ 17,100		
3.4	Staging	lot	1	$ 5,224.00	$ 5,224		
				Sub-Total	$ 89,224		
4	**094 Interest Capitalized**						
4.1	Interest Capitalized	lot	1	$ 1,723.65	$ 1,724		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 1,724		
5	**095 Administrative Overhead**						
5.1	Contracts AO	lot	1	$ 8,717.18	$ 8,717		
5.2	Regular Labour AO	lot	1	$ 2,339.63	$ 2,340		
5.3					$ -		
				Sub-Total	$ 11,057		
				SUB-TOTAL (no AO, AFUDC)	$ 300,261		
				TOTAL (AO, AFUDC included)	$ 313,042		
6	**Original Cost**						
6.1					$ 44,750		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

ANIXTER

QUOTATION

See attached Anixter Terms and Conditions of Sale

Date: 5/14/2013
Quote #: 75452
Customer #: 012310

CEPHAS HOPE
NOVA SCOTIA POWER

Anixter Canada Inc.
86 Troop Avenue, Unit H
Dartmouth, Nova Scotia
B3B 1Z1

Phone:
Fax:

TUFTS COVE

Item	Quantity	Anixter Catalog Number and Description	Unit	Unit Price	Extended Price
01	1500	N/S AETNA WIRE TECK90 #1000-1/C.XLPE 5KV.SHIELDED AIA TECK90 PVC JKT CSA ***DELIVERY=6 WEEKS*** NOTE:MIN.ORDER IS 1500 METERS	MT	[redacted]	CAD [redacted]
02	1	3M-7625-T-110 3M ELECT 7625-T-110 INDOOR TERM QT-III COLD SHRNK SHLD CABLE KITS TYPE 5-15KV INS O.D. 1.05-1.80"	BX	[redacted]	CAD [redacted]
03	1	TECK200-13 ANIX KITS TECK200-13 2" ALUMINUM TECK CONNECTOR C/W LOCK NUT RANGE: 1.900"-2.187"	EA	[redacted]	CAD [redacted]

Page Total: **CAD** [redacted]
Quote Total: **CAD** [redacted]

TERMS NET30THPROX, subject to credit approval
F.O.B. SHIP.PT., PREPAID
SHIPMENT: MATERIAL @ ANIXTER IS SUBJECT TO PRIOR SALE
NOTES: QUOTE IS BASED ON METAL PRICES AS NOTED,AND IS SUBJECT TO CHANGE TO REFLECT CURRENT METALS AT TIME OF SHIPMENT

Please refer all inquiries to:
RON ROY

ANIXTER CANADA INC.
86 TROOP AVE.

DARTMOUTH, N.S. B3B 1Z1

Phone: 902-481-3609
Fax: 902-468-8422

COMMENTS: CUSTOMER ACCEPTANCE OF A QUOTE,DESIGNATED WITH N/S PART #'S ARE NON-CANCELABLE AND NON-RETURNABLE



CI Number: 42943

Title: TUC2 - Turbine-Generator (T-G) Area Fire Protection

Start Date: 2014/05
Final Cost Date: 2015/02
Function: Generation
Forecast Amount: $292,621

DESCRIPTION:

The purpose of this project is to install a fire suppression system in the Unit 2 Turbine-Generator area at the Tufts Cove Generating Station. At the time of original construction, the fire protection infrastructure was compliant with standards of the day, but more recent risk analysis identified that the fire protection around the turbine generator no longer meets current industry guidelines. Scope of the project will include design and installation of a fixed automatic wet, and pre-action sprinkler system. Design of the system will be similar to work undertaken at the Lingan Generating Station (CIs 29039, 38846, 40184 and 40427).

Summary of Related CIs +/- 2 years:
2011 CI 39563 TUC U&U Burner Front Water Sprinkler System $50K

JUSTIFICATION:

Justification Criteria: Health & Safety

Sub Criteria: Buildings

Why do this project?

In an 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 fire risk is primarily due to the large quantities of lubricating oil and the extensive pressurized lubricating oil delivery piping. 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). 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?

NS Power's insurance providers have recommended additional fire system risk-control measures. NS Power believes these modifications are important now due to the plant's age. A staged installation of one unit at a time is appropriate to reduce risk in the long term. Unit 2 is scheduled for a maintenance outage in 2014 which will facilitate installation of the fire suppression equipment.

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 - Turbine-Generator (T-G) Area Fire Protection **Project Number**

Parent CI Number : -

Cost Centre : 318 - 318-TC Unit 2 Capital **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		6,397	0	6,397
095		095-Thermal & Hydro Contracts AO		14,655	0	14,655
095		095-Thermal Regular Labour AO		5,056	0	5,056
001	003	001 - THERMAL Regular Labour	003 - SGP - Bldg.,Struct.Grnd.	26,513	0	26,513
002	003	002 - THERMAL Overtime Labour	003 - SGP - Bldg.,Struct.Grnd.	0	0	0
012	003	012 - Materials	003 - SGP - Bldg.,Struct.Grnd.	90,000	0	90,000
013	003	013 - POWER PRODUCTION Contracts	003 - SGP - Bldg.,Struct.Grnd.	150,000	0	150,000
			Total Cost:	292,621	0	292,621
			Original Cost:			

Location: Tufts Cove Generating Station
CI# / FP#: 42943
Title: TUC2 - Turbine - Generator Area Fire Protection
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	pd	20.0	$ 339	$ 6,786		29039, 38846, 40184,
1.2	Engineering (P.Eng)	pd	17.1	$ 384	$ 6,580		40427
1.3	Maintenance Trades	pd	30.0	$ 345	$ 10,363		
1.4	CADD	pd	11.4	$ 244	$ 2,785		
1.5				$ -	$ -		
				Sub-Total	$ 26,513		
2	**012 Materials**						
2.1	Electrical Cabling and Associated Material	lot	1	$ 5,000.00	$ 5,000		29039, 38846, 40184,
2.2	Sprinkler System Materials	lot	1	$ 80,000.00	$ 80,000		40427
2.3	Containment System	lot	1	$ 5,000.00	$ 5,000		
				Sub-Total	$ 90,000		
3	**013 Power Production Contracts**						
3.1	Fire Suppression Equipment and Installation	lot	1	$ 120,000.00	$ 120,000		29039, 38846, 40184,
3.2	Scaffolding	lot	1	$ 25,000.00	$ 25,000		40427
3.3	Fire Alarm System Contractor	lot	1	5000	$ 5,000		
				Sub-Total	$ 150,000		
4	**094 Interest Capitalized**						
4.1	Interest Capitalized	lot	1	$ 6,396.70	$ 6,397		
4.2					$ -		
				Sub-Total	$ 6,397		
5	**095 Administrative Overhead**						
5.1	Contracts AO	lot	1	$ 14,655.00	$ 14,655		
5.2	Regular Labour AO	lot	1	$ 5,056.03	$ 5,056		
5.3	Overtime AO	lot	1				
				Sub-Total	$ 19,711		
				SUB-TOTAL (no AO, AFUDC)	$ 266,513		
				TOTAL (AO, AFUDC included)	$ 292,621		
6	**Original Cost**						
6.1					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
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes
Note 3: Small differences in totals are attributable to rounding.

Risk Services

ZURICH

400 UNIVERSITY AVENUE, TORONTO, ONTARIO M5G 1S7
Visit us on the Internet: http://www.zurichcanada.com
Email: riskservices@zurich.com

ISO 9001
Quality-Assured Service Unit

September 24, 2008

Jerry MacKinnon, Risk Manager

Emera Inc.

Coverages: Property, Contingent Business Interruption, and Extra Expense

1894 Barrington Street

Barrington Tower

Halifax, Nova Scotia B3J 2A8

Risk Assessment Report

Report By

Lino Di Leonardo

Tel: (519) 824-4548

Fax: (519) 824-0916

Email: lino.di.leonardo@zurich.com

Our Ref. No. 895P2111

This Report is based on conditions and practices observed at the time of our inspection and information obtained from your management and other sources. It does not purport to list all hazards or to indicate that other hazards do not exist. Inspections and recommendations made by ZURICH are advisory. Any decision on measures to be taken, as well as their implementation and control, shall be your sole obligation and responsibility. No representation is made that compliance with any or all recommendations guarantees the fulfillment of any legal obligation, or render your facilities, products or services free of hazard or risk. By delivery of this Report, ZURICH does not assume any responsibility for discovery, notification or elimination of hazards or risks.

You acknowledge and agree that ZURICH is entitled to fully or partly disclose this Report and other information obtained in connection with the preparation of this Report to your insurance broker, to any reinsurer or other insurer which participates or may participate in any insurance policy that may be issued to you, as well as to any other person when so required by law, statute, regulation or an order of a public authority or court.

Neither Zurich nor its representatives shall be liable, either directly or indirectly, for any loss, damage (whether special, direct, consequential or otherwise), injury or costs suffered or incurred by you or any other person arising or alleged to have arisen out of any act, error, omission or negligence of Zurich or its representatives in connection with or occasioned by this Report.

May, 2005

™ Trademark of Zurich Insurance Company ™ Marque de commerce de «Zurich» Compagnie d'Assurances

On September 8 to 12, 2008 I had the opportunity to view the operations and facilities located at the following locations:

Lingan Generating Station (September 8);
Point Aconi Generating Station (September 9);
Point Tupper Generating Station (September 10);
Trenton Generating Station (September 11);
Tufts Cove Generating Station (September 12).

A meeting with Mr. Rick Janega, General Manager Power Production was held on September 12.

The purpose of my visit was to gather information for underwriting purposes and offer advice that may help to reduce or eliminate accidental losses.

LINGAN GENERATING STATION

Recommendation 2005-4 dealing with providing adequate mechanical ventilation in the battery room has been completed.

Recommendation 2006-1 dealing with providing exposure sprinkler for the windows above the transformers has been removed. The windows were replaced with translucent panels and the vents were blocked off. Everything is now sealed.

No new recommendations have been submitted as a result of our 2008 risk assessment. Actuators on the condenser vacuum breakers have been installed on all units except U3. Adequate operating procedures are in place in conjunction with fire fighting procedures involving a TG lube oil fire.

Advice for Risk Improvement

2005-1
Essential

Turbine Generators: Protect the turbine generators per NFPA 850 which include the following:

a) Turbine-generator **bearings** should be protected with an automatic closed-head sprinkler system utilizing directional nozzles. Automatic actuation is more reliable than manual action. Fire protection systems for turbine-generator bearings should be designed for a density of 0.25 gpm/ft² over the protected area of all bearings. (Per NFPA 850, 7.7.4.2.1).

b) Provide automatic sprinkler or foam-water sprinkler protection to cover **all areas beneath** the turbine-generator operating floor that are subject to oil flow, oil spray, or oil accumulation. This coverage normally includes all areas beneath the operating floor in the turbine building. The sprinkler system beneath the turbine-generator should

ZURICH

take into consideration obstructions from structural members and piping and should be designed to a density of 0.30 gpm/ft^2 over a minimum application of 5000 ft^2. (Per NFPA 850, 7.7.4.1.1).

c) Lubricating oil lines above the turbine operating floor should be protected with an automatic sprinkler system covering those areas subject to oil accumulation including the area **within the turbine lagging (skirt)**. The automatic sprinkler system should be designed to a density of 0.30 gpm/ft^2. (Per NFPA 850, 7.7.4.1.2).

d) Provide fireproofing for the steel pedestals supporting the 4 turbine generators using materials having a 2½ hour fire resistive rating by UL 1709. The protection should extend to the full load-bearing height of the pedestals.

e) Review the design and capabilities of the existing drainage system surrounding the turbine generators, lube oil, and seal oil tanks. (Refer to NFPA 850, 5.6 and NFPA 15, 4.2).

COMMENTS: This recommendation is being reviewed as part of corporate management initiative.

The first phase which was to conduct a gap analysis with respect to existing industry standards such as NFPA 850 and FM DS 7-101. This phase has been completed.

The next phase is to prioritize the recommendations for each station and develop a corporate risk matrix. Costs to complete the recommendations and loss scenarios will be developed. The results of this study will be presented to the regulators and board of directors for approval. If approved, the recommendations will be completed over several years.

2008 Comments: The protection for Unit 4 is being engineered. Quotes have been let and bidding is to be completed by end of September. Plans are to provide the recommended protection for Unit 4 by end of 2008. Plans are to extend the protection to Unit 3 in 2009.

2005-2

Essential

Control Room, Cable Spreading Room, and MCC Rooms: Protect these rooms as follows:

a) **Cable spreading rooms and cable tunnels and MCC rooms** should be protected with automatic sprinkler, water spray, or automatic gaseous extinguishing systems. Automatic sprinkler systems should be designed for a density of 0.30 gpm/ft^2 over 2500 ft^2 or the most remote 100 linear ft of cable tunnels up to 2500 ft^2. (Per NFPA 850, 7.8.2.1).

b) Seal all cable tray openings with 2 hour rated fire stopping

ZURICH

materials.

c) Separate the control room from the rack room by 2 hour rated partition.

d) Provide a special extinguishing system for the Relay Room (Refer to recommendation 2005-2 indicated below for details).

COMMENTS: This recommendation is being reviewed as part of corporate management initiative.

2005-3

Essential

Multi Level Cable Trays: Protect the multiple level (3 levels or higher) electrical cable trays by providing the following:

a) A line of directional spray automatic sprinklers to protect the cable tray runs.

b) Metal barriers beneath and along the sides of the trays to protect the cables from an exposing fire.

- Noted areas include the Turbine Generator operating floor.

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative.

2008 Comments: Station has purchased a multi-vac unit which will be used to keep the trays cleaned. Still investigating capital options as part of divisional gap analysis.

2005-5

Important

Boilers: Boiler-furnaces with multiple oil-fired burners or using oil for ignition should be protected with automatic sprinkler, water spray, foam, or foam-water sprinkler systems covering the burner front oil hazard. Sprinkler and water spray systems should be designed for a density of 0.25 gpm/ft^2 over the protected area. (Refer to NFPA 850, 7.5.1.1 and 7.5.1.2).

Note: Sprinkler protection should extend to the light oil and heavy oil transfer pumps. (This will be completed in 2009.)

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative. See comments above.

2008 Comments: Developed procedures for fire fighting at the burner front. Training/education with flow /pressure sensing devices. Heavy Fuel Oil & Light Fuel Oil - new foam generators, training to operators and Emergency Response Team are provided.

ZURICH

2005-7

Routine

Maintenance Items: Make the following improvements:

a) Provide a day tank for the diesel engine fire pump. (Under review).

c) Provide 2 hour rated fire retardant coating on the used oil tank supports located in the diked area. (Under review).

d) Provide sprinkler protection over the fire pump area. (To do in 2009).

2007-1

Critical

Water Supplies: Investigate the low suction pressures on the suction side of the fire pumps.

COMMENTS: The fire pumps at this facility are rated for 2000 gpm at 100 psi. The May 26, 2007 pump tests indicated low suction pressures, the test was halted, and the pumps could not be tested to their 150% rated capacity. When flowing 2228 gpm, suction pressures dropped to 10 psi and when flowing 2404 gpm, suction pressures dropped to 5 psi.

The low suction pressures appear to be caused by long run of 8 inch municipal water mains coupled with 8 inch on-site supply piping to the pumps.

UL/ULC or FM approved fire pumps are listed to supply minimum their rated flow and pressures and 65% rated pressures at 150% rated flow. Annually, fire pumps should be tested and their performance compared to their original manufacturer's rated characteristics. Low suction pressures may cause the main to collapse, cause damages the pump itself, or create hazardous process upsets to other municipal users.

Fire pumps should be tested to their 150% of rated flow and it's recommended that suction pressures should not drop below 20 psi. Hence, the high friction losses of the supply piping should be investigated.

2008 Comments: Local management is aware of this issue and it will be resolved in 2009. Considering installing new fire pumps and suction tank in conjunction with the U4 sprinkler protection project.

POINT ACONI GENERATING STATION

No new recommendations have been added as a result of the 2008 risk assessment.

ZURICH

Advice for Risk Improvement

2005-1

Essential

Turbine Generators: Protect the turbine generators per NFPA 850 which include the following:

a) Provide automatic sprinkler or foam-water sprinkler protection to cover all areas beneath the turbine-generator operating floor that are subject to oil flow, oil spray, or oil accumulation. This coverage normally includes all areas beneath the operating floor in the turbine building. The sprinkler system beneath the turbine-generator should take into consideration obstructions from structural members and piping and should be designed to a density of 0.30 gpm/ft^2 over a minimum application of 5000 ft^2. (Per NFPA 850, 7.7.4.1.1).

b) Lubricating oil lines above the turbine operating floor should be protected with an automatic sprinkler system covering those areas subject to oil accumulation including the area **within the turbine lagging (skirt)**. The automatic sprinkler system should be designed to a density of 0.30 gpm/ft^2. (Per NFPA 850, 7.7.4.1.2).

c) Review the design and capabilities of the existing drainage system surrounding the turbine generator, lube oil, and seal oil tanks. (Refer to NFPA 850, 5.6 and NFPA 15, 4.2).

COMMENTS: This recommendation is being reviewed as part of corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2008 Comments: This initiative is still at a corporate level as far as funding and evaluation.

2005-2

Essential

Digital Processing Unit (DPU) Room: Provide an automatic fixed pipe clean agent system to protect the 50 ft by 100 ft DPU room. Include the following in the system design:

a) A system of spot-type smoke detectors.
b) A connected reserve supply in case of reflash.
c) A system control unit designed for release device service to monitor the detectors and actuate the system.
d) A system control unit arranged to provide an "and gate" function, so that two detectors must operate before the system actuates.
e) Interlocks to shutdown the ventilation system and close dampers and doors prior to discharge, when the system is activated either automatically or manually.
f) A clearly identified manual means of operating the system located outside the immediate fire area. Actuate the entire system by a single action of the individual operating the system.

ZURICH

g) Acceptance tests conducted in the presence of a Zurich Risk Services representative. A door fan test should be conducted to ensure the integrity of the room.

COMMENTS: This room is critical to the continued operation and contains main and back-up control units in the same area. This room contains grouped cables and is provided with smoke detectors but is not sprinkler protected. In event of a fire, loss of this room would cause extensive delays in restoring production. This recommendation is being reviewed as part of corporate management initiative.

2008 Comments: Very early warning fire detection (VEWFD) systems for the DPU room is complete. The installation also included the upgrade of the Control Room Fire Alarm panel.

2005-3

Essential

Multi Level Cable Trays: Protect the multiple level (3 levels or higher) electrical cable trays by providing the following:

a) A line of directional spray automatic sprinklers to protect the cable tray runs.
b) Metal barriers beneath and along the sides of the trays to protect the cables from an exposing fire.

Noted areas include the Boiler and Turbine Generator operating floor.

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative.

2008 Comments: Plant initiative is to increase proactive cleaning cycles to remove all combustible materials from areas where build up normally occurs.

2005-4

Essential

Crusher Building – Explosion Venting: Review the design details pertaining to the explosion relief venting capabilities of the Crusher Building.

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2005-5

Important

Boiler: Boiler-furnaces with multiple oil-fired burners or using oil for ignition should be protected with automatic sprinkler, water spray, foam, or foam-water sprinkler systems covering the burner front oil hazard. Sprinkler and water spray systems should be designed for a density of 0.25 gpm/ft^2 over the protected area. (Refer to NFPA 850, 7.5.1.1 and 7.5.1.2).

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative. Refer to comments of Recommendation

ZURICH

2005-1 (Lingan Generating Station) for details.

2008 Comments: Procedure for use at Point Aconi dealing with burner boiler front is being developed. Fire fighting training is continuous every year and portable foam stations are now in place at the burner stations for use in an emergency.

2005-6

Routine

Maintenance Items: Make the following improvements:

b) Relocate the diesel tank away from the conveyor support or provide 2 hour rated fire retardant coating on the steel supports.
c) Provide smoke/heat detection in the waste water treatment building.

2008 Comments: Providing fire retardant coating on the steel supports is under review. A quote to provide smoke detectors for the waste treatment building has been received and is being evaluated for installation in 2008/2009.

2006-1

Important

Exposure Protection: Provide a line of exposure sprinklers for the windows located above the outside transformers or seal all the wall openings.

2008 Comments: Quotes have been received on installing a fire resistant window in the control room area immediately above the transformer. This will be considered for installation after the 2008 shutdown. Corporate management will review installing sprinklers along the boiler house windows.

2007-1

Critical

Fire Pump: Repair the diesel engine fire pump such that it can supply its full rated flow and pressure characteristics.

COMMENTS: Results of the September 20, 2007 tests indicated that it was operating approximately 30% below its rated pressure at 100% rated flow. The fire pumps at this facility are rated for 2000 gpm at 165 psi. When flowing 2258 gpm, only 100 psi discharge pressures were produced.

Note: A proper annual pump test should be performed per NPFA standards such that their performance can be compared to its original manufacturer's characteristics. Flow tests should be conducted such that discharge pressure pressures can be measured at 150% of rated flow (i.e. 3000 gpm).

2008 Comments: It is believed that the main relief valve was open during previous tests and requires maintenance. This will be corrected prior to retesting scheduled for October, 2008.

ZURICH

POINT TUPPER GENERATING STATION

Risk Improvement Advice Implemented

2005-6	**Exposure Protection:** Provide a line of exposure sprinklers for the windows located above the outside transformers.
2005-7	**Maintenance Items:** Make the following improvements: c) Provide sprinkler protection over the diesel fire pump and tank. d) Provide a floor drain for the bathroom located adjacent the control room. f) Provide smoke detection (arranged to annunciate to the control room) in the crude oil transfer house. g) Provide sprinkler protection for the compressor room. h) Provide sprinkler protection for the diesel generator room.
2006-1	**Conveyor Gallery Supports:** Provide suitable barriers to prevent vehicular damage to the conveyor gallery supports.

Please accept my thanks for the advice, which has been addressed.

One new recommendation dealing with protection of the Point Tupper Marine Terminal has been added as a result of this risk assessment.

Advice for Risk Improvement

2005-1

Essential

Turbine Generators: Protect the turbine generator per NFPA 850 which include the following:

a) Turbine-generator **bearings** should be protected with an automatic closed-head sprinkler system utilizing directional nozzles. Automatic actuation is more reliable than manual action. Fire protection systems for turbine-generator bearings should be designed for a density of 0.25 gpm/ft² over the protected area of all bearings. (Per NFPA 850, 7.7.4.2.1).

b) Provide automatic sprinkler or foam-water sprinkler protection to cover **all areas beneath** the turbine-generator operating floor that are subject to oil flow, oil spray, or oil accumulation. This coverage normally includes all areas beneath the operating floor in the turbine building. The sprinkler system beneath the turbine-generator should take into consideration obstructions from structural members and piping and should be designed to a density of 0.30 gpm/ft^2 over a minimum application of 5000 ft^2. (Per NFPA 850, 7.7.4.1.1).

c) Lubricating oil lines above the turbine operating floor should be protected with an automatic sprinkler system covering those areas

ZURICH

subject to oil accumulation including the area **within the turbine lagging (skirt)**. The automatic sprinkler system should be designed to a density of 0.30 gpm/ft^2. (Per NFPA 850, 7.7.4.1.2).

d) Provide containment dikes around the lube oil/hydrogen seal oil tanks.

e) Provide fireproofing for the steel columns supporting the lube oil/seal oil tanks using materials having a 2½ hour fire resistive rating by UL 1709. The protection should extend to the full load-bearing height of the columns.

f) Review the design and capabilities of the existing drainage system surrounding the turbine generator, lube oil, and seal oil tanks. (Refer to NFPA 850, 5.6 and NFPA 15, 4.2).

COMMENTS: This recommendation is being reviewed as part of corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2008 Comments: New Vacuum breaker control valve installed November 2007. Draft Procedure reviewed by POT Operations for lube oil fire response. Sprinkler systems for bearings, area under turbine and lubricating oil lines being reviewed as part of corporate management initiative.
(Note: POT has sprinkler protection under all areas of turbine with exception of under condenser). Containment dykes for seal oil systems, fireproofing for steel columns supporting lube/seal oil tanks and drainage design and capability review for TG, lube oil and seal oil tanks being reviewed as part of corporate management initiative.

2005-2

Essential

Control Room, Cable Spreading Room, and MCC Rooms: Protect these rooms as follows:

a) **Cable spreading rooms and cable tunnels and MCC rooms** should be protected with automatic sprinkler, water spray, or automatic gaseous extinguishing systems. Automatic sprinkler systems should be designed for a density of 0.30 gpm/ft^2 over 2500 ft^2 or the most remote 100 linear ft of cable tunnels up to 2500 ft^2. (Per NFPA 850, 7.8.2.1).
b) Seal all cable tray openings with 2 hour rated fire stopping materials.
c) Separate the control room from the rack room by 2 hour rated partition.
d) Provide a special extinguishing system for the Rack Room (For details, refer to recommendation 2005-2 pertaining to Point Aconi above).

ZURICH

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

A report for firestopping various areas has been developed and this will be completed on a program basis.

2008 Comments: Full scope for fire stopping and rack room sprinkler system being reviewed as part of corporate management initiative. However POT has proceeded with scoping proposal for fire stopping; sub-scope being evaluated for 2008 along with internal engineering evaluation of control/rack room separation. Very early warning fire detection being evaluated as an option for relay rooms.

2005-3

Essential

Multi Level Cable Trays: Protect the multiple level (3 levels or higher) electrical cable trays by providing the following:

a) A line of directional spray automatic sprinklers to protect the cable tray runs.
b) Metal barriers beneath and along the sides of the trays to protect the cables from an exposing fire.

Noted areas include the adjacent and below the Turbine Generator.

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2005-4

Essential

Coal System – Explosion Venting: Review the design details pertaining to the explosion relief venting capabilities of the coal system. This includes the dust collector and the 4-300 Tonne silos.

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2008 Comments: The dust collector is vented outside as per drawing #

A01C-2-354-51-201. However, the drawing does not indicate the venting capacity. Under review.

2005-5

Important

Boilers: Boiler-furnaces with multiple oil-fired burners or using oil for ignition should be protected with automatic sprinkler, water spray, foam, or foam-water sprinkler systems covering the burner front oil hazard. Sprinkler and water spray systems should be designed for a density of 0.25 gpm/ft^2 over the protected area. (Refer to NFPA 850, 7.5.1.1 and 7.5.1.2).

ZURICH

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2008 Comments: POT has contacted contractor regarding re-installation of header and sprinklers and is evaluating portable foam.

2007-1

Critical

Water Supplies: Investigate the low suction pressures on the suction side of the fire pumps.

COMMENTS: The fire pumps at this facility are rated for 1000 gpm at 100 psi. The January 19, 2007 pump tests indicated low suction pressures. When flowing 1454 gpm, suction pressures dropped to 8 psi and when flowing 1543 gpm, suction pressures dropped to 0 psi.

Low suction pressures may cause the main to collapse, cause damages the pump itself, or create hazardous process upsets to other municipal users. It is recommended that suction pressures should not be dropped below 20 psi.

Note: When sprinkler protection for the turbine generators is provided, it is estimated that both fire pumps are needed to supply the required sprinkler water demand. It is estimated that 2200 gpm should be made available for fire protection. Hence, the low suction pressures should be investigated.

2008 Comments: Fire pump flow tests were completed in 2007 and January 2008. Interim Draft Hydrant to be installed in CW outfall 2008 for unlimited water supply per review with local fire Department and c/w response procedures. Issue with fire pump suction being pursued with Capital in place for 2009 (CI#30385).

2008-1

Essential

POINT TUPPER MARINE TERMINAL - INHAUL CONVEYOR PROTECTION: Provide automatic water spray or sprinkler protection for the enclosed inhaul conveyor. Sprinkler should be designed for a minimum 0.25 gpm/ft^2 density over 2000 ft^2 of enclosed area or the most remote 100 linear ft of conveyor structure up to 2000 ft^2.

COMMENTS: This inhaul conveyor is approximately 520 m long, critical for the process, enclosed and should be sprinkler protected. Refer to NFPA 850, 7.4.6.2. This will be referred to corporate management for review.

ZURICH

TRENTON GENERATING STATION

Risk Improvement Advice Implemented

2005-8

Maintenance Items: Make the following improvements:
a) Provide "misalignment" interlock for conveyor No. 5 (To do in 2007)

e) Provide sprinkler protection for the compressor room. (To do in 2007).

Please accept my thanks for the advice, which has been addressed.

No new recommendations have been submitted as a result of this survey.

Advice for Risk Improvement

2005-1

Essential

Turbine Generators: Protect the turbine generator per NFPA 850 which include the following:

a) Turbine-generator **bearings** should be protected with an automatic closed-head sprinkler system utilizing directional nozzles. Automatic actuation is more reliable than manual action. Fire protection systems for turbine-generator bearings should be designed for a density of 0.25 gpm/ft² over the protected area of all bearings. (Per NFPA 850, 7.7.4.2.1).

b) Provide automatic sprinkler or foam-water sprinkler protection to cover **all areas beneath** the turbine-generator operating floor that are subject to oil flow, oil spray, or oil accumulation. This coverage normally includes all areas beneath the operating floor in the turbine building. The sprinkler system beneath the turbine-generator should take into consideration obstructions from structural members and piping and should be designed to a density of 0.30 gpm/ft^2 over a minimum application of 5000 ft^2. (Per NFPA 850, 7.7.4.1.1).

c) Lubricating oil lines above the turbine operating floor should be protected with an automatic sprinkler system covering those areas subject to oil accumulation including the area **within the turbine lagging (skirt)**. The automatic sprinkler system should be designed to a density of 0.30 gpm/ft^2. (Per NFPA 850, 7.7.4.1.2).

d) Protect the hydrogen seal oil and lube oil units per item (b) above.

e) Encase in concrete the steel column supports for Unit 6 TG or provide fireproofing for the steel pedestals supporting the turbine

ZURICH

generator using materials having a 2½ hour fire resistive rating by UL 1709. The protection should extend to the full load-bearing height of the pedestals.

f) Provide containment dikes around the lube oil and hydrogen seal oil tanks for Unit 5 TG.

g) Provide fireproofing for the steel columns supporting the lube oil/seal oil tanks using materials having a 2½ hour fire resistive rating by UL 1709. The protection should extend to the full load-bearing height of the columns.

h) Review the design and capabilities of the existing drainage system surrounding the turbine generator, lube oil, and seal oil tanks. (Refer to NFPA 850, 5.6 and NFPA 15, 4.2).

COMMENTS: This recommendation is being reviewed as part of corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2005-2

Essential

Control Room, Cable Spreading Room, Relay , and MCC Rooms: Protect these rooms as follows:

a) **Cable spreading rooms and cable tunnels and MCC rooms** should be protected with automatic sprinkler, water spray, or automatic gaseous extinguishing systems. Automatic sprinkler systems should be designed for a density of 0.30 gpm/ft^2 over 2500 ft^2 or the most remote 100 linear ft of cable tunnels up to 2500 ft^2. (Per NFPA 850, 7.8.2.1).

d) Provide a special extinguishing system for the Rack Room (For details, refer to recommendation 2005-2 pertaining to Point Aconi above).

COMMENTS: A very early warning detection system (VEWD) has been installed for U5 and U6 relay rooms, spreader rooms. This recommendation is being reviewed as part of corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2005-3

Essential

Multi Level Cable Trays: Protect the multiple level (3 levels or higher) electrical cable trays by providing the following:

a) A line of directional spray automatic sprinklers to protect the cable tray runs.
b) Metal barriers beneath and along the sides of the trays to protect the cables from an exposing fire.

ZURICH

COMMENTS: This recommendation is being reviewed as part of corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2005-5

Important

Boilers: Boiler-furnaces with multiple oil-fired burners or using oil for ignition should be protected with automatic sprinkler, water spray, foam, or foam-water sprinkler systems covering the burner front oil hazard. Sprinkler and water spray systems should be designed for a density of 0.25 gpm/ft^2 over the protected area. (Refer to NFPA 850, 7.5.1.1 and 7.5.1.2)

Note: This refers to both Unit 5 and 6 burner floors. Sprinkler protection should extend to the light oil and heavy oil transfer pumps.

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2005-6

Important

Exposure Protection: Provide a line of exposure sprinklers for the windows located above the outside transformers.

COMMENTS: This recommendation is being reviewed as part of corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2005-8

Routine

Maintenance Items: Make the following improvements:
c) Provide sprinkler protection for the coal dust collector and the associated ductwork for Unit 6. (Will investigate)

2006-1

Critical

Water Supplies: Investigate the low suction pressures on the suction side of the fire pumps.

COMMENTS: Review of the pump tests revealed low suction pressures, as follows:

July 2008: Flowing 1581 gpm, suction pressures dropped to 5 psi.

September 2007: Flowing 2025 gpm, suction pressures dropped to -9 psi.

November 2006: Flowing 2274 gpm, suction pressures dropped to -8 psi.

The fire pumps at this facility are rated for 2000 gpm/100 psi and take suction from 8 coal bunkers with a normally shut by-pass connection to the town water supply. Previous years tests on the by-pass city supply indicated that the city supply did not have adequate pressures to supply the pumps.

ZURICH

Since our previous visit, the strainers on the suction side of the pumps have been removed however; low suction pressures are still evident. The low suction pressures appear to be caused by high friction losses on the supply piping due to aging or corrosion.

UL/ULC or FM approved fire pumps are listed to supply minimum their rated flow and pressures and 65% rated pressures at 150% rated flow. Annually, fire pumps should be tested to 150% rated flow and their performance compared to their original manufacturer's rated characteristics.

Due to the low suction pressures, fire pumps can not be properly tested nor can their performance adequately assessed.

Also, low suction pressures may cause the mains to collapse or cause damages the pump itself.

In addition, in the event of a fire, the sprinkler system would activate discharging water. Throttling the valve of the discharge side of the fire pump may be required to ensure the suction pressures do not drop excessively. Therefore, reducing the quantity of water actually being discharged over the fire.

Note: The water supply at this facility can adequately provide the highest designed flow and pressures for their existing sprinkler systems (i.e. transformer deluge system plus hose stream demand). It is not adequate for the recommended turbine generator protection noted above nor does it have sufficient capacity for a 2 hour duration (264,000 gal estimated and 195,000 gal provided).

2008 Comments: Local management is aware of this water supply issue and it is presently under review. A second pump for non-fire protection use has been installed.

2006-2

Important

Conveyor Gallery Supports: Relocate the diesel fire pump tank to a new location such that it does not impinge on the conveyor gallery supports.

COMMENTS: Sprinkler protection over the tank is proposed and this will be an adequate alternative to relocating the tank.

2008 Comments: Sprinkler protection has been installed in the dike area of the tank; however, a fire involving the diesel tank would create an exposure to the gallery supports which may cause its collapse. The tank should be relocated or sprinklers installed above the tank or facing the gallery support themselves.

ZURICH

TUFTS COVE GENERATING STATION

Recommendation 2007-2 dealing with repairing the wharf fire pump to its full rated capacity has been completed.

One new recommendation has been submitted as a result of this survey.

Advice for Risk Improvement

2005-1

Essential

Turbine Generators: Protect the turbine generator per NFPA 850 which include the following:

a) Turbine-generator **bearings** should be protected with an automatic closed-head sprinkler system utilizing directional nozzles. Automatic actuation is more reliable than manual action. Fire protection systems for turbine-generator bearings should be designed for a density of 0.25 gpm/ft² over the protected area of all bearings. (Per NFPA 850, 7.7.4.2.1).

b) Provide automatic sprinkler or foam-water sprinkler protection to cover **all areas beneath** the turbine-generator operating floor that are subject to oil flow, oil spray, or oil accumulation. This coverage normally includes all areas beneath the operating floor in the turbine building. The sprinkler system beneath the turbine-generator should take into consideration obstructions from structural members and piping and should be designed to a density of 0.30 gpm/ft^2 over a minimum application of 5000 ft^2. (Per NFPA 850, 7.7.4.1.1).

c) Lubricating oil lines above the turbine operating floor should be protected with an automatic sprinkler system covering those areas subject to oil accumulation including the area **within the turbine lagging (skirt)**. The automatic sprinkler system should be designed to a density of 0.30 gpm/ft^2. (Per NFPA 850, 7.7.4.1.2).

d) Encase in concrete the steel column supports for Units 2 and 3 TGs or provide fireproofing for the steel pedestals supporting the turbine generator using materials having a 2½ hour fire resistive rating by UL 1709. The protection should extend to the full load-bearing height of the pedestals.

e) Provide containment dikes around the lube oil and hydrogen seal oil tanks.

f) Review the design and capabilities of the existing drainage system surrounding the turbine generator, lube oil, and seal oil tanks. (Refer to NFPA 850, 5.6 and NFPA 15, 4.2).

ZURICH

Note: The existing manual sprinkler protection under TG3 should be reviewed and restored to automatic service. (This is in progress and should be completed within next couple of weeks.)

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2005-2

Essential

Control Room, Cable Spreading Room, Relay, and MCC Rooms: Protect these rooms as follows:

a) **Cable spreading rooms and cable tunnels and MCC rooms** should be protected with automatic sprinkler, water spray, or automatic gaseous extinguishing systems. Automatic sprinkler systems should be designed for a density of 0.30 gpm/ft^2 over 2500 ft^2 or the most remote 100 linear ft of cable tunnels up to 2500 ft^2. (Per NFPA 850, 7.8.2.1).

c) Provide a special extinguishing system for the Rack Room and Relay Rooms. (For details, refer to recommendation 2005-2 pertaining to Point Aconi above).

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2005-3

Essential

Multi Level Cable Trays: Protect the multiple level (3 levels or higher) electrical cable trays by providing the following:

a) A line of directional spray automatic sprinklers to protect the cable tray runs.

b) Metal barriers beneath and along the sides of the trays to protect the cables from an exposing fire.

Note areas include the adjacent and below the Turbine Generator.

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

ZURICH

2005-4

Important

Boilers: Boiler-furnaces with multiple oil-fired burners or using oil for ignition should be protected with automatic sprinkler, water spray, foam, or foam-water sprinkler systems covering the burner front oil hazard. Sprinkler and water spray systems should be designed for a density of 0.25 gpm/ft^2 over the protected area. (Refer to NFPA 850, 7.5.1.1 and 7.5.1.2)

Note: Sprinkler protection should also be provided over the light and Bunker C oil feed pumps.

COMMENTS: This recommendation is being reviewed as part of a corporate management initiative. Refer to comments of Recommendation 2005-1 (Lingan Generating Station) for details.

2007-1

Essential

Water Supply: Conduct yard hydrant flow tests to confirm the adequacy of the city water supply. A minimum flow of 3000 gpm and residual pressures should be measured.

COMMENTS: The fire protection water for this facility consists of a public system supplemented with booster pumps for hoses and for the foam system protecting the wharf. An updated flow test is needed to ensure that the public water supply alone is sufficient to supply this facility with adequate volume and pressures. A flow of approximately 2500 gpm is needed for the recommended turbine generator sprinkler protection and a flow of 3000 gpm is needed to determine whether the city water supply can provide adequate pressures for a 2000 gpm booster pump.

2008 Comments: This is scheduled for completion for October, 2008.

2008-1

Important

Maintenance Items: Make the following improvements:

a) Conduct a proper annual test on the wharf fire pump per NPFA standards such that their performance can be compared to its original manufacturer's characteristics. Flow tests should be conducted such that discharge pressure pressures can be measured at 150% of rated flow (i.e. 1500 gpm).
b) Conduct weekly tests of the fire pump (presently done monthly).
c) Provide smoke detection in the precipitator penthouse (MCC room) arranged to annunciate to the control room.

COMMENTS: Proper tests of the fire pump should be performed such that one can evaluate its performance and whether it is requires maintenance. The precipitator penthouse contains 3 oil filled transformers (each containing 200 gal of oil). This area is not sprinkler protected and as a minimum, detection should be provided.

ZURICH

CORPORATE MANAGEMENT RECOMMENDATIONS

Risk Improvement Advice Implemented

2006-2	**Hot Work Permit system:** Develop a separate "hot work" permit system. The implementation of a separate hot work permit system will ensure proper precautions are taken to minimize potential fires.
2006-3 (a)	**Pre-emergency Planning**: Supplement the existing pre-emergency planning to specifically include "Lube oil fires".

Please accept my thanks for the advice, which has been addressed.

Advice for Risk Improvement

2006-1 **Essential**	**Substations:** Review the protection for critical substations. Example, the Onslow substation control room should be protected with an automatic gaseous suppression systems.
2006-3 **Essential**	**Management of Change:** Develop a management of change program throughout the organization. Establish and implement written procedures to manage changes (except for "replacement in Kind) to process equipment, technology, procedures, and products requiring different operating parameters, and also for changes to facilities that affect a covered process. This also includes a change in control logic; change in logic will require approval of two members of engineering review committee. The written procedures shall assure that the following considerations are addressed prior to any change: a. The technical basis for the proposed change; b. Impact of the change on safety and health; c. Modifications to operating procedures; d. Necessary time period for the change; and e. Authorization requirements for the proposed change.

ZURICH

2006-3

Essential

Pre-emergency Planning: Supplement the existing pre-emergency planning to specifically include the following emergency procedures:

b) Transformer oil fires.
c) Conveyor fires
d) Coal dust explosion/fires.
e) Fires involving asbestos contaminated areas.
f) Fuel fires, Bunker C Natural gas, #2 Fuel Oil
g) Cable spreading room fire.

COMMENTS: This recommendation is under review and will be completed on a program basis.

Items marked **Critical** are items that, if not corrected immediately, will lead to an accident or loss.
Items marked **Essential** require prompt corrective action.
Items marked **Important** may require further assessment on your part due to capital cost, however, when completed, will have a positive impact on loss severity and/or frequency.
Items marked **Routine** are easily implemented with little or no cost and should be completed with minimum delay.

We would appreciate your written comments in response to the above advice, indicating what action you have taken, will take or what alternatives you may have to offer. You may e-mail your reply to me at (lino.di.leonardo@zurich.com). Please quote our reference number 895P2111 when replying. We would appreciate a response to the above advice within 30 days of receipt of this letter.

Thank you for the time and co-operation of all the participants. Zurich's Risk Services is available to provide resource materials and services to assist you in your risk management efforts. Should you require any information on the content of this report, please do not hesitate to contact us.

Distribution:

Addressee: 1) Jerry MacKinnon (Jerald.mackinnon@emera.com)

Copy: 2) Mr. Martin Clouthier, Marsh Canada Inc. (martin.clouthier@marsh.com)
3) Mr. Christopher Rose, Zurich U/W
4) RE files

Risk Services

400 UNIVERSITY AVENUE, TORONTO, ONTARIO M5G 1S7
Visit us on the Internet: http://www.zurichcanada.com
Email: riskservices@zurich.com

ZURICH

ISO 9001
Quality-Assured Service Unit

ACKNOWLEDGEMENT FROM: The report recipient named below.

TO: Zurich/Risk Services
400 University Avenue, 16th Floor
Toronto, ON M5G 1S7

Fax: 416-813-3355
Email: risk.services@zurich.com

SUBJECT: Risk Assessment Report - Our Ref. No: 895P2111
Report based on a visit to Emera Inc. 5 location on September 8 to 12, 2008 by Lino Di Leonardo

Thank you for using Zurich Risk Services. In the interest of continuous improvement to our level of service, we value your feedback to monitor and optimize our service quality. Our service levels are constantly reviewed and improved with the help of surveys like this. Please complete this form and fax/email it to the number/email address listed above.

Please indicate how well our service meets your expectations/requirements:	Exceeds	Meets	Partially Meets	Does not meet	Not applicable
1. Arrangements for the delivery of the service:	☐	☐	☐	☐	☐
2. Professional execution of the site visit and exit meeting:	☐	☐	☐	☐	☐
3. Report presentation and clarity:	☐	☐	☐	☐	☐
4. Technical content and practicality of advice given:	☐	☐	☐	☐	☐
5. Accuracy of report/service relative to the site visit/exit meeting:	☐	☐	☐	☐	☐
6. Timing of the delivery of report/service:	☐	☐	☐	☐	☐
7. Overall, how well the service meets your needs:	☐	☐	☐	☐	☐

Add here any additional comments to explain your ratings or how we can further improve our service.

What other services can Zurich Risk Services offer you?

☐ Property Protection	☐ Motor Fleet	☐ Machinery Breakdown	☐ Thermography
☐ Business Continuity	☐ Health & Safety	☐ Engineering Inspection	☐ On-line Reporting
☐ General Liability	☐ Occupational Hygiene	☐ Strategic Risk	☐ Training
☐ Product Liability	☐ Environmental	☐ Zurich Hazard Analysis	☐ Risk information Services

For more information about these services, either contact your location Zurich representatives or log onto our website: www.zurich.com

Your job title & company:

Your name (block capitals please):

The date you received this report: Your signature:

Your feedback on our reports, whether as a customer, broker or colleague, is always greatly appreciated. Thank you for your cooperation.

CI Number: 43567

Title: TUC3 - Circulating Water (CW) Travelling Screens Refurbishment

Start Date: 2014/07
Final Cost Date: 2015/02
Function: Generation
Forecast Amount: $283,750

DESCRIPTION:

This project is to address the deficiencies of circulating water (CW) traveling screens at Tufts Cove Unit 3 (TUC3). The two screens, North and South, are original equipment from the commissioning of Unit 3 in 1976, and they are reaching the end of their service life due to salt water corrosion and normal wear and tear. 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: None

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 the power generating unit. The main purpose of the screen system is to filter out foreign materials such as seaweed and debris from sea water as it is being extracted from the harbor. Failure of the screen system would allow foreign materials carried by cooling water into the CW system and result in increased downstream fouling. Increased fouling often results in poor performance of the condenser and coolers, component failures of CW pumps due to high mechanical loading, and 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 and they are reaching the end of their useful life. A thorough inspection was completed in 2013, and based on screen condition the refurbishment will be required in 2014. 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-SB71 - TUC3 - CW travelling screens refurbishment **Project Number** SB71

Parent CI Number : -

Cost Centre : 319 - 319-TC Unit 3 Capital **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		1,248	0	1,248
095		095-Thermal & Hydro Contracts AO		14,179	0	14,179
095		095-Thermal Regular Labour AO		9,151	0	9,151
095		095-Thermal Overtime Labour AO		2,964	0	2,964
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	47,987	0	47,987
002	014	002 - THERMAL Overtime Labour	014 - SGP - Circ.Water Sys.	31,090	0	31,090
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:	283,750	0	283,750
			Original Cost:	71,122		

TUC3 CW Travelling Screens Structural Refurbishment
Summary of Alternatives

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Tufts Cove	**CI Number:**	43567
Originator :		**Project No. :**	SB71

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Refurbish Screens	6.49%	-1,034,164	842,329	1	24.56%	7.8 years
B	Replace Screens	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Refurbish the CW screens to restore them to reliable service.

Notes/Comments :

Refurbish Screens

Without a properly functioning screen system, it is very likely that sever fouling will devlop in the CW system and lead to unit de-rating or outage. It is estimated that the probability of failure of the screens which would remove the unit from service is 25%, increasing each year. Quick repairs to return teh screens to service would cost an estimated $100K and keep the unit offline for two weeks.

Replace Screens

Full replacement of the screens is not required at this time, and would be far more costly than refurbishment of worn and damaged components. Therefore, this option was not evaluted further.

Test 3

Test 4

TUC3 CW Travelling Screens Structural Refurbishment
Summary of Sensitivities

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Tufts Cove	**CI Number:**	43567
Originator :		**Project No. :**	SB71

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Screens	6.49%	-1,034,164	842,329	1	24.56%	7.8 years
B	Replace Screens	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Screens	10%	-1,008,362	822,391	1	23.09%	8.5 years
B	Replace Screens	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
Change:	**A**		25,802	-19,938	0	-1.46%	0.6 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish Screens	-10%	-904,946	738,158	1	22.94%	8.5 years
B	Replace Screens	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
Change:	**A**		129,218	-104,171	0	-1.61%	0.7 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement		PV of Revenue Requirement	PV of Revenue Requirement	PV of Revenue Requirement	Delay?
	Yrs Delay:	1	2	3	
	A	25,274	48,082	63,695	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

TUC3 CW Travelling Screens Structural Refurbishment
Avoided Cost Calculations

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Tufts Cove	**CI Number:**	43567
Originator :		**Project No. :**	SB71

Refurbish Screens

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			100,000	102,000		
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	$2,241	$9,882	$25,000	$27,540	$27,241	$37,422

Total Capital Cost of Alternative **$283,750**

Replace Screens

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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**

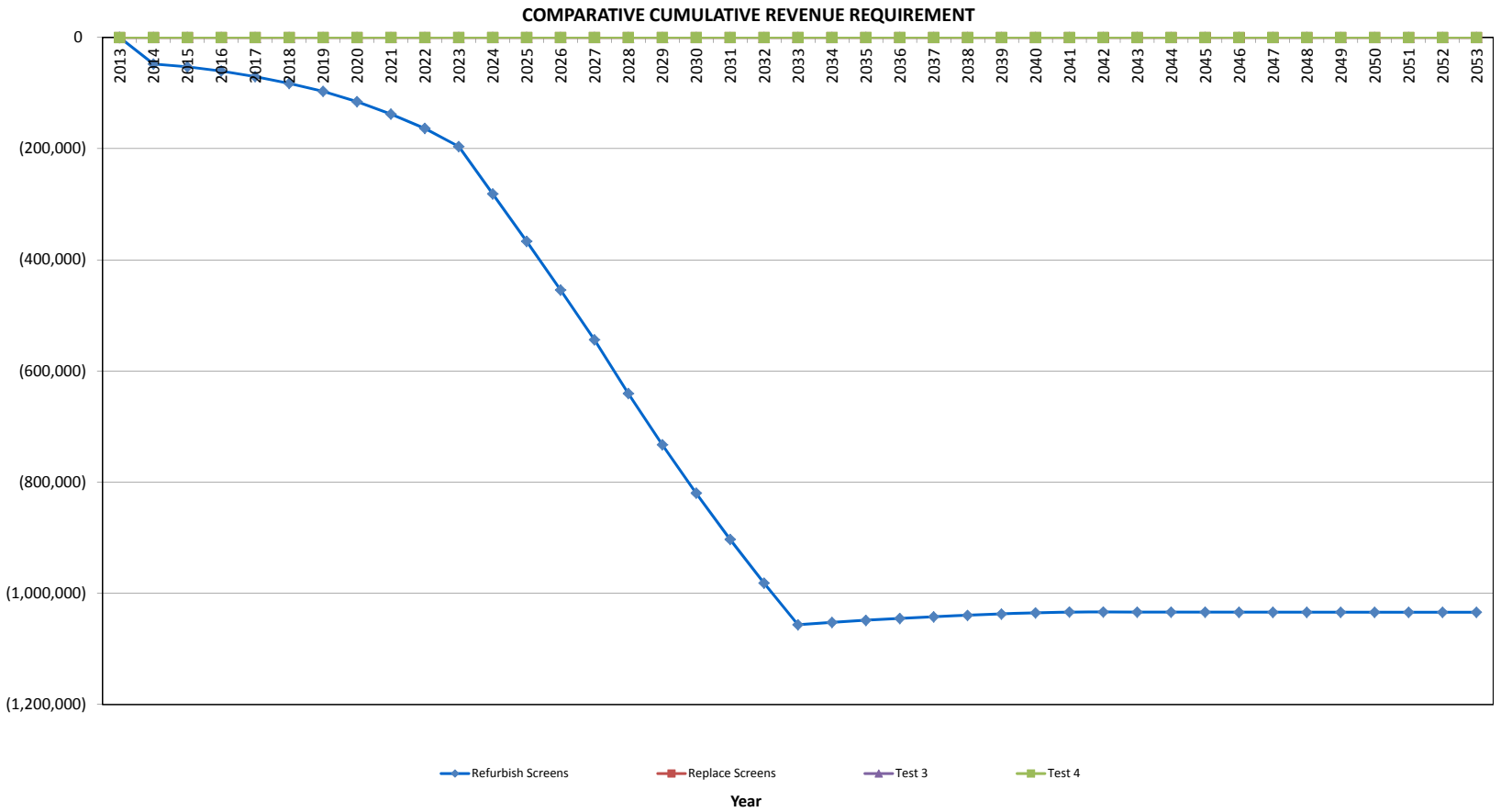
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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**

TUC3 CW Travelling Screens Structural Refurbishment
Refurbish Screens

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	27,240.8	(257,455.0)	10,248.3	253,216.1	(230,214.2)	(5,267.7)	(235,481.9)	(221,130.5)	0.94	(221,130.5)
2015	-	-	37,421.9	-	19,676.7	232,327.8	37,421.9	(5,501.0)	31,920.9	28,148.6	0.88	(192,981.9)
2016	-	-	40,997.7	-	18,102.6	213,110.5	40,997.7	(7,097.5)	33,900.2	28,072.2	0.83	(164,909.7)
2017	-	-	44,701.7	-	16,654.4	195,430.5	44,701.7	(8,694.7)	36,007.0	27,999.6	0.78	(136,910.2)
2018	-	-	48,537.3	-	15,322.0	179,165.0	48,537.3	(10,296.8)	38,240.6	27,924.2	0.73	(108,986.0)
2019	-	-	52,508.6	-	14,096.2	164,200.7	52,508.6	(11,907.8)	40,600.8	27,840.8	0.69	(81,145.2)
2020	-	-	61,210.0	-	12,968.5	150,433.6	61,210.0	(14,954.9)	46,255.2	29,785.1	0.64	(51,360.2)
2021	-	-	70,238.5	-	11,931.1	137,767.8	70,238.5	(18,075.3)	52,163.2	31,542.3	0.60	(19,817.8)
2022	-	-	79,603.6	-	10,976.6	126,115.3	79,603.6	(21,274.4)	58,329.2	33,121.3	0.57	13,303.4
2023	-	-	97,434.8	-	10,098.5	115,395.0	97,434.8	(27,074.3)	70,360.5	37,518.1	0.53	50,821.5
2024	-	-	221,956.5	-	9,290.6	105,532.3	221,956.5	(65,926.4)	156,030.1	78,128.8	0.50	128,950.3
2025	-	-	236,532.8	-	8,547.3	96,458.7	236,532.8	(70,675.5)	165,857.3	77,988.2	0.47	206,938.5
2026	-	-	258,496.5	-	7,863.5	88,110.9	258,496.5	(77,696.2)	180,800.3	79,833.4	0.44	286,771.8
2027	-	-	281,244.2	-	7,234.5	80,430.9	281,244.2	(84,943.0)	196,301.2	81,395.3	0.41	368,167.2
2028	-	-	322,727.8	-	6,655.7	73,365.4	322,727.8	(97,982.3)	224,745.4	87,510.2	0.39	455,677.3
2029	-	-	329,182.3	-	6,123.2	66,865.1	329,182.3	(100,148.3)	229,034.0	83,745.0	0.37	539,422.3
2030	-	-	335,766.0	-	5,633.4	60,884.8	335,766.0	(102,341.1)	233,424.9	80,148.8	0.34	619,571.1
2031	-	-	342,481.3	-	5,182.7	55,382.9	342,481.3	(104,562.6)	237,918.7	76,713.1	0.32	696,284.2
2032	-	-	349,330.9	-	4,768.1	50,321.2	349,330.9	(106,814.5)	242,516.4	73,430.0	0.30	769,714.2
2033	-	-	356,317.5	-	4,386.7	45,664.4	356,317.5	(109,098.6)	247,218.9	70,291.9	0.28	840,006.1
2034	-	-	-	-	4,035.7	41,380.2	-	1,251.1	1,251.1	334.0	0.27	840,340.1
2035	-	-	-	-	3,712.9	37,438.7	-	1,151.0	1,151.0	288.6	0.25	840,628.7
2036	-	-	-	-	3,415.8	33,812.5	-	1,058.9	1,058.9	249.3	0.24	840,878.0
2037	-	-	-	-	3,142.6	30,476.4	-	974.2	974.2	215.4	0.22	841,093.4
2038	-	-	-	-	2,891.2	27,407.3	-	896.3	896.3	186.1	0.21	841,279.5
2039	-	-	-	-	2,659.9	24,583.6	-	824.6	824.6	160.8	0.19	841,440.3
2040	-	-	-	-	2,447.1	21,985.8	-	758.6	758.6	138.9	0.18	841,579.2
2041	-	-	-	-	2,251.3	19,595.9	-	697.9	697.9	120.0	0.17	841,699.2
2042	-	-	-	-	2,071.2	17,397.1	-	642.1	642.1	103.7	0.16	841,802.8
2043	-	-	-	-	1,905.5	15,374.3	-	590.7	590.7	89.6	0.15	841,892.4
2044	-	-	-	-	1,753.1	13,513.3	-	543.5	543.5	77.4	0.14	841,969.8
2045	-	-	-	-	1,612.8	11,801.1	-	500.0	500.0	66.8	0.13	842,036.6
2046	-	-	-	-	1,483.8	10,225.9	-	460.0	460.0	57.7	0.13	842,094.4
2047	-	-	-	-	1,365.1	8,776.8	-	423.2	423.2	49.9	0.12	842,144.2
2048	-	-	-	-	1,255.9	7,443.6	-	389.3	389.3	43.1	0.11	842,187.3
2049	-	-	-	-	1,155.4	6,217.0	-	358.2	358.2	37.2	0.10	842,224.6
2050	-	-	-	-	1,063.0	5,088.6	-	329.5	329.5	32.2	0.10	842,256.8
2051	-	-	-	-	977.9	4,050.4	-	303.2	303.2	27.8	0.09	842,284.5
2052	-	-	-	-	899.7	3,095.3	-	278.9	278.9	24.0	0.09	842,308.6
2053	-	-	-	-	827.7	2,216.6	-	256.6	256.6	20.7	0.08	842,329.3
Total	**-**	**-**	**3,593,930.6**	**(257,455.0)**	**246,688.1**		**3,336,475.6**	**(1,037,645.2)**	**2,298,830.5**	**842,329.3**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(200,000)
(400,000)
(600,000)
(800,000)
(1,000,000)
(1,200,000)
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
2053
Refurbish Screens
Replace Screens
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: Tufts Cove
CI# / FP#: 43567
Title: TUC3 - CW Travelling Screens Structural Refurbishment
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	pd	2.5	$ 339	$ 848		
1.2	Utility	pd	25.0	$ 227	$ 5,686		
1.3	Maintenance Trades	pd	120.0	$ 345	$ 41,453		
1.4							
				Sub-Total	$ 47,987.00		41796, 41946
2	**012 Materials**						
2.1	New bearing or bushings (head section)	lot	1	$ 12,000.00	$ 12,000		
2.2	Screen trays	lot	1	$ 10,000.00	$ 10,000		
2.3	Misc. Materials	lot	1	$ 10,000.00	$ 10,000		
2.4					$ -		
				Sub-Total	$ 32,000		41796, 41946
3	**013 Contracts**						
3.1	Rebuild boot and Intermediate Sections	lot	1	$ 56,000.00	$ 56,000		
3.2	Segment for Driven Sprocket	lot	1	$ 3,200.00	$ 3,200		
3.3	Sand Blast and Paint	lot	1	$ 10,000.00	$ 10,000		
3.4	Lighting	lot	1	$ 2,000.00	$ 2,000		
3.5	Crane/Boom Truck Rental Service	lot	1	$ 15,000.00	$ 15,000		
3.6	Installation Stop Log	lot	1	$ 5,000.00	$ 5,000		
3.7	Staging	lot	1	$ 15,000.00	$ 15,000		
3.8	CW Pump Cleaning	lot	1	$ 20,000.00	$ 20,000		
3.9	Contingency	%	15	$ 126,200	$ 18,930		
3.10							
				Sub-Total	$ 145,130		41796, 41946
4	**002 Overtime Labour**						
4.1	Maintenance Trades	pd	45	$ 690.88	$ 31,090		
4.2							
4.3					$ -		
				Sub-Total	$ 31,090		
5	**094 Interest Capitalized**						
5.1	AFUDC	lot	1	1248.18	$ 1,248		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 1,248		
6	**095 Administrative Overhead**						
6.1	Contracts AO	lot	1	14179.2	$ 14,179		
6.2	Regular Labour AO	lot	1	9151.13	$ 9,151		
6.3	Overtime Labour AO	lot	1	2964.44	$ 2,964		
				Sub-Total	$ 26,295		
				SUB-TOTAL (no AO, AFUDC)	$ 256,207		
				TOTAL (AO, AFUDC included)	$ 283,750		
7	**Original Cost**						
7.1					$ 71,122		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 44725

Title: TRE5 Baghouse Filter Replacements

Start Date: 2014/04
Final Cost Date: 2014/10
Function: Generation
Forecast Amount: $260,875

DESCRIPTION:

The Trenton Unit 5 baghouse was constructed and commissioned in 2009. The baghouse consists of eight modules, each containing 493 bags, for a total of 3944 bags. The bags have a finite life of approximately five to six years. The bags are now reaching the end of their useful life, and must be replaced. Bags in each module will be replaced in a phased approach, with three modules being replaced in 2014.

Summary of Related CIs +/- 2 years:
2015 TRE5 Baghouse Filter Replacements Phase 2 $275K (est)
2016 TRE5 Baghouse Filter Replacements Phase 3 $275K (est)

JUSTIFICATION:

Justification Criteria: Environment

Sub Criteria: Equipment Replacement

Why do this project?

On Trenton Unit 5, a baghouse is used in series with an electrostatic precipitator (ESP) to remove flyash and other particulate from the boiler flue gas. The bags that were installed in 2009 have an estimated lifespan of five to six years.

Testing completed by the Original Equipment Manufacturer (OEM) on samples of bags provided by NS Power has concluded that the bags are aging as expected. The bags must be replaced prior to end of useful life to ensure that the baghouse performs as designed, and NS Power continues to meet emissions requirements.

Why do this project now?

Replacement of the bags will be completed over a three year span, starting in 2014. This project must be executed in order to ensure that the baghouse performs as designed. The baghouse is designed to remove particulate, and it is an integral part of the plant's emissions management system. The baghouse also allows for greater flexibility in coal fuel blends because of its high fly-ash capture rate.

Why do this project this way?

Replacement of the bags will be completed in three phases over three years, changing bags in three modules in year one and year two, and the final two modules in year three. This allows for staggered lifetime for bags so that all eight modules do not experience end of life failure in the same period of time. Staggering in this way will also help reduce the capital investment required in a given year. NS Power will continue to evaluate the condition of the bags to maximize useful life, while ensuring the continued reliable operation of the baghouse.

A staggered approach to replacing these bags will also allow for this work to be done during regular outages on the unit. Work on this number of bags can be completed within a normal outage window and is anticipated to take one to two weeks. The time required to change the bags in all eight modules would require a major shutdown, and is estimated to take up to six weeks.

CI Number : 44725 - TRE5 Baghouse Filter Replacements **Project Number**

Parent CI Number : -

Cost Centre : 340 - 340-Trenton Unit 5 Capital **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		4,246	0	4,246
095		095-Thermal & Hydro Contracts AO		479	0	479
095		095-Thermal Regular Labour AO		4,032	0	4,032
095		095-Thermal Term Labour AO		3,728	0	3,728
001	017	001 - THERMAL Regular Labour	017 - SGP - Draft Equip./Stacks	15,440	0	15,440
002	017	002 - THERMAL Overtime Labour	017 - SGP - Draft Equip./Stacks	0	0	0
004	017	004 - THERMAL Term Labour	017 - SGP - Draft Equip./Stacks	19,546	0	19,546
012	017	012 - Materials	017 - SGP - Draft Equip./Stacks	[redacted]	0	[redacted]
013	017	013 - POWER PRODUCTION Contracts	017 - SGP - Draft Equip./Stacks	4,900	0	4,900
001	085	001 - THERMAL Regular Labour	085 Design	1,316	0	1,316
001	087	001 - THERMAL Regular Labour	087 Field Super.& Ops.	4,386	0	4,386
011	087	011 - Travel Expense	087 Field Super.& Ops.	[redacted]	0	[redacted]
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:	260,875	0	260,875
			Original Cost:	241,865		

Capital Project Detailed Estimate

Location: Trenton Generating Station
CI# / FP#: 44725
Title: TRE5 Baghouse Filter Replacements
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Utility	pd	15.0	$ 227	$ 3,412		
1.2	Mechanical	pd	25.0	$ 345	$ 8,636		
1.3	Instrumentation	pd	5.0	$ 339	$ 1,696		
1.4	Electrical	pd	5.0	$ 339	$ 1,696		
1.5	Internal Engineering	pd	3.4	$ 384	$ 1,316		
1.6	Internal Supervision	pd	11.4	$ 384	$ 4,386		
				Sub-Total	$ 21,143		
2	**004 Term Labour**						
2.1	Utility	pd	10.0	$ 227	$ 2,274		
2.2	Mechanical	pd	50.0	$ 345	$ 17,272		
2.3					$ -		
				Sub-Total	$ 19,546		
3	**012 Materials**						
3.1	Filter Bag Replacements	each	1500	[redacted]		Cost Support 1, 1 USD = 1.04 CDN	
3.2	Filter Cage Replacements	each	1500	[redacted]		Cost Support 1, 1 USD = 1.04 CDN	
3.3	Contingency on Materials (10%)	%	[redacted]			Includes currency risk	
3.4					$ -		
3.5					$ -		
				Sub-Total	[redacted]		
4	**013 Contracts**						
4.1	Vacuum Services	lot	1	$ 2,500.00	$ 2,500		
4.2	Crane Services	hr	16	$ 150.00	$ 2,400		
4.3					$ -		
4.4					$ -		
4.5					$ -		
				Sub-Total	$ 4,900		
5	**011 Travel Expense**						
5.1	Travel	lot	1	[redacted]			
5.2					$ -		
				Sub-Total	[redacted]		
6	**021 Telephones**						
6.1	Phone	lot	1	$ 250.00	$ 250		
6.2					$ -		
				Sub-Total	$ 250		
7	**041 Meals & Entertainment**						
7.1	Meals	lot	1	$ 250.00	$ 250		
7.2							
7.3							
				Sub-Total	$ 250		
8	**094 Interest Capitalized**						
8.1	AFUDC		1	$ 4,246.03	$ 4,246		
				Sub-Total	$ 4,246		
9	**095 Administrative Overhead**						
9.1	Regular AO	lot	1	$ 4,031.92	$ 4,032		
9.2	Overtime AO	lot	1		$ -		
9.3	Term AO	lot	1	$ 3,727.50	$ 3,728		
9.4	Contracts AO	lot	1	$ 478.73	$ 479		
				Sub-Total	$ 8,238		
				SUB-TOTAL (no AO, AFUDC)	$ 248,391		
				TOTAL (AO, AFUDC included)	$ 260,875		
10	**Original Cost**						
10.1					$ 241,865		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

DUSTEX CORPORATION

322 NORTH POINTE PKWY
SUITE K
ACWORTH, GA 30201
Phone: (678) 574-4535
Fax: (678) 574-4980

Quotation

Date	Page
Apr 23, 2013	1
Order Number	
QT02391	

Sold To:

XXXXXXXXNova Scotia Power, IncXXXXXXXXXXXXXXXXX
PO 910
Halifax, Nova Scotia B3J2W5
CANADA

Ship To:

XXXXXXXXNova Scotia Power, IncXXXXXXXXXXXXXXXXX
PO 910
Halifax, Nova Scotia, B3J2W5
CANADA

Reference	PO Number	Customer No.	Salesperson	Order Date	Ship Via	Terms
		19653US		Apr 23, 2013	UPS	NET30

Qty. Ord.	Qty. Shp.	Qty. B/O	Item Number	Description	Unit Price	UOM	Extended Price
4,000.00	0.0000	4,000.00	07-B16-07266-B1	FILTER BAG-6" x 313-3/8" LG, PPS	[redacted]	EA	[redacted]
4,000.00	0.0000	4,000.00	07-B17-07266-C1	FILTER CAGE: 6" nom X 26' lg nom., SPLIT w/ VEN	[redacted]	EA	[redacted]

Comments:

THANKS FOR THE ORDER!

FOR QUESTIONS CONCERNING THIS ORDER PLEASE CONTACT
SHERRI OLLIS @ (678) 213-0295 OR FAX (678) 574-4980

Tax Summary:

GSTHST [redacted]

Less	
Included Tax	**0.00**
Order Discount	**0.00**
Subtotal	[redacted]
Total sales tax	[redacted]
Total order	[redacted]

DUST COLLECTOR FILTER BAG PERMEABILITY TEST RESULTS

CUSTOMER:	Nova Scotia Power	**DUSTEX MODEL:**	
Test Date:	10/30/2012	**DUSTEX JOB #:**	266

BAG MATERIAL: PPS
(NEW MATERIAL RATED AIR FLOW IS 35-50 CFM /SQ.FT AT .5" W.G.)

SAMPLE # 1 -Module 8 Side A Outside Row

TOP OF BAG	CFM/SQ. FT. AT .5" W.G.
AS RECEIVED	18
AFTER LIGHT BRUSH	14.5
AFTER VACUUMING	28
MIDDLE OF BAG	
AS RECEIVED	18
AFTER LIGHT BRUSH	13
AFTER VACUUMING	31
BOTTOM OF BAG	
AS RECEIVED	11
AFTER LIGHT BRUSH	9.5
AFTER VACUUMING	25

SAMPLE # 2 Module 2 Side A South Outside Row

TOP OF BAG	
AS RECEIVED	20.5
AFTER LIGHT BRUSH	7
AFTER VACUUMING	24
MIDDLE OF BAG	
AS RECEIVED	19
AFTER LIGHT BRUSH	14
AFTER VACUUMING	41
BOTTOM OF BAG	
AS RECEIVED	15
AFTER LIGHT BRUSH	10
AFTER VACUUMING	40

SAMPLE # 3 Module 2
Side A North Outside
Row

TOP OF BAG	CFM/SQ. FT. AT .5" W.G.
AS RECEIVED	21
AFTER LIGHT BRUSH	6
AFTER VACUUMING	24
MIDDLE OF BAG	
AS RECEIVED	17
AFTER LIGHT BRUSH	14
AFTER VACUUMING	35
BOTTOM OF BAG	
AS RECEIVED	9.5
AFTER LIGHT BRUSH	8
AFTER VACUUMING	38.5

NOTE:
AFTER LIGHT BRUSH SIMULATES 1 CLEANING PULSE
AFTER VACUUMING SIMULATES SEVERAL CLEANING PULSES

DUST COLLECTOR FILTER BAG PERMEABILITY TEST RESULTS

CUSTOMER:	Nova Scotia Power	**DUSTEX MODEL:**	
Test Date:	10/24/2011	**DUSTEX JOB #:**	266

BAG MATERIAL: PPS

(NEW MATERIAL RATED AIR FLOW IS 35-50 CFM /SQ.FT AT .5" W.G.)

SAMPLE # 1-Module 1 North

TOP OF BAG	CFM/SQ. FT. AT .5" W.G.
AS RECEIVED	8.3
AFTER LIGHT BRUSH	8.3
AFTER VACUUMING	25.8
MIDDLE OF BAG	
AS RECEIVED	13.4
AFTER LIGHT BRUSH	13.4
AFTER VACUUMING	15
BOTTOM OF BAG	
AS RECEIVED	8.3
AFTER LIGHT BRUSH	7.1
AFTER VACUUMING	26.6

SAMPLE # 2 Module 1 South

TOP OF BAG	
AS RECEIVED	6
AFTER LIGHT BRUSH	4.8
AFTER VACUUMING	23.5
MIDDLE OF BAG	
AS RECEIVED	13.5
AFTER LIGHT BRUSH	23.5
AFTER VACUUMING	50
BOTTOM OF BAG	
AS RECEIVED	1..5
AFTER LIGHT BRUSH	13.2
AFTER VACUUMING	36

SAMPLE # 3 Middle of Module

TOP OF BAG	CFM/SQ. FT. AT .5" W.G.
AS RECEIVED	9
AFTER LIGHT BRUSH	10.8
AFTER VACUUMING	28.8
MIDDLE OF BAG	
AS RECEIVED	10.8
AFTER LIGHT BRUSH	12
AFTER VACUUMING	30
BOTTOM OF BAG	
AS RECEIVED	8.3
AFTER LIGHT BRUSH	7.1
AFTER VACUUMING	31

NOTE:
AFTER LIGHT BRUSH SIMULATES 1 CLEANING PULSE
AFTER VACUUMING SIMULATES SEVERAL CLEANING PULSES

CI Number: 44352

Title: LIN CW Screen Refurbish

Start Date: 2014/02
Final Cost Date: 2015/02
Function: Generation
Forecast Amount: $255,007

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 sections. 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 bottom and intermediate sections are submerged in salt seawater, and the upper sections are wetted components, and in a salt spray environment.

During periods of low seaweed loading, screens can be taken out of service with no impact to production, and refurbished. Screens are selected for refurbishment based on performance, condition and operational strategy for the unit. Screens 1A (Unit 1) and 3A (Unit 3) are identified for refurbishment in 2014.

Summary of Related CIs +/- 2 years:
2012 CI 41124 LIN CW Travelling Screen Refurbish $251K
2013 CI 43169 LIN CW Screen Refurbishment $218K
2015 CI TBD LIN CW Screen Refurbishment $250K (est.)
2016 CI TBD LIN CW Screen Refurbishment $250K (est.)

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

Eel grass passing through degraded or non-functioning travelling screen panels results in downstream fouling of strainers at CW and Auxiliary CW 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 seawater 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 : 44352 - LIN CW Screen Refurbish **Project Number**

Parent CI Number : -

Cost Centre : 305 - 305-Lingan 3&4 Prod.Unit **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		10,352	0	10,352
095		095-Thermal Regular Labour AO		19,919	0	19,919
095		095-Thermal & Hydro Contracts AO		782	0	782
001	014	001 - THERMAL Regular Labour	014 - SGP - Circ.Water Sys.	104,454	0	104,454
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.	111,500	0	111,500
013	014	013 - POWER PRODUCTION Contracts	014 - SGP - Circ.Water Sys.	8,000	0	8,000
			Total Cost:	255,007	0	255,007
			Original Cost:	86,748		

44352 LIN CW Screen Refurbishment
Summary of Alternatives

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Lingan	**CI Number:**	44352
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Refurbish CW Screens	6.49%	-899,939	628,370	1	84.43%	1.6 years
B	CW Screen Replacement	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Refurbish 2 CW screens to avoid screen failure which would require removal for emergency repair and unplanned downtime for the unit.

Notes/Comments :

Refurbish CW Screens

If failure of the CW screen occurred during late summer / fall months, the amount of eelgrass and seaweed present in Lingan Bay could clog the CW system and reduce cooling capability, resulting in a unit trip and / or derating. De-rating of the unit due to a lost CW screen is assumed to be 60MW, and it is estimated to take approximately 2 weeks to return it to service.

CW Screen Replacement

Replacement of the full screen assembly is not required at this time, and is more costly than refurbishment. Therefore, replacement has not been analyzed further.

Test 3

Test 4

44352 LIN CW Screen Refurbishment
Summary of Sensitivities

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Lingan	**CI Number:**	44352
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish CW Screens	6.49%	-899,939	628,370	1	84.43%	1.6 years
B	CW Screen Replacement	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish CW Screens	10%	-878,322	610,072	1	74.71%	1.7 years
B	CW Screen Replacement	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
Change:	**A**		21,617	-18,298	0	-9.72%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Refurbish CW Screens	-10%	-788,328	547,235	1	73.76%	1.8 years
B	CW Screen Replacement	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
Change:	**A**		111,611	-81,135	0	-10.67%	0.2 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement	Yrs Delay:	PV of Revenue Requirement 1	PV of Revenue Requirement 2	PV of Revenue Requirement 3	Delay?
	A	83,042	224,012	373,449	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

44352 LIN CW Screen Refurbishment
Avoided Cost Calculations

Division :	Power Production	**Date :**	**19-Nov-13**
Department :	Lingan	**CI Number:**	44352
Originator :		**Project No. :**	

Refurbish CW Screens

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			81,453	83,082		
Events/Outages (#)	1	2	1	2		
Probability of Occurance (%)	60%	60%	60%	60%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	60	60				
Duration (Hours)	336	336				
Totals	$40,631	$73,934	$48,872	$99,698	$89,503	$173,632

Total Capital Cost of Alternative **$255,007**

CW Screen Replacement

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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**

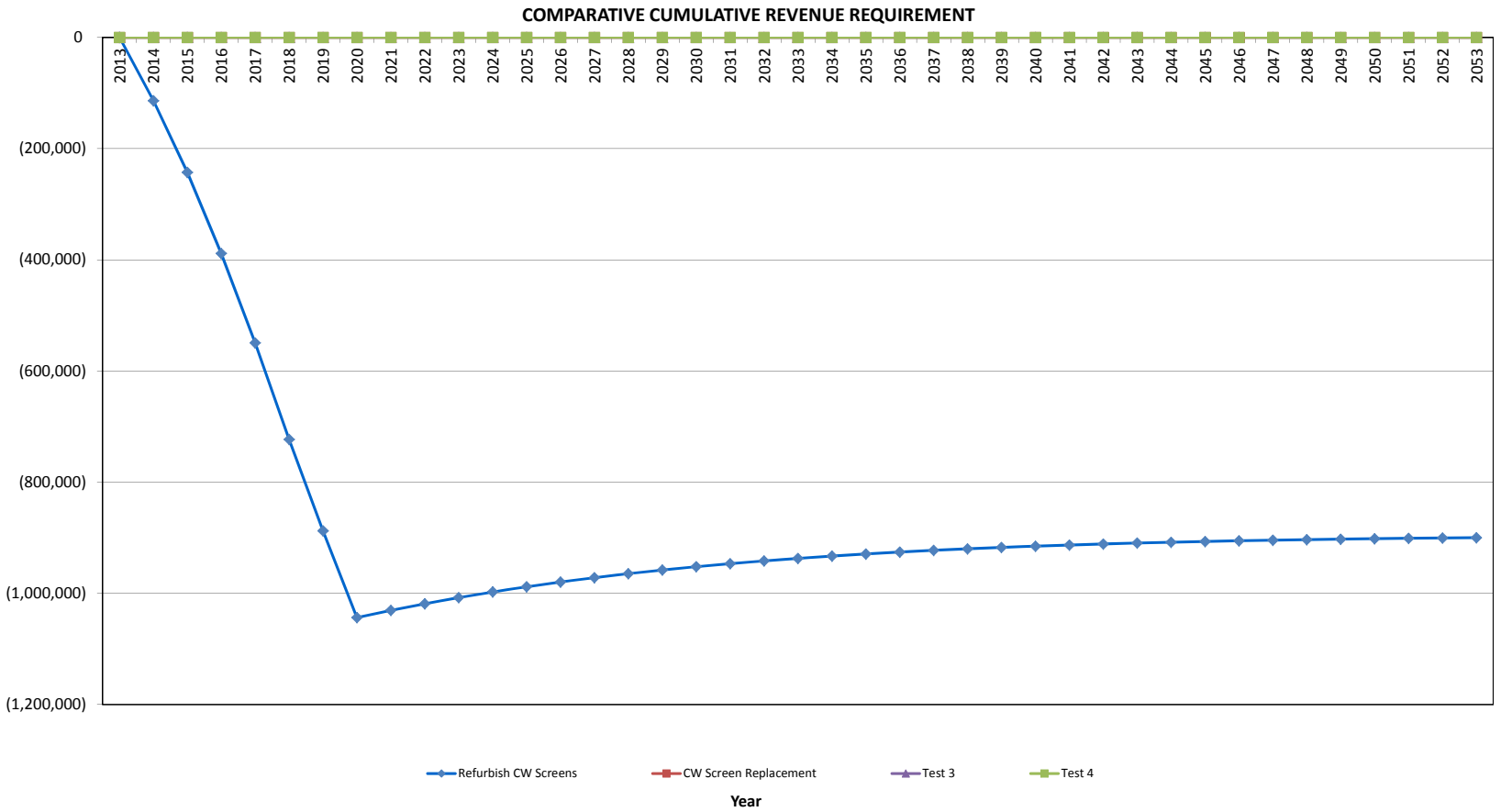
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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**

44352 LIN CW Screen Refurbishment
Refurbish CW Screens

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1.00	-
2014	-	-	89,503.1	(234,306.1)	8,958.2	220,709.8	(144,803.0)	(24,968.9)	(169,772.0)	(159,425.3)	0.94	(159,425.3)
2015	-	-	173,632.1	-	17,199.7	202,556.2	173,632.1	(48,494.1)	125,138.1	110,349.9	0.88	(49,075.4)
2016	-	-	206,622.2	-	15,823.7	185,854.8	206,622.2	(59,147.5)	147,474.7	122,121.2	0.83	73,045.8
2017	-	-	240,862.5	-	14,557.8	170,489.6	240,862.5	(70,154.4)	170,708.0	132,745.2	0.78	205,790.9
2018	-	-	276,389.7	-	13,393.2	156,353.6	276,389.7	(81,528.9)	194,860.8	142,291.9	0.73	348,082.9
2019	-	-	281,917.5	-	12,321.7	143,348.5	281,917.5	(83,574.7)	198,342.8	136,007.7	0.69	484,090.6
2020	-	-	287,555.8	-	11,336.0	131,383.8	287,555.8	(85,628.1)	201,927.7	130,027.2	0.64	614,117.8
2021	-	-	-	-	10,429.1	120,376.3	-	3,233.0	3,233.0	1,955.0	0.60	616,072.7
2022	-	-	-	-	9,594.8	110,249.4	-	2,974.4	2,974.4	1,689.0	0.57	617,761.7
2023	-	-	-	-	8,827.2	100,932.6	-	2,736.4	2,736.4	1,459.1	0.53	619,220.8
2024	-	-	-	-	8,121.0	92,361.1	-	2,517.5	2,517.5	1,260.6	0.50	620,481.4
2025	-	-	-	-	7,471.4	84,475.4	-	2,316.1	2,316.1	1,089.1	0.47	621,570.5
2026	-	-	-	-	6,873.6	77,220.6	-	2,130.8	2,130.8	940.9	0.44	622,511.4
2027	-	-	-	-	6,323.8	70,546.1	-	1,960.4	1,960.4	812.9	0.41	623,324.2
2028	-	-	-	-	5,817.9	64,405.6	-	1,803.5	1,803.5	702.3	0.39	624,026.5
2029	-	-	-	-	5,352.4	58,756.3	-	1,659.3	1,659.3	606.7	0.37	624,633.2
2030	-	-	-	-	4,924.2	53,559.0	-	1,526.5	1,526.5	524.1	0.34	625,157.3
2031	-	-	-	-	4,530.3	48,777.4	-	1,404.4	1,404.4	452.8	0.32	625,610.1
2032	-	-	-	-	4,167.9	44,378.4	-	1,292.0	1,292.0	391.2	0.30	626,001.3
2033	-	-	-	-	3,834.4	40,331.3	-	1,188.7	1,188.7	338.0	0.28	626,339.3
2034	-	-	-	-	3,527.7	36,608.0	-	1,093.6	1,093.6	292.0	0.27	626,631.3
2035	-	-	-	-	3,245.5	33,182.5	-	1,006.1	1,006.1	252.3	0.25	626,883.6
2036	-	-	-	-	2,985.8	30,031.1	-	925.6	925.6	217.9	0.24	627,101.5
2037	-	-	-	-	2,747.0	27,131.8	-	851.6	851.6	188.3	0.22	627,289.8
2038	-	-	-	-	2,527.2	24,464.4	-	783.4	783.4	162.7	0.21	627,452.4
2039	-	-	-	-	2,325.0	22,010.4	-	720.8	720.8	140.5	0.19	627,593.0
2040	-	-	-	-	2,139.0	19,752.8	-	663.1	663.1	121.4	0.18	627,714.4
2041	-	-	-	-	1,967.9	17,675.7	-	610.1	610.1	104.9	0.17	627,819.3
2042	-	-	-	-	1,810.5	15,764.8	-	561.2	561.2	90.6	0.16	627,909.9
2043	-	-	-	-	1,665.6	14,006.8	-	516.3	516.3	78.3	0.15	627,988.2
2044	-	-	-	-	1,532.4	12,389.5	-	475.0	475.0	67.6	0.14	628,055.8
2045	-	-	-	-	1,409.8	10,901.5	-	437.0	437.0	58.4	0.13	628,114.2
2046	-	-	-	-	1,297.0	9,532.5	-	402.1	402.1	50.5	0.13	628,164.7
2047	-	-	-	-	1,193.2	8,273.1	-	369.9	369.9	43.6	0.12	628,208.3
2048	-	-	-	-	1,097.8	7,114.4	-	340.3	340.3	37.7	0.11	628,246.0
2049	-	-	-	-	1,010.0	6,048.5	-	313.1	313.1	32.5	0.10	628,278.5
2050	-	-	-	-	929.2	5,067.8	-	288.0	288.0	28.1	0.10	628,306.7
2051	-	-	-	-	854.8	4,165.5	-	265.0	265.0	24.3	0.09	628,330.9
2052	-	-	-	-	786.4	3,335.4	-	243.8	243.8	21.0	0.09	628,351.9
2053	-	-	-	-	723.5	2,571.8	-	224.3	224.3	18.1	0.08	628,370.1
Total	**-**	**-**	**1,556,483.0**	**(234,306.1)**	**215,633.8**		**1,322,176.8**	**(415,663.2)**	**906,513.6**	**628,370.1**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(200,000)
(400,000)
(600,000)
(800,000)
(1,000,000)
(1,200,000)
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
2053
Refurbish CW Screens
CW Screen Replacement
Test 3
Test 4
Year

Capital Project Detailed Estimate

Location: Lingan
CI# / FP#: 44352
Title: LIN CW Screens Refurbishment
Execution Year: 2014

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)	pd	2.1	$ 384	$ 822		
1.2	Maintenance Trades	pd	240.0	$ 345	$ 82,906		
1.3	Maintenance Removal	pd	60.0	$ 345	$ 20,726		
1.4				$ -	$ -		
				Sub-Total	$ 104,454		43169, 41124
2	**012 Materials**						
2.1	Top boot screen components	lot	2	19250	$ 38,500		
2.2	Screen Section Panels	lot	2	13250	$ 26,500		
2.3	Bottom Boot screen components	lot	2	18250	$ 36,500		
2.4	Contingency on Materials	lot	1	10000	$ 10,000		
				Sub-Total	$ 111,500		43169
3	**013 Power Production Contracts**						
3.1	Machining and Refurbishing	lot	2	4000	$ 8,000		43169
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 8,000		
4	**094 Interest Capitalized**						
4.1	Interest	lot	1	10351.69	$ 10,352		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 10,352		
5	**095 Administrative Overhead**						
5.1	Contracts AO	lot	1	781.6	$ 782		
5.2	Regular Labour AO	lot	1	19919.46	$ 19,919		
				Sub-Total	$ 20,701		
				SUB-TOTAL (no AO, AFUDC)	$ 223,954		
				TOTAL (AO, AFUDC included)	$ 255,007		
6	**Original Cost**						
6.1					$ 86,748		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 45116

Title: BGT1 GG4C-1D Engine Refurbishment

Start Date: 2014/05
Final Cost Date: 2015/02
Function: Generation
Forecast Amount: $1,152,807

DESCRIPTION:

This project is for the refurbishment of a GG4C engine for the Burnside Unit1 Combustion Turbine (BGT1). The refurbishment will include all necessary work, as well as implementation of applicable Service Bulletins, to enable the engine to provide reliable service for an anticipated 10 years or greater. It is expected that the Burnside units will be required to provide firm capacity, 10-minute reserve, fast acting generation, Voltage Ampere Reactive (VAR) support at the load center, and Black Start capability for the foreseeable planning window (greater than 10 years).

A comprehensive assessment of NS Power's CT fleet was concluded in 2013. This effort recommended the refurbishment of this engine, and also provided a health assessment of each CT at the component level, and specified investment guidelines by component, to sustain operation of the fleet well into the future.

This assessment effort is similar to previous work on Steam Turbines and Generators and is in keeping with NS Power's Asset Management approach. Industry experts were engaged to aid NS Power in developing the health assessments and recommendations to sustain operation for this complex asset class. The results of this work have enabled NS Power to have a view to the investment requirements related to CTs for an extended period. In addition, this long term view of asset health and investment provides input to generation planning activities and has illustrated that sustaining the existing CT fleet is a viable part of long term generation planning.

The asset life is expected to be greater than 10 years.

This project will be depreciated in the Burnside depreciation class.

Summary of Related CIs +/- 2 years:
No other investments are planned for this engine. Similar investments are planned for other Burnside CT units as follows:
2014 CI 33142 CT – BGT4 Unit Restoration $3.7M (est)
2015 CI TBD CT – BGT2 GG4C Engine Refurbishment $1.3M (est)
2016 CI TBD CT – BGT3 GG4C Engine Refurbishment $1.3M (est)

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Maintenance

Why do this project?

Burnside, Victoria Junction, and Tusket Units are required to support Black Start, 10- minute reserve, Voltage-Ampere Reactive (VAR) support, Peak Generation Support, and fuel flexibility. As determined by the fleet-wide assessment, engines of the CT fleet are due for refurbishment. Refurbishing this engine will enable it to continue to provide its critical system support services in a reliable manner.

Why do this project now?

Fleet assessments have outlined a schedule of investments to sustain the CT fleet. Components are nearing the end of their service life, and need refurbishment or replacement to provide reliable operation. This approach will schedule the timing of investments to minimize the effect on generation and system requirements. The latest generation planning demonstrates the ongoing need for the CTs to deliver ancillary services to the power system.

Fleet health assessments have demonstrated that the existing fleet can be maintained at a comparatively low cost when compared to building new fast acting generation.

Refurbishing this engine now is part of a controlled refurbishment schedule for the remainder of the liquid fueled CT fleet.

Why do this project this way?

Refurbishment of engines in this manner will keep maximum availability for the seven liquid-fired units. NS Power will continue to review the needs of the fleet, including the need for fast-acting generation to support the increasing amount of renewables, VAR support and black-start capabilities, and re-confirm the path-forward for each refurbishment. Components for each of the seven liquid-fired engines are transferrable, so any and all equipment can be re-located to another unit if strategic planning for these units changes over time.

CI Number : 45116 - BGT1 - GG4C-1D Engine Refurbishment **Project Number**

Parent CI Number : -

Cost Centre : 393 - 393-Burnside C/T **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		12,031	0	12,031
095		095-Thermal Overtime Labour AO		259	0	259
095		095-Thermal & Hydro Contracts AO		83,136	0	83,136
095		095-Thermal Regular Labour AO		2,348	0	2,348
001	030	001 - THERMAL Regular Labour	030 - GTG - Gas Turbine Engines	12,313	0	12,313
002	030	002 - THERMAL Overtime Labour	030 - GTG - Gas Turbine Engines	2,714	0	2,714
012	030	012 - Materials	030 - GTG - Gas Turbine Engines	3,000	0	3,000
013	030	013 - POWER PRODUCTION Contracts	030 - GTG - Gas Turbine Engines	850,927	0	850,927
015	030	015 - Frt, Post & Delivery	030 - GTG - Gas Turbine Engines	[redacted]	0	[redacted]
041	030	041 - Meals & Entertainment	030 - GTG - Gas Turbine Engines	240	0	240
066	030	066 - Other Goods & Services	030 - GTG - Gas Turbine Engines	[redacted]	0	[redacted]
			Total Cost:	1,152,807	0	1,152,807
			Original Cost:	309,992		

Location: Burnside
CI# / FP#: 45116
Title: BGT1 - GG4C-1D Engine Refurbishment
Execution Year: 2014

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)	pd	1.1	$ 384	$ 439		
1.2	Gas Turbine Operator	pd	35.0	$ 339	$ 11,875		
1.3					$ -		
				Sub-Total	$ 12,313		
2	**012 Materials**						
2.1	Consumables	lot	1	$ 3,000.00	$ 3,000		
2.2					$ -		
				Sub-Total	$ 3,000		
3	**013 Power Production Contracts**						
3.1	OEM Field Service Advisors	lot	1	[redacted]			
3.2	Refurbish Engine	lot	1			Cost Support 1	
3.3	LPT disassembly, assembly, clean, refurbish, balance	lot	1				
3.3	HPT disassembly, assembly, clean, refurbish, balance	lot	1				
3.4	Crane Rental	lot	1	$ 2,000.00	$ 2,000		
				Sub-Total	$ 850,926.70		
4	**041 Meals and Entertainment**						
4.1	Per Diem	each	16	15	$ 240		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 240		
5	**002 Overtime Labour**						
5.1	Gas Turbine Operator	pd	4.0	$ 679	$ 2,714		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 2,714		
6	**053 Freight**						
6.1	Freight	lot	1	[redacted]			
6.2							
6.3							
				Sub-Total			
7	**066 Other Goods and Services**						
7.1	Contingency	%	[redacted]			includes currency risk	
7.2							
7.3							
				Sub-Total			
8	**094 Interest Capitalized**						
8.1	Interest Capitalized	lot	1	$ 12,031.34	$ 12,031		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 12,031		
9	**095 Administrative Overhead**						
9.1	Contracts AO	lot	1	$ 83,135.53	$ 83,136		
9.2	Regular Labour AO	lot	1	$ 2,348.18	$ 2,348		
9.3	Overtime Labour AO	lot	1	$ 258.79	$ 259		
				Sub-Total	$ 85,743		
				SUB-TOTAL (no AO, AFUDC)	$ 1,055,033		
				TOTAL (AO, AFUDC included)	$ 1,152,807		
10	**Original Cost**						
10.1					$ 309,992		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 43153

Title: CT - TUC4 Control Upgrade

Start Date: 2014/01
Final Cost Date: 2014/12
Function: Generation
Forecast Amount: $535,493

DESCRIPTION:

This project is for replacement of the Mark VI control system on Tufts Cove Unit 4.

The LM6000 units at Tufts Cove, Unit 4 (TUC4) and Unit 5 (TUC5), are fully automated, enabling remote operation with minimal site intervention. The control systems required to enable this mode of operation are fully integrated and distributed throughout the LM 6000 units. The Original Equipment Manufacturer (OEM) has advised that it has ceased production of the existing OEM Control System, Mark VI, as of September 2009. Spare parts have already become more difficult to obtain, and the lead time for parts has increased.

This control upgrade will also introduce a number of improvements. A second card will be added to the vibration monitoring system which will reduce trips due to connector issues. Flow detection in the vent fan systems will also be improved to reduce failed starts due to sequencing issues.

The equipment removed from TUC4 will be utilized as spare parts for TUC5 to allow for the deferral of the control system upgrade on that unit.

Summary of Related Cls +/- 2 years: None

JUSTIFICATION:

Justification Criteria: Thermal

Sub Criteria: Equipment Replacement

Why do this project?

Loss of one of the LM6000 units results in both the lost generation from the unit itself, as well as partial lost generation from Tufts Cove Unit 6 (TUC6). Upgrading the control system on one LM6000 unit will increase the reliability of both gas turbine driven units. The new control system uses hardware supported by local vendors, enabling more efficient repairs, replacements and trouble-shooting. The retired control system components will become spare parts inventory for the second LM6000. The new control system also integrates new unit management protocols to reduce false indication and resultant trips.

Why do this project now?

As of 2009, the OEM no longer produces components for the present control system, and the supply of spare parts will become more uncertain as time elapses. Replacement lead times for many of the control system components may be a number of months. Upgrading the control system now will introduce spares into inventory for TUC5, and reduce the likelihood of lengthy downtime on the upgraded unit. Nuisance trip related forced outages, triggered by the current OEM control system, will be reduced by completing this project.

Why do this project this way?

Other control system options were reviewed, including the superseding product, Mark VIe. Mark VIe has experienced reliability challenges, and is not viewed as being a technically viable solution. In addition, a third solution was assessed, though the system is proprietary and would require a higher degree of vendor interface for support and parts, resulting in increased downtime and the inability to trouble-shoot by plant personnel as they can now.

The product selected is a cost effective, technically-acceptable, low impact approach to reducing control system related downtime on both LM6000 units and the Heat Recovery unit. In addition, the spares created by this upgrade will allow NS Power to defer replacement of the control system of the second LM6000 unit.

CI Number : 43153 - CT - TUC4 Control Upgrade **Project Number**

Parent CI Number : -

Cost Centre : 394 - 394-LM 6000 TC #4 **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		18,076	0	18,076
095		095-Thermal Overtime Labour AO		[redacted]	0	[redacted]
095		095-Thermal Regular Labour AO		3,046	0	3,046
095		095-Thermal & Hydro Contracts AO		[redacted]	0	[redacted]
001	011	001 - THERMAL Regular Labour	011 - GTG - Plant Control and Inst	15,970	0	15,970
002	011	002 - THERMAL Overtime Labour	011 - GTG - Plant Control and Inst	5,428	0	5,428
012	011	012 - Materials	011 - GTG - Plant Control and Inst	5,000	0	5,000
013	011	013 - POWER PRODUCTION Contracts	011 - GTG - Plant Control and Inst	[redacted]	0	[redacted]
015	011	015 - Frt, Post & Delivery	011 - GTG - Plant Control and Inst	5,000	0	5,000
028	011	028 - Consulting	011 - GTG - Plant Control and Inst	0	0	0
041	011	041 - Meals & Entertainment	011 - GTG - Plant Control and Inst	480	0	480
056	011	056 - Training & Development	011 - GTG - Plant Control and Inst	20,000	0	20,000
066	011	066 - Other Goods & Services	011 - GTG - Plant Control and Inst	[redacted]	0	[redacted]
			Total Cost:	535,493	0	535,493
			Original Cost:	417,953		

CT - TUC4 Control Upgrade
Summary of Alternatives

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Gas Turbine Group	**CI Number:**	43153
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank (based on PV of RR)	IRR	Disc Pay
A	Control System Upgrade, proposed sol	6.49%	-4,963,907	3,855,373	1	91.71%	1.7 years
B	Control System Upgrade, other options	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

Recommendation :

Proceed with replacement of the Mark VI control system on TUC4 to mitigate the risk of unplanned downtime due to a failure on a system which is no longer supported by the OEM. Components from this system can be used as spares for TUC5, allowing for deferral of an upgrade to that system to a future year.

Notes/Comments :

Control System Upgrade, proposed solution

It is estimated that there is a 50% chance of failure of a control card in the existing system, increasing to 95% by 2021. Failure of the control card would result in an estimated $12K in materials, and 20 days of downtime for TUC4 while the part is sourced. In addition, TUC6 would also experience a de-rating for 20 days. 50MW loss would be experiened by TUC4 with an additional 25MW from TUC6.

Control System Upgrade, other options

Other control system replacements were reviewed, including the superseding product, Mark VIe. Mark VIe has experienced reliability challenges, and is not viewed as being a technically viable solution. In addition, a third solution was identified, though the system is proprietary and would require a higher degree of vendor interface for support and parts, resulting in increased downtime and inability to trouble-shoot by plant personnel as they can now. For these reasons, other options identified are not considered technically feasible, and were not evaluated further here.

Test 3

Test 4

CT - TUC4 Control Upgrade
Summary of Sensitivities

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Gas Turbine Group	**CI Number:**	43153
Originator :		**Project No. :**	

	Alternative	After Tax WACC	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Control System Upgrade, proposed solution	6.49%	-4,963,907	3,855,373	1	91.71%	1.7 years
B	Control System Upgrade, other options	6.49%	0	0	2	#NUM!	0.0 years
C	Test 3	6.49%	0	0	2	#NUM!	0.0 years
D	Test 4	6.49%	0	0	2	#NUM!	0.0 years

	Alternative Variance on Capital Spend	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Control System Upgrade, proposed solution	10%	-4,916,742	3,816,552	1	79.58%	2.0 years
B	Control System Upgrade, other options	10%	0	0	2	#NUM!	0.0 years
C	Test 3	10%	0	0	2	#NUM!	0.0 years
D	Test 4	10%	0	0	2	#NUM!	0.0 years
Change:	**A**		47,165	-38,821	0	-12.13%	0.3 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

	Alternative Variance on Avoided Expenses	Variance (%)	PV of Revenue Requirement	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Control System Upgrade, proposed solution	-10%	-4,420,352	3,431,015	1	78.45%	2.0 years
B	Control System Upgrade, other options	-10%	0	0	2	#NUM!	0.0 years
C	Test 3	-10%	0	0	2	#NUM!	0.0 years
D	Test 4	-10%	0	0	2	#NUM!	0.0 years
Change:	**A**		543,556	-424,358	0	-13.26%	0.3 years
	B		0	0	0	#NUM!	0.0 years
	C		0	0	0	#NUM!	0.0 years
	D		0	0	0	#NUM!	0.0 years

Alternative Variance on Avoided Expenses - Change in Revenue Requirement		PV of Revenue Requirement	PV of Revenue Requirement	PV of Revenue Requirement	Delay?
	Yrs Delay:	1	2	3	
	A	301,474	533,050	736,477	No
	B	0	0	0	No
	C	0	0	0	No
	D	0	0	0	No

CT - TUC4 Control Upgrade
Avoided Cost Calculations

Division :	Power Production	**Date :**	**18-Nov-13**
Department :	Gas Turbine Group	**CI Number:**	43153
Originator :		**Project No. :**	

Control System Upgrade, proposed solution

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Replacement Energy Cost ($/MWh)	[redacted]					
Repair Cost ($)			12,170	12,413		
Events/Outages (#)	1	1	1	1		
Probability of Occurance (%)	50%	50%	50%	50%		
Capacity Factor (%)	[redacted]					
Energy Replaced (MW)	75	75				
Duration (Hours)	480	480				
Totals	$318,844	$283,442	$6,085	$6,207	$324,929	$289,648
Total Capital Cost of Alternative						$535,493

Control System Upgrade, other options

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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

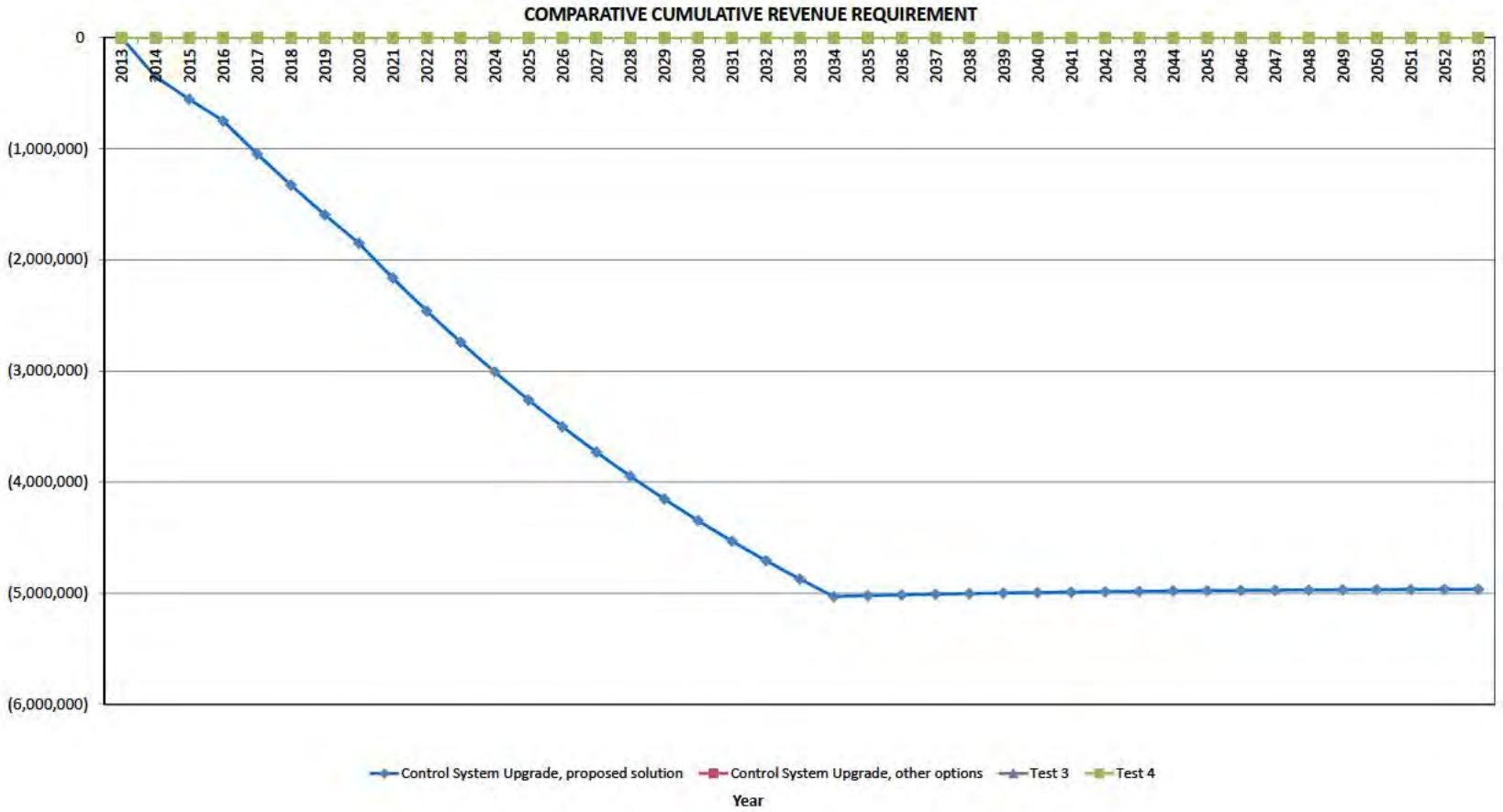
Test 4

	Avoided Replacement Energy Costs		Avoided Unplanned Repair Costs		Total Annual Avoided Costs	
Year	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
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 Control Upgrade

Control System Upgrade, proposed solution

Year	Total Revenue	Operating Costs	Avoided Expenses	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	-	-	-	-	-	-	-	-	1 00	-
2014	-	-	324,928.5	(497,930.4)	19,194 2	471,027.5	(173,001.8)	(94,777.7)	(267,779 5)	(251,459.7)	0 94	(251,459.7)
2015	-	-	289,648.2	-	36,852 8	432,443.8	289,648.2	(78,366.6)	211,281.6	186,313.4	0 88	(65,146.3)
2016	-	-	295,441.2	-	33,904.6	396,946.8	295,441.2	(81,076.3)	214,364 8	177,511.7	0 83	112,365.4
2017	-	-	452,025.0	-	31,192 2	364,289.6	452,025.0	(130,458.2)	321,566 8	250,055.2	0.78	362,420.6
2018	-	-	461,065.5	-	28,696 8	334,244.9	461,065.5	(134,034.3)	327,031 2	238,805.9	0.73	601,226.5
2019	-	-	470,286.8	-	26,401.1	306,603.8	470,286.8	(137,604.6)	332,682 2	228,127.0	0.69	829,353.5
2020	-	-	479,692.5	-	24,289 0	281,174.0	479,692.5	(141,175.1)	338,517.4	217,981.3	0.64	1,047,334.8
2021	-	-	619,762.7	-	22,345 9	257,778.6	619,762.7	(185,199.2)	434,563 5	262,774.2	0.60	1,310,108.9
2022	-	-	632,158.0	-	20,558 2	236,254.8	632,158.0	(189,595.9)	442,562.1	251,301.3	0 57	1,561,410.2
2023	-	-	644,801.2	-	18,913.6	216,452.9	644,801.2	(194,025.2)	450,776 0	240,365.7	0 53	1,801,775.9
2024	-	-	657,697.2	-	17,400 5	198,235.1	657,697.2	(198,492.0)	459,205 2	229,937.4	0 50	2,031,713.4
2025	-	-	670,851.1	-	16,008.4	181,474.8	670,851.1	(203,001.2)	467,849 9	219,988.8	0.47	2,251,702.2
2026	-	-	684,268.1	-	14,727 8	166,055.3	684,268.1	(207,557.5)	476,710.6	210,494.2	0.44	2,462,196.4
2027	-	-	697,953.5	-	13,549 5	151,869.4	697,953.5	(212,165.2)	485,788 3	201,429.7	0.41	2,663,626.0
2028	-	-	711,912.6	-	12,465.6	138,818.3	711,912.6	(216,828.6)	495,084 0	192,773.1	0 39	2,856,399.2
2029	-	-	726,150.8	-	11,468 3	126,811.4	726,150.8	(221,551.6)	504,599 3	184,503.8	0 37	3,040,903.0
2030	-	-	740,673.8	-	10,550 9	115,765.0	740,673.8	(226,338.1)	514,335.7	176,602.4	0 34	3,217,505.4
2031	-	-	755,487.3	-	9,706 8	105,602.3	755,487.3	(231,192.0)	524,295.4	169,050.8	0 32	3,386,556.2
2032	-	-	770,597.1	-	8,930 3	96,252.6	770,597.1	(236,116.7)	534,480.4	161,831.9	0 30	3,548,388.0
2033	-	-	786,009.0	-	8,215 8	87,650.9	786,009.0	(241,115.9)	544,893.1	154,929.7	0 28	3,703,317.8
2034	-	-	801,729.2	-	7,558.6	79,737.3	801,729.2	(246,192.9)	555,536 3	148,329.3	0 27	3,851,647.1
2035	-	-	-	-	6,953 9	72,456.8	-	2,155.7	2,155.7	540.5	0 25	3,852,187.6
2036	-	-	-	-	6,397.6	65,758.7	-	1,983 2	1,983 2	467.0	0 24	3,852,654.6
2037	-	-	-	-	5,885 8	59,596.5	-	1,824.6	1,824.6	403.4	0 22	3,853,058.0
2038	-	-	-	-	5,414 9	53,927.3	-	1,678.6	1,678.6	348.5	0 21	3,853,406.5
2039	-	-	-	-	4,981.7	48,711.6	-	1,544 3	1,544 3	301.1	0.19	3,853,707.6
2040	-	-	-	-	4,583 2	43,913.2	-	1,420 8	1,420 8	260.1	0.18	3,853,967.7
2041	-	-	-	-	4,216 5	39,498.6	-	1,307.1	1,307.1	224.7	0.17	3,854,192.5
2042	-	-	-	-	3,879 2	35,437.2	-	1,202.6	1,202.6	194.2	0.16	3,854,386.6
2043	-	-	-	-	3,568 9	31,700.7	-	1,106 3	1,106 3	167.7	0.15	3,854,554.4
2044	-	-	-	-	3,283.4	28,263.2	-	1,017 8	1,017 8	144.9	0.14	3,854,699.3
2045	-	-	-	-	3,020.7	25,100.6	-	936.4	936.4	125.2	0.13	3,854,824.5
2046	-	-	-	-	2,779 0	22,191.1	-	861 5	861.5	108.2	0.13	3,854,932.6
2047	-	-	-	-	2,556.7	19,514.3	-	792.6	792.6	93.4	0.12	3,855,026.1
2048	-	-	-	-	2,352 2	17,051.6	-	729 2	729.2	80.7	0.11	3,855,106.8
2049	-	-	-	-	2,164 0	14,786.0	-	670 8	670.8	69.7	0.10	3,855,176.5
2050	-	-	-	-	1,990 9	12,701.6	-	617 2	617.2	60.3	0.10	3,855,236.8
2051	-	-	-	-	1,831.6	10,784.0	-	567 8	567.8	52.1	0 09	3,855,288.8
2052	-	-	-	-	1,685.1	9,019.8	-	522.4	522.4	45.0	0 09	3,855,333.8
2053	-	-	-	-	1,550 3	7,396.7	-	480.6	480.6	38.9	0 08	3,855,372.7
Total	**-**	**-**	**12,673,139.3**	**(497,930.4)**	**462,026.3**		**12,175,208.9**	**(3,785,445.0)**	**8,389,763.9**	**3,855,372.7**		


COMPARATIVE CUMULATIVE REVENUE REQUIREMENT
0
(1,000,000)
(2,000,000)
(3,000,000)
(4,000,000)
(5,000,000)
(6,000,000)
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
2053
Control System Upgrade, proposed solution
Control System Upgrade, other options
Test 3
Test 4
Year

Location: TUC 4
CI# / FP#: 43153
Title: CT - TUC4 Control Upgrade
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	pd	6.3	$ 339	$ 2,121		
1.2	Gas Turbine Operator	pd	40.0	$ 339	$ 13,571		
1.3	CADD	pd	1.1	$ 244	$ 278		
1.4							
				Sub-Total	$ 15,970		
2	**012 Materials**						
2.1	Consumables	lot	1	5000	$ 5,000		
2.2					$ -		
				Sub-Total	$ 5,000		
3	**013 Power Production Contracts**						
3.1	Control Upgrade Installation Services	lot	1	[redacted]		Cost Support	
3.2							
3.3							
3.4							
				Sub-Total	[redacted]		
4	**056 Training**						
4.1	Training	each	1	20000	$ 20,000		
4.2							
				Sub-Total	$ 20,000		
5	**015 Freight**						
5.1	Freight	each	1	5000	$ 5,000		
5.2							
				Sub-Total	$ 5,000		
6	**041 Meals and Entertainment**						
6.1	Meal Chit	each	32	$15.00	$ 480		
6.5					$ -		
				Sub-Total	$ 480		
7	**002 Overtime Labour**						
7.1	Gas Turbine operator	pd	8	$679	$ 5,428		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 5,428		
8	**066 Other Goods and Services**						
8.1	Contingency	%	[redacted]				
8.2					$ -		
				Sub-Total	[redacted]		
9	**094 Interest Capitalized**						
9.1	AFUDC	each	1	18075.97	$ 18,076		
9.2					$ -		
				Sub-Total	$ 18,076		
10	**095 Administrative Overhead**						
10.1	Thermal Contracts AO	each	1	[redacted]			
10.2	Thermal Overtime Labour AO	each	1				
10.3	Thermal Regular Labour AO	each	1	3045.51	$ 3,046		
				Sub-Total	$ 37,563		
				SUB-TOTAL (no AO, AFUDC)	$ 479,854		
				TOTAL (AO, AFUDC included)	$ 535,493		
11	**Original Cost**						
11.1					$ 417,953		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

GE Energy

GEZ-S2000

Product Life-Cycle Announcement

Mark* VI Control
End of Regular Production

February, 2009

GE will cease normal production of the Mark VI control platform effective September 30, 2009. GE will transition to a post-production product support phase that includes active parts support and migration kits for designated applications. As part of GE's product technology roadmap, core applications previously supported by Mark VI controls, which were introduced in 1999, are now supported by Mark VIe controls.

The primary objective of GE's life-cycle commitment is to protect the customer's investment with extensive replacement parts availability (typically extending up to 10 years following the end of production date), and planned upgrade paths to current control technologies. GE will also maintain on-going services to the installed base including:

- Online access to site-specific manuals and drawings
- Standard and custom training classes
- Site service of equipment including 24/7 remote monitoring & support capability
- Controls service agreements

Following the post-production support period, GE will transition to a repair and return parts cycle, which typically lasts at least five years.

The Mark VIe control offers many advantages over the legacy Mark VI control. These advantages include distributed control architecture, reduced footprint, enhanced computing, and simpler product structure. The Mark VIe control is the control platform of choice for GE's expanded solution portfolio including GE's Integrated Gasification Combined Cycle (IGCC) reference plant design and Wind turbine-generator controls. The Mark VIe control fully supports advance applications such as the OpFlex* Turn down and Peak Fire packages, which improve gas turbine performance and operation by leveraging control innovations such as model based controls.

GE is committed to the life-cycle support of your Mark VI controls and associated equipment. Should you have any questions, contact your local GE Energy Service Manager or Account Manager.

Thomas Finucane
Mark VI Product Line Manager

© 2009, General Electric Company, All rights reserved.
* Trademark of General Electric Company.

GEZ-S2000 090224



The Open-Architecture Alternative to Proprietary OEM Gas Turbine Control Systems

How an Open-Architecture and Engineered Approach Increases Flexibility and Longevity while Lowering Operating Costs

Author: Clark Weaver

Wood Group GTS
Keep on turning

Executive Summary

Situation: In today's globally competitive environment, power plant managers must maximize performance in the face of diminishing resources and spiraling costs. Maintenance and upgrade programs are designed to deliver high levels of availability, reliability, extend the life and improve the performance of equipment.

Responsible plant managers follow a maintenance program that leverages best practices to optimize the owner's costs and minimize outages. When it comes to maintaining vital control systems for gas turbines, users are often at the mercy of an original equipment manufacturer (OEM). Many owners and operators of mature-technology turbine control systems are experiencing issues due to control system obsolescence and reliance on their OEM for support.

Fortunately, open-platform, flexible, cost-effective solutions for upgrading gas turbine control systems are available to help improve plant operations and drive down operating costs.

Problem: The dominance of proprietary OEM control systems represents one of the greatest hurdles to optimizing performance and managing costs for gas turbines. These systems cannot be modified by the user, triggering higher support and operating costs. Another glaring issue with this scenario is premature system obsolescence dictated by the OEM.

Solution: Managers facing maintenance or obsolescence issues with gas turbine control systems are demanding third party solutions that allow them flexibility to manage these systems from a best practices perspective. An open-platform solution for power generation and mechanical drive packages delivers all the benefits of the OEM package, with significant advantages that cannot be realized by using the OEM's approach. Plant and asset managers should look for a proven, safe and field-tested solution.

Result: An open-architecture solution provides an easily supported and serviced turbine control system that is flexible enough to adapt to the unique needs of different plant configurations and installations. With a qualified third party provider, plant and asset managers can address problems and shed light on issues that may not have been considered in the past.

When evaluating a third party solution, look for a provider that considers all aspects of control systems maintenance, to ensure a maximum return on investment from valuable power generation assets. The ultimate outcome is greater plant flexibility today that drives additional top-line revenue tomorrow.

Relying on Proprietary, One-Size-Fits-All OEM Gas Turbine Control Systems can be Costly and Diminish Asset Performance:

- OEM hardware obsolescence at discretion of OEM
- Locked, "black box" software; high cost or unavailability of customization, long wait times for issue resolution
- Proprietary platform locks users into OEM; high cost of spares and support, shorter life cycle
- Upgrades budgeted due to obsolescence, rather than from a planned maintenance perspective
- Inability to respond to changing operating requirements

Introduction: Safe, Efficient, Reliable, Profitable: Third Party Control Maintenance Solutions

With rising global demand for energy, dwindling resources and volatile commodity prices, utilities, municipalities and independent power producers face mounting challenges to manage power generating assets effectively and profitably.

Gas turbine owners and operators are confronted with shifting operating profiles brought on by complex market dynamics. The pressure is on to drive operational flexibility and life cycle cost improvements, while also meeting regulatory emissions levels and achieving high thermal efficiencies.

Each plant operator has to balance risk and reward; at the end of the day, they need to ensure that control systems operate safely and efficiently while delivering a return on investment. Ultimately their job is to keep assets operating safely, efficiently, cost effectively and reliably.

Following Best Practices

Savvy plant management looks for every opportunity to drive performance improvements and extend the life cycle of their power generating assets. Maintaining the control system is critical to managing and maintaining a gas turbine in a safe and efficient manner.

It is not easy when maintenance budgets are depleted by costly proprietary technology and options are restricted by a lack of alternative solutions. Proprietary "black box" software and hardware make it burdensome to address controls maintenance using industry-standard best practices such as preventive maintenance or reliability centered maintenance

Many wait until the control system fails, or default to simply budgeting controls upgrades around OEM scheduled obsolescence. It does not have to be that way—gas turbine owners can retrofit their control systems with flexible, customizable open-architecture control platforms which address the OEM approach.

More and more utilities and industrial companies are looking to improve the availability, operational flexibility and extend the life of their existing turbines by freeing themselves from proprietary technology that can only be maintained by the OEM. The need to upgrade or replace aging gas turbine control systems is prompting power plant managers to reassess their options.

Many of these managers are turning to third party, open-platform control solutions. Today's third party gas turbine control systems solutions not only provide a good alternative to the OEM, but also help operators customize their functionality, avoid obsolescence, and extend the life cycle of the asset.

An integrated, comprehensive, engineered third party solution developed by a reputable firm can provide a high quality, proven and safe option. Not only do you receive all the benefits the OEM can provide, but also advantages that cannot be realized by using the OEM's approach.

Goals for Gas Turbine Control Systems Maintenance:

- Protect assets and enhance their safety, productivity, and useful life
- Achieve measurable performance improvement
- Protect critical assets from operation interruption and damage
- Enhance operational flexibility and life cycle of critical assets
- Enable improved asset management

Problem Assessment: Are Proprietary OEM Control Systems Limiting Performance and Reliability?

A gas turbine is a capital asset that demands complex maintenance. The control system protects and controls the gas turbine, and is the main interface to controlling the digital fuel admission system. These are complex systems, and the requirements for gas turbine controls are among the most challenging in the utility industry. Maintaining control systems is critical to managing and maintaining a gas turbine in a safe and cost effective manner.

With so much at stake, it is tempting for plant managers to fall back on the apparent simplicity offered by the proprietary nature of the OEM control system.

With purpose-built systems and convenient single sourcing for software, hardware, spare parts and training, the OEM model seems like an easy option. But, it also presents operators with significant limitations on system flexibility, incurring high support costs when modification is required. OEM system upgrades or product replacement strategies can induce premature obsolescence, leaving an operator with limited or no support service.

Most plant managers understand this on some level, but many continue to rely on OEM control systems, because they are unaware of alternatives or lack confidence in third party solutions.

Is Obsolescence the End of the Road?

The fact is, popular gas turbines such as the GE® LM6000 have been in operation for 20 years or longer. These installations play an essential part in driving today's power plants and industrial power generation facilities. However, the proprietary systems that control these turbines are nearing the end of their natural life cycles, prompting replacement.

In addition, many power generation packages installed in the past ten years are starting to experience unexpected obsolescence, driving their replacement somewhat prematurely in the normal upgrade life cycle. Some engines require fuel system upgrades or greater flexibility within their operating regimes, driving a control system upgrade to support the new configuration or operating profile. Hardware obsolescence can leave plants stranded should they have a failure and lack adequate spares or the ability to quickly procure replacement parts.

Compelling Reasons for Control Systems Upgrades:

Obsolescence:

- Spare parts and system support become hard to get
- New software revisions
- OEM product upgrades obsolete the existing control system

Changes required at the plant:

- Increasing flexibility to meet demand signals
- Compliance with regulatory mandates
- Ability to effectively troubleshoot/self-support your unit(s)

Lack of Visibility and Flexibility

Locked software impacts operational efficiency in a few ways. In many cases, users cannot see the engine control logic to troubleshoot, make changes, or manage the system themselves. If a unit exhibits abnormal performance this is a problem.

Managers may simply want to operate the unit slightly differently or pull incremental data out of the turbine controls to send to their plant control system—often, the base package provided by the OEM simply does not provide that much flexibility without modifications.

Getting the OEM to make site-specific modifications is expensive and time consuming. When software is upgraded, these customizations may be lost, leaving the user to pay the OEM one more time for making the changes.

All this becomes unnecessarily inconvenient and costly when a plant operator needs to make an operational change such as a water injection schedule to regulate emissions, or modification to meet site-specific contract or permitting issues. Software releases may include functionality built to fix other sites, and may not apply to the site getting the core upgrade.

Flexibility and Control, to Meet Unique, Site-Specific Needs

This situation gives plant management a great opportunity to evaluate alternative solutions. These days, plant and asset managers require more open, accessible control systems that can be easily supported, while extending flexibility, system life cycles and driving down total cost of ownership.

Replacing proprietary "purpose built" control systems that have limited their ability to make necessary modifications would extend longevity and lower operating costs.

Every power generation plant has unique nuances, which vary from site to site: gas contract stipulations, purchase power stipulations (revenue), or emissions contracts. Plant operators must have the flexibility to meet their contractual obligations and to meet these needs at a site level.

Gas turbine owners and operators now have more options for gas turbine and plant control system solutions. These options provide more timely support response, lower cost of replacement parts, and complete control of budgeting upgrades. There are hardware platform providers with hundreds of thousands of installed units in the field protecting a wide variety of critical equipment in comparison to just a few thousand purpose-built systems that are difficult to support.

Third party solutions available in the market can deliver the best of both worlds: flexible control to extend longevity and drive down cost, combined with the proven track record of a low-risk solution provider.

Top Four Challenges to Optimizing Gas Turbine Performance with an OEM Solution:

1. **Premature Obsolescence of OEM Hardware and Software**

- Installed base of turbine control packages nearing end of their natural life cycles
- Hardware lacks adequate spare parts; low volume purpose-built availability renders managers unable to procure parts in the event of outages
- Increased risk of long downtime periods
- OEMs push upgrades that may not be needed

2. **OEM proprietary Locked Control Software; No Toolset Support**

- "Black box" approach can leave managers unable to access, control or make system changes to control logic
- Troubleshooting to prevent problems and lowering operating costs is not possible
- Site-specific system customizations are exceedingly costly and time consuming

3. **Expensive, Proprietary "Purpose Built" Hardware Platforms**

- Closed solution manufactured, supported, and priced by OEM
- Software license only available from OEM
- Access to vendor and third party training, parts, support, service are limited

4. **Change in Operating Requirements**

- Equipment upgrades or modifications that require control system updates
- Inability to respond to operating regime change due to curtailment of high emission generating sources or seasonal spikes in demand
- Increasing flexibility to meet demand signals
- Compliance with regulatory mandates

Solution: A Value-Oriented, Fully Engineered, Open-Architecture Approach for Gas Turbine Control Maintenance

Leaving behind the proprietary, purpose-built system for an open-platform delivers tangible and indirect benefits. With an independent, open-platform approach, operators enjoy the best solution for their needs, instead of purpose-built closed, costly and restrictive black box architecture.

Different plant configurations and installations require sufficiently different solutions—evaluate each provider's capabilities to ensure that they are a good fit for the specific plant and equipment.

Why Flexibility and Control are Critical to Cost, Efficiency and Compliance

As part of a purchase power agreement, a plant may need to change its water injection schedule or enable a ten-minute fast start that will meet emissions and/or other contract criteria. An OEM contract for the modification can be extremely costly; where working with a third party provider would cost a fraction for the same outcome.

Evaluating Third Party Providers

First, make sure the short-listed providers have a deep and broad industry background, with extensive experience in other engine programs and controls.

Look for a solution partner who can deliver the strengths of the OEM platform: proven control software, carefully configured and managed engine safety and operating parameters, and quality project execution. One must make sure they can also provide benefits the OEM does not provide: an off-the-shelf control platform, open software and programming tools, customized user training and long term support options. This will deliver the ability to be self-sufficient, reduce life cycle costs, and improve plant flexibility.

A quality independent service provider must be able to provide the strong engineering capabilities and application knowledge necessary to program an open-platform that will meet the specific needs of the package and engine, as well as the balance

Beat the Top Three OEM Challenges With a Qualified Third Party Solutions Provider:

1. Premature Obsolescence

- Get support for obsolescence of OEM hardware and software
- Prevent ongoing obsolescence with continuous support via software tools, vendor support, and recommendations to extend life cycle

2. Locked Software

- A qualified third party solution provider supplies the necessary programming and application tools to ensure complete system control, modification and the ability to self-support

3. Purpose-Built Proprietary Platforms

- Open-platforms have the capability to support the most demanding turbine and balance of plant applications with off-the-shelf hardware and software
- Look for a customer-centric approach—vs. OEM product-centric approach—solutions designed to meet the customer need

Evaluating a Third Party Solution Provider:

- Industry experience
- Turbine and plant system knowledge
- Controls experience
- Technical support capability
- Working knowledge of NERC/FERC regulations

of plant control systems or what is typically termed Distributed Control System (DCS). For many plants, the DCS is suffering the same level of obsolescence as the turbine control.

Look for software that is safe and proven. Is the solution completely open? Are all software, programming tools and documentation provided? Can the third party provider extend the same control platform to cover the entire plant and process equipment? Does the provider offer a turnkey solution? How self-sufficient will the site be?

In addition, make sure the provider can handle the turbine and balance of plant controls. Many LM6000 unit owners are facing the decision to replace both the turbine and balance of plant controls. There are vendors that can handle the balance of plant but not the turbine, and vice versa. Look for a support team that can retrofit both pieces of plant under an open architecture, easily supported platform.

Subsystem controllers—such as a generator voltage regulator, power system stabilizer, vibration monitor, and PCs that operate the interface graphics and more—have their own life cycles and obsolescence issues. A thorough provider will audit each site's complete system to ensure anything that is nearing or at the end of its life cycle is taken into consideration and addressed.

Case Study: Control System Retrofit – GE LM6000 Turbine

Situation:

Facing control system obsolescence, a United States municipal power producer needed a control system retrofit solution for their dual fuel fired LM6000 PC unit. The company wanted a solution that could be supported in-house, freeing it from dependency on the OEM.

Problem:

- Sourcing spares for the control system was increasingly difficult, a problem that could lead to excessive downtime if unaddressed
- The power producer could not service the control system or solve issues without the OEM becoming involved
- The client wanted the system to be able to accept low pressure compressor spray injection in the future
- Client's desire to reuse as much existing cabinetry and wiring as possible

Solution:

- Client-specific solution integrated a control system retrofit including modifications to accept the future addition of low pressure compressor spray injection
- An open-architecture platform built with easily sourced components housed in existing cabinetry and connected using existing wiring

Results:

- Increased system reliability and availability
- Enhanced operational flexibility and load delivery capabilities
- Control system support can now be performed in-house or by an independent service company
- Improved network capability and data management

Third Party Evaluation Bottom Line:

Vast industry experience with gas turbine control systems combined with well-supported open-architectures and a comprehensive engineered solution produces a low risk, long term control solution that removes restrictive barriers, empowers greater control and lowers overall plant operating costs.

Concluding Summary

The need for greater control over gas turbine engines to lower power plant operating costs is forcing plant and asset managers to rethink previous commitments to expensive and inflexible OEM purpose-built control systems. Open-architecture control systems provided by an experienced third party provider will result in a great deal of flexibility and value.

Power plant operators and asset managers reap four primary benefits with an open architecture, and a fully engineered control system approach:

- **A Low Risk, Reassured and Long Term Solution –** Say goodbye to premature system obsolescence and hello to working with a provider that thoroughly knows the gas turbine environment without the rigidity of doing business directly with an OEM
- **An Open-Architecture System –** Enjoy the benefits of broad industry support and toolsets for complete modification and control, with all the programming tools and software needed to be self-sufficient
- **A Highly Cost Effective Approach –** Both upfront cost of doing the conversion and upgrade, and the longer life cycle cost – the cost to keep it running and make incremental changes is the bigger cost that is most impacting operational budgets
- **A Flexible, Supportive Business Relationship –** Maximize success without dependency; a customer-centric approach supports customers every step of the way. A flexible, supportive relationship makes it easier to do business – depend on Wood Group GTS without being dependent

A Third Party Engineered Solution Integrates All Key Aspects of Gas Turbine Controls Maintenance to Ensure Maximum Uptime and Top Performance:

- Hardware platform and software environment
- Application engineering/software
- Auxiliaries
- Project management
- Documentation
- Site services
- Aftermarket support

Why Power Generation Facilities Worldwide Rely on Wood Group GTS Control Systems Solutions:

- Field tested, plant-proven gas turbine retrofit successes: Over 500 systems retrofitted; 17 different turbine manufacturers, 60 different turbine models
- One-stop-shop for any size power plant controls automation project.
- Largest automation company in the Americas—over 500 control systems engineers on staff.
- Extensive power plant and cogeneration experience, ranging from simple cycle to 800MW combined cycle and 600 MW cogeneration projects
- Global execution capabilities include execution centers in South America, UK, Saudi Arabia, and Singapore
- Control Magazine Integrator of the Year 2010 in large category; first time an engineering firm has been so recognized

About Wood Group GTS

Wood Group GTS provides owners and operators of gas and steam turbines with a comprehensive range of control system solutions. With an independent, open-platform approach, our technical specialists select from both off-the-shelf and purpose-built control systems to deliver the best solution for power generation and mechanical drive packages.

Finally there is a proven alternative to OEM dependency:

1. A validated, field-tested alternative to the OEM—established solutions running in the field
2. Open-platform—vs. proprietary, purpose-built platform
3. All software and licenses are provided—vs. "locked" OEM systems
4. Flexible and configurable solution—vs. "this is what you get"

We offer a portfolio of solutions to help formulate an upgrade strategy based on plant-specific needs, delivering increased output, improved engine performance, enhanced plant availability and the flexibility to adapt to changing operating demands and regulatory requirements. Our capabilities and approach apply to the turbine and balance of plant controls equally, leveraging the skill and experience of Wood Group GTS' seasoned professionals.

We work to understand our customer's unique needs, in order to deliver the best solution for power generation and mechanical drive packages. We help cover operator risk—protecting the engine and critical parameters are paramount to our team. Our organizational focus on the end user helps ensure their success while maintaining equipment safety, plant integrity and environmental, and health & safety (EHS) compliance.

Wood Group GTS' solution offers the ability to have one control platform for all plant and process equipment, provided with all programming tools and open software, in a well-documented fashion. Our team can execute turnkey conversions with some of the fastest turn times in the industry helping each site be as self-sufficient as desired.

We offer an engineered solution that provides safe and effective control of prime movers such as the GE LM6000 gas turbine leveraging Rockwell Automation's open PlantPAx™ platform and Wood Group GTS' extensive LM6000 experience. The partnership with Rockwell, along with our engine and application expertise, gives our clients the best of both worlds:

- Absolute ability to be self-sufficient long term—no longer tied exclusively to the OEM
- A well-supported and cost effective hardware solution
- Single platform applicable to turbine control and balance of plant control—one set of tools, one set of spares, reduced training, and other efficiencies

Our clients enjoy the benefits of support programs like Rockwell's Parts Service Agreement (PSA), extensive training, local spares support from distributors, and thousands of resources capable of supporting the platform, NERC CIP proactive compliance, and more.

Wood Group GTS delivers quality and reliability that can only come from more than 25 years of experience in the field servicing gas turbine generating assets. We support customers in more than 50 countries, delivering integrated maintenance solutions for all high speed rotating equipment needs, whatever the application or scale of operation. Our customers rely on us to keep their valuable assets performing, so they can generate power and revenue.

Find out more: Call +1 970-669-0801 or email us at powerplantservices@woodgroup.com today to schedule a site visit. We will audit current controls maintenance needs and show how our solution, experience, process and procedures can help make power generation assets more safe, efficient, reliable and profitable.

Wood Group GTS

Keep on turning

US Headquarters

15600 JFK Blvd, Suite 500

Houston, TX 77032, USA

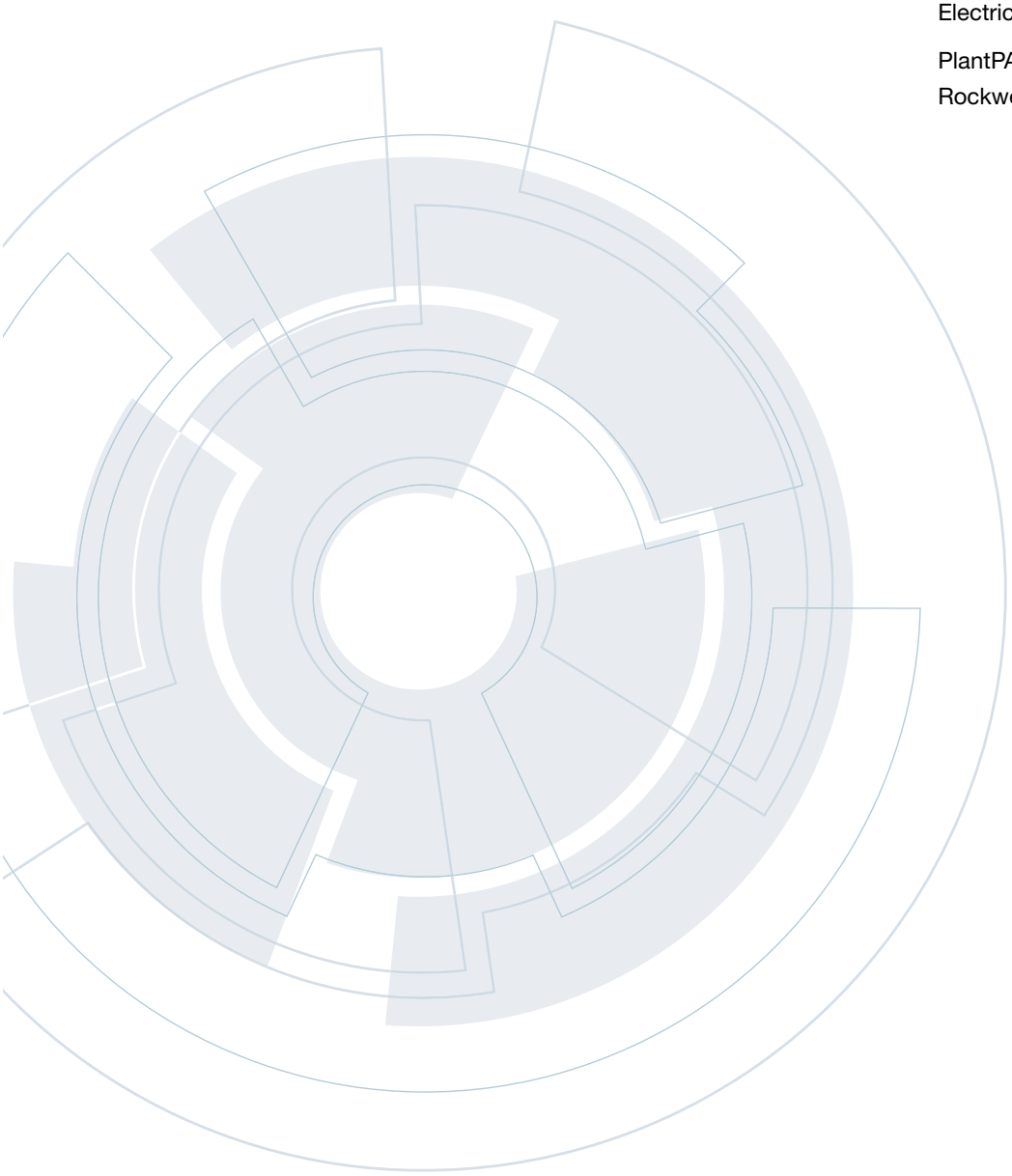
Tel: +1 (281) 227 5600

www.woodgroupgts.com

Legal Statements and Disclaimers:

GE is a registered trademark of General Electric Company.

PlantPAx™ is a registered trademark of Rockwell Automation.



© 2012 Wood Group GTS. All rights reserved.

Transmission

CI Number: 43205

Title: L5510 Insulator Replacements

Start Date: 2014/03
Final Cost Date: 2016/06
Function: Transmission
Forecast Amount: $3,191,398

DESCRIPTION:

This project is for the replacement of insulators on L5510 from 62N Bridge Avenue to 95H Malay Falls. The insulators which are identified for replacement in this project have an industry known cement growth failure mechanism which leads to unplanned transmission and customer outages.

Summary of Related CIs +/- 2 years:
CI 40387 – 2012 Transmission Line Insulator Replacements
CI 41399 – 2012 Substation Insulator and Cutouts
CI 43260 – 2013 Transmission Line Insulator Replacements

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

The specific 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 the failure of the insulator. The issue was identified through the transmission inspection program. By replacing the defective insulators, the reliability of this line will be improved through avoiding unplanned customer and transmission outages.

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 the new improved type of insulators is the only option.

This project is expected to be completed by an external contractor.

CI Number : 43205 - L5510 Insulator Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		27,746	0	27,746
094		094 - Interest Capitalized		138,039	0	138,039
095		095-COPS Regular Labour AO		39,398	0	39,398
095		095-COPS Contracts AO		612,249	0	612,249
013	007	013 - COPS Contracts	007 - TP - Environmental	30,787	0	30,787
012	035	012 - Materials	035 - TP - Wood Poles	21,868	0	21,868
013	035	013 - COPS Contracts	035 - TP - Wood Poles	53,550	0	53,550
012	038	012 - Materials	038 - TP - Insulators	107,272	0	107,272
013	038	013 - COPS Contracts	038 - TP - Insulators	1,025,795	0	1,025,795
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	1,735	0	1,735
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.	1,083,524	0	1,083,524
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:	3,191,398	0	3,191,398
			Original Cost:	187,744		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 43205
Title: L5510 Insulator Replacement
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Site Supervision	PD	118.0	$ 397.00	$ 46,832.54		
1.2	Line Switching	PD	5.2	$ 336.89	$ 1,734.65		
1.3	Procurement	Lot	1.0	$ 2,583.18	$ 2,583.18		
1.4					$ -		
1.5					$ -		
				Sub-Total	$ 51,150.37		
2	**012 Materials**						
2.1	Insulators, Poles, Conductor	Lot	1	129159.06	$ 129,159.06		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 129,159.06		
3	**013 Contracts**						
3.1	PLT Labour	hrs	[redacted]		$ 2,160,468.76		
3.2	Bog Mats	lot	1	30786.6	$ 30,786.60		
3.3	Pole Hauling	lot	1	2400	$ 2,400.00		
				Sub-Total	$ 2,193,655.36		
4	**094 Interest Capitalized**						
4.1					$ 138,039.44		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 138,039.44		
5	**095 Administrative Overhead**						
5.1	095-COPS Regular Labour AO				$ 39,397.69		
5.2	095-COPS Overtime Labour AO				$ -		
5.3	092-Vehicle T&D Reg. Labour AO				$ 27,746.43		
5.4	092-Vehicle T&D OT Labour AO				$ -		
5.5	095-COPS Contracts AO				$ 612,249.16		
				Sub-Total	$ 679,393.28		
				SUB-TOTAL (no AO, AFUDC)	$ 2,373,964.79		
				TOTAL (AO, AFUDC included)	$ 3,191,397.51		
6	**Original Cost**						
6.1					$ 187,743.68		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

[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

$$\nabla \times \tilde{H} = \tilde{J} \tag{A-1}$$

$$\nabla \cdot \tilde{B} = 0 \tag{A-2}$$

$$\tilde{B} = \mu \tilde{H} \tag{A-3}$$

$$\frac{\partial \tilde{B}}{\partial t} \tag{A-4}$$

$$+ \tilde{v} \times \tilde{B}) \tag{A-5}$$

eliminate $\tilde{E}$ in (A-4):

$$\times (\tilde{v} \times \tilde{B}) = -\frac{\partial \tilde{B}}{\partial t} \tag{A-6}$$

he curl of (A-1) into (A-6) yields:

$$B) - \nabla \times (\tilde{v} \times \tilde{B}) = -\frac{\partial \tilde{B}}{\partial t} \tag{A-7}$$

dentity:

$$= \nabla (\nabla \cdot \tilde{B}) - \nabla^2 \tilde{B} \tag{A-8}$$

APPENDIX B: FORMULAE

$$\begin{bmatrix} N & N \\ [D\,B_m(y+t/2)] & [0] \\ [0] & [D\,B_m(y+t/2)] \end{bmatrix} \tag{B-1}$$

2)] is a diagonal NxN matrix whose

$$\triangleq \beta_{mn}\, e^{-\beta_{mn}(y+t/2)} \tag{B-2}$$

$$[G\,F_m] \triangleq \begin{matrix} L & L \\ [G_m] & [F_m] \\ [\hat{G}_m] & [\hat{F}_m] \end{matrix}\ \begin{matrix} N \\ N \end{matrix} \tag{B-3}$$

$$[F\,G_m] \triangleq \begin{matrix} L & L \\ [F_m] & [G_m] \\ [\hat{F}_m] & [\hat{G}_m] \end{matrix}\ \begin{matrix} N \\ N \end{matrix} \tag{B-4}$$

The formulae of the n-ℓth elements of the submatrices are:

$$(G_m)_{n\ell} \triangleq \frac{z_{n\ell}\, e^{-\Gamma_{m\ell} t/2}}{\beta_{mn} + \Gamma_{m\ell}} \tag{B-5}$$

$$(F_m)_{n\ell} \triangleq \frac{z_{n\ell}\, e^{\Gamma_{m\ell} t/2}}{\beta_{mn} - \Gamma_{m\ell}} \tag{B-6}$$

$$(\hat{G}_m)_{n\ell} \triangleq -\frac{z^*_{n\ell}\, e^{-\Gamma_{m\ell} t/2}}{\beta_{mn} + \Gamma_{m\ell}} \tag{B-7}$$

$$(\hat{F}_m)_{n\ell} \triangleq -\frac{z^*_{n\ell}\, e^{\Gamma_{m\ell} t/2}}{\beta_{mn} - \Gamma_{m\ell}} \tag{B-8}$$

$$[S_{m1}] \triangleq \int_{-h/2}^{h/2} [DD\,R_m(y)]^{*T} [ARCL]^{*T} [DG\,B_m(y+t/2)]\,dy \tag{B-9}$$

$$[S_{m2}] \triangleq \int_{-h/2}^{h/2} [DD\,R_m(y)]^{*T} [ARCL]^{*T} [DG\,B_m(-y+t/2)]\,dy \tag{B-10}$$

$$[S_{m3}] \triangleq \int_{-h/2}^{h/2} [DD\,R_m(y)]^{*T} [ARCL]^{*T} [DG\,B_m(-y+h)]\,dy \tag{B-11}$$

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.(15)
Γ_{ml} = eq.(24)

Hot Taps
Leak Sealing • Transformer/Circuit Breaker Repair Line Stops
Stick with a winner!

IEEE Transactions on Power Apparatus and Systems, Vol. PAS-102, No. 8, August 1983

CEMENT GROWTH FAILURE OF PORCELAIN SUSPENSION INSULATORS

E.A. Cherney
Ontario Hydro
800 Kipling Avenue
Toronto, Ontario
M8Z 5S4

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.

0018-9510/83/0800-2765$01.00 © 1983 IEEE

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.

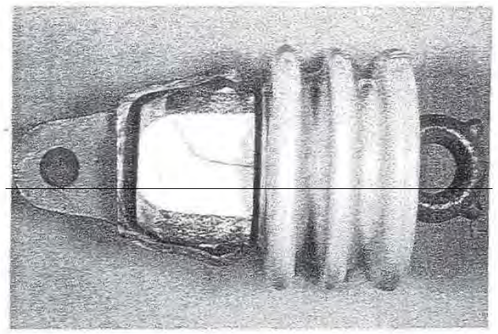


Fig. 1. Radial crack concealed in the head of an insulator.

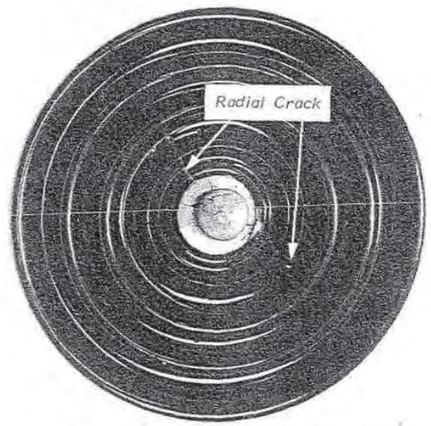


Fig. 2. Radial crack visible in the shell of a suspension insulator.

The equations governing the stress are

$$S_r = E(\varepsilon_r - c) + \sigma(S_\theta + S_z) \quad (1)$$

in the radial direction, and

$$S_\theta = E(\varepsilon_\theta - c) + \sigma(S_r + S_z) \quad (2)$$

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

$$\varepsilon_r = du/dr \quad (3)$$

in the radial direction, and

$$\varepsilon_\theta = u/r \quad (4)$$

in the circumferential direction, where u represents the component of the displacement vector in the r direction.

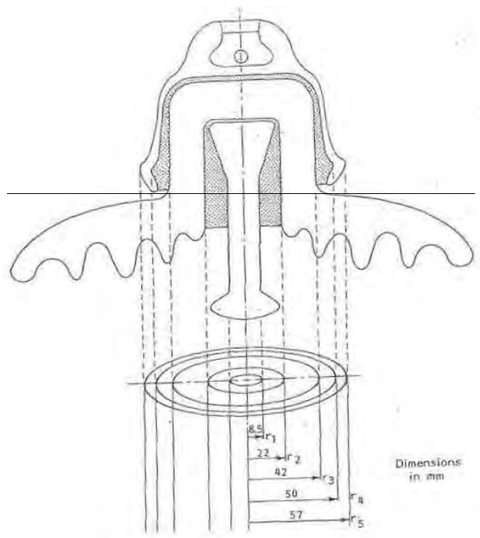


Fig. 3. Cylindrical approximation of the 5-3/4 x 10 in suspension insulator.

Equations 1-4 and the equation of equilibrium

$$\frac{dS_r}{dr} + \frac{S_r - S_\theta}{r} = 0 \quad (5)$$

yield the differential equation

$$r^2 \frac{d^2u}{dr^2} + r\frac{du}{dr} - u = 0 \quad (6)$$

with general solution

$$u = ar + b/r \quad (7)$$

Thus, strain in the circumferential direction becomes

$$\varepsilon_\theta = a + b/r^2 \quad (8)$$

and stress in the radial direction becomes

$$S_r = \frac{E}{1-\sigma^2}\left[\left(a - \frac{b}{r^2} - c\right) + \sigma\left(a + \frac{b}{r^2} - c\right)\right] + \frac{\sigma}{1-\sigma} S_z \quad (9)$$

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 x10^6	7-8.5	10-12	3	30
THERMAL COEFFICIENT OF EXPANSION x10^{-6}/°C	5	7	9	12
FLEXURE STRENGTH psi x10^3	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.

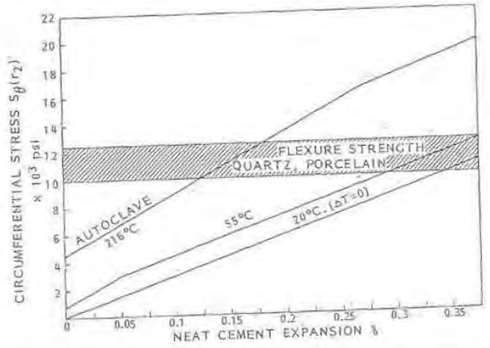


Fig. 4. Circumferential stress S_θ (r_2) in quartz porcelain for cement expansion in per cent.

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.

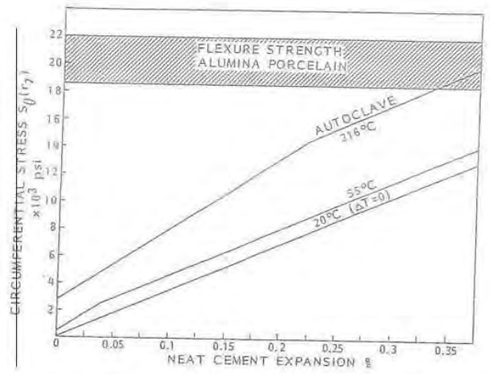


Fig. 5. Circumferential stress $S\theta$ (r_2) in alumina porcelain for cement expansion in per cent.

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.

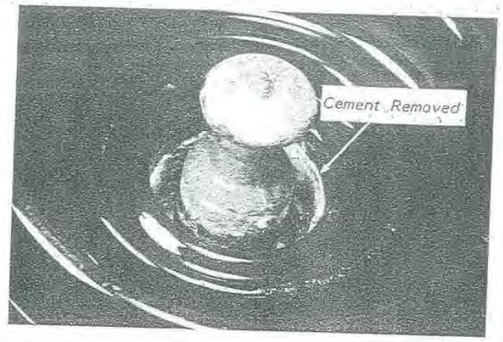


Fig. 6 Insulator pin cement removed for Thermal tests.

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.

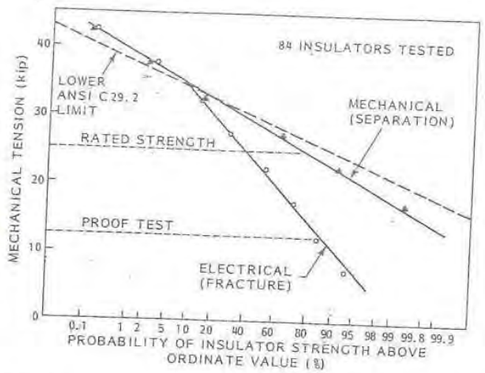


Fig. 7. Distribution of M&E strength for 25 000 lb insulators removed from the field.

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.

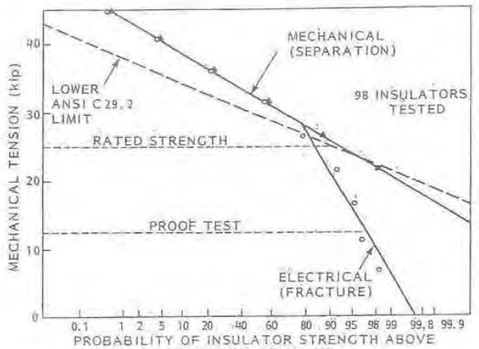


Fig. 8 Distribution of M&E strength of unused 25 000 lb insulators manufactured in 1965.

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.

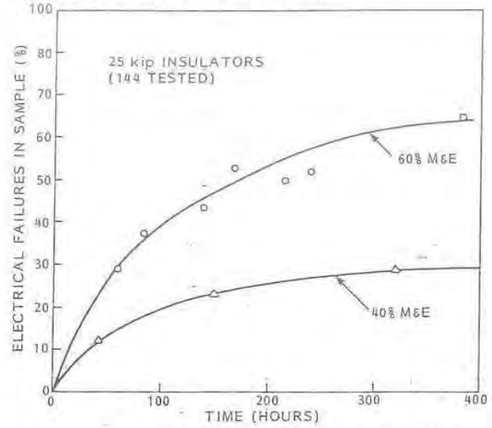


Fig. 9. Time-load test on unused 25 000 lb insulators manufactured in 1965.

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).

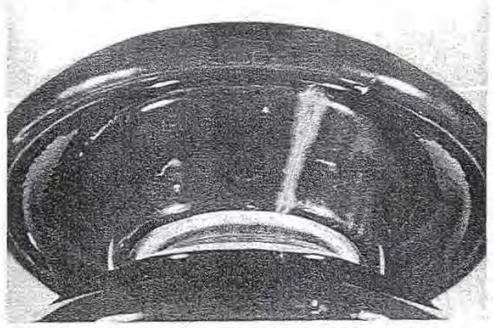


Fig. 10. Aged apparatus cap-and-pin insulator subjected to cement autoclave expansion test.

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 ($CaSO \cdot 2H_2O$), 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 ($3CaO \cdot Al_2O_3 \cdot 3\ CaSO_4 \cdot 31H_2O$). 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.

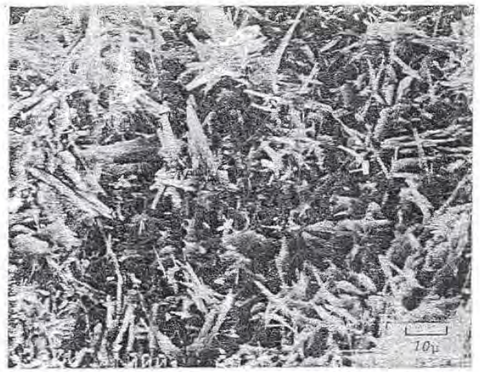


Fig. 11 Scanning electron microscope photograph of tricalcium sulphoaluminate crystals in an insulator cement at 1000 X.

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.

REFERENCES

[1] P.W. Sothman, "Comparative Tests on High-Tension Suspension Insulators", AIEE Trans, Vol XXXI, 1912, pp 2143-2226.

[2] "Cement Growth and its Effect on Porcelain Insulators", Lapp Insulator, Leroy, N.Y.

[3] E.S. Zobel, "Insulators Lose Strength with Age", Electrical World, Sept 1962, pp 40-42.

[4] J. Kaminski, "Long-Time Mechanical and Electrical Strength of Suspension Insulators", IEEE PAS, Aug 1963, pp 446-451.

[5] C.E. Corey and R.C. Fournier, "Insulator Design Related to Service Failures", Paper presented at the 33rd Annual International Conference of Doble Clients, 1966.

[6] D.E. Alexander, "Portland Cement Curing and Volume Characteristics", IEEE PAS paper F76 375-6.

[7] "Improvement of Mechanical and Electrical Strength of Porcelain Insulators", EPRI Research Project No 424-1, prepared by Gould Inc, Nov 1977.

[8] "Method for Autoclave Expansion of Portland Cement", American National Standard C151, 1978.

[9] "Specification for Wet-Process Porcelain and Toughened Glass Insulators (suspension type)", American National Standard C29.2, 1977.

[10] "Investigations of the Hydration Expansion Characteristics of Portland Cements", H.F. Gonnerman, W. Lerch and T.M. Whiteside, Portland Cement Association, Bulletin 45, 1953.

[11] "Properties of Concrete", A.M. Neville, Sir Isaac Pitman and Sons Ltd., 1963.

[12] "Standard Specification for Portland Cement", American National Standard C150, 1978.

[13] G.E. Monfore, "Properties of Expansive Cement Made with Portland Cement, Gypsum, and Calcium Aluminate Cement", Journal of the PCA Research and Development Laboratories, Vol 6, No 2 May 1964, pp 2-9.

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?

REFERENCE

[1] T. D. Robson, High Alumina Cements and Concretes, John Wiley and Sons, 1962.

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.

SINGLE PHASE SWITCHING TESTS ON THE AEP 765 KV SYSTEM - EXTINCTION TIME FOR LARGE SECONDARY ARC CURRENTS

A. G. Fakheri (SM) T. C. Shuter (M) J. M. Schneider (NM) C. E. Shih (SM)

American Electric Power Service Corporation
Columbus, Ohio

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_s) 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. 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

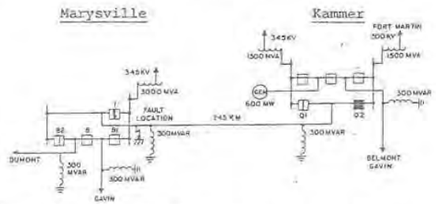


Figure 1: - One Line Diagram of the Test Line
■ - Breaker used for SPS Operations
◫ - Open Breaker
⊟ - Closed Breaker

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

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.

0018-9510/83/0800-2775$01.00 © 1983 IEEE

TRANSMISSION & DISTRIBUTION WORLD

PRINTTHIS
Powered by Limelight Networks

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.
edward@primus.ca

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.

2008 Penton Media, Inc. All rights reserved.

CI Number: 44974

Title: 2014 Substation Polychlorinated Biphenol (PCB) Equipment Removal Program

Start Date: 2014/02
Final Cost Date: 2015/03
Function: Transmission
Forecast Amount: $1,172,392

DESCRIPTION:

This project provides for the costs associated with the PCB sampling of all substation oil-filled equipment (350 in 2014) and the removal of substation devices with 500 mg/kg, or more of PCBs, to be in compliance with 2008 Federal Environmental PCB Regulations.

Summary of Related CIs +/- 2 years:
CI 41429 2012 Substation PCB Management $1,854,665
CI 43231 2013 Substation PCB Equipment Removal $1,496,626

JUSTIFICATION:

Justification Criteria: Environment

Sub Criteria: Requirement to Serve

Why do this project?

This is year five 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 effectively managed. 2014 is year five of a five year program to address PCB removal requirements. All remaining transmission substation equipment that does not fall below federal PCB concentration limits must be removed in 2014.

This work is expected to be completed by internal resources.

CI Number : 44974 - 2014 Substation Poly Chlorinated Bi-Phenol (PCB) Equipment Removal **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		89,902	0	89,902
092		092-Vehicle T&D OT Labour AO		994	0	994
095		095-COPS Regular Labour AO		127,653	0	127,653
095		095-COPS Contracts AO		39,636	0	39,636
095		095-COPS Overtime Labour AO		1,412	0	1,412
095		095 - T&CS Regular Labour AO		1,921	0	1,921
012	004	012 - Materials	004 - TP - Misc.Equipment	6,000	0	6,000
001	007	001 - T&D Regular Labour	007 - TP - Environmental	3,500	0	3,500
013	007	013 - COPS Contracts	007 - TP - Environmental	22,313	0	22,313
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	124,664	0	124,664
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	3,481	0	3,481
011	043	011 - Travel Expense	043 - TP - Substn Dev.	15,000	0	15,000
012	043	012 - Materials	043 - TP - Substn Dev.	437,312	0	437,312
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	86,100	0	86,100
041	043	041 - Meals & Entertainment	043 - TP - Substn Dev.	1,800	0	1,800
012	044	012 - Materials	044 - TP - Substn.Transf.	138,000	0	138,000
013	044	013 - COPS Contracts	044 - TP - Substn.Transf.	33,600	0	33,600
001	085	001 - T&CS Regular Labour	085 Design	4,092	0	4,092
001	085	001 - T&D Regular Labour	085 Design	29,200	0	29,200
001	085	001 - Regular Labour (No AO)	085 Design	5,813	0	5,813
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
			Total Cost:	1,172,392	0	1,172,392
			Original Cost:	137,231		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 44974
Title: 2014 PCB Equipment Removals
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	PD	359.33	$ 346.93	$ 124,663.51		
1.2	Project Management	PD	80.00	$ 365.00	$ 29,200.00		
1.3	Engineering	PD	9.00	$ 365.00	$ 3,285.00		
1.4	CADD	PD	3.00	$ 269.00	$ 807.00		
1.5	Project Support	Lot	1.00	$ 9,313.12	$ 9,313.12		
1.6							
				Sub-Total	$ 167,268.63		
2	**002 OT Labour**						
2.1	Electrician	PD	5.02	$ 693.86	$ 3,480.87		
2.2					$ -		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 3,480.87		
3	**012 Materials**						
3.1	69kV Breaker	ea	1	55000	$ 55,000.00		
3.2	138kV Breaker	ea	2	75000	$ 150,000.00		
3.3	69kV CT's and PT's	ea	12	5000	$ 60,000.00		
3.4	138kv CT's and PT's	ea	12	6500	$ 78,000.00		
3.5	69kV Bushings	ea	24	3000	$ 72,000.00		43231
3.6	138kV Bushings	ea	24	6500	$ 156,000.00		
3.7	25kV Sealed Bushings	ea	6	525	$ 3,150.00		
3.8	Misc. Materials (Conductors, lugs)	lot	6	1000	$ 6,000.00		
3.9	Replacement Oil	Litres	390	2.98	$ 1,162.20		
				Sub-Total	$ 581,312.20		
4	**013 Contracts**						
4.1	Crane (Breakers)	ea	3	3500	$ 10,500.00		
4.2	Crane (CT's & PT's)	ea	24	1400	$ 33,600.00		
4.3	Crane (Bushings)	ea	54	1400	$ 75,600.00		
4.4	Sample Processing	ea	350	33.75	$ 11,812.50		
4.5	Misc.				$ 10,500.00		
4.6							
				Sub-Total	$ 142,012.50		
5	**011 Travel Expense**						
5.1					$ 15,000.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 15,000.00		
6	**041 Meals & Entertainment**						
6.1					$ 1,800.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 1,800.00		
7	**095 Administrative Overhead**						
7.1	095-COPS Regular Labour AO				$ 127,653.28		
7.2	095-COPS Overtime Labour AO				$ 1,411.86		
7.3	092-Vehicle T&D Reg. Labour AO				$ 89,901.84		
7.4	092-Vehicle T&D OT Labour AO				$ 994.30		
7.5	095-COPS Contracts AO				$ 39,635.71		
7.6	T&CS Reg. Labour				$ 1,921.15		
				Sub-Total	$ 261,518.14		
				SUB-TOTAL (no AO, AFUDC)	$ 910,874.20		
				TOTAL (AO, AFUDC included)	$ 1,172,392.34		
8	**Original Cost**						
8.1					$ 137,231.39		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 44980

Title: 2014 Switch & Breaker Replacements

Start Date: 2014/02
Final Cost Date: 2015/03
Function: Transmission
Forecast Amount: $1,095,553

DESCRIPTION:

This project provides for reliability improvements on the NS Power transmission system through the replacement of deteriorated substation switches and circuit breakers. This estimate includes the procurement and installation of 8 circuit breakers, and installation of 6 switches.

Summary of Related CIs +/- 2 years:
CI 41426 2012 Transmission Switch and Breaker Replacements $2,000,849
CI 43226 2013 Transmission Switch and Breaker Replacements $1,969,767
CI TBD 2015 Transmission Switch and Breaker Replacements $TBD

Depreciation Class – Transmission Station Equipment

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

This project will replace circuit breakers that are malfunctioning due to age. In addition, switch modifications/additions will result in improved switching capability and 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, spare parts are no longer available for the circuit breakers that are being replaced due to the age of the devices. Various switches are being modified or changed out due to either operational issues or targeted improvements to the capability of the switch. These modifications will result in improved customer reliability.

This work is expected to be completed by internal resources.

CI Number : 44980 - 2014 Transmission Switch and Breaker Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		80,369	0	80,369
092		092-Vehicle T&D OT Labour AO		2,191	0	2,191
095		095 - T&CS Regular Labour AO		17,895	0	17,895
095		095-COPS Overtime Labour AO		3,111	0	3,111
095		095-COPS Contracts AO		23,444	0	23,444
095		095-COPS Regular Labour AO		114,118	0	114,118
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	48,000	0	48,000
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	16,956	0	16,956
002	039	002 - T&D Overtime Labour	039 - TP - O/H Cond.	2,120	0	2,120
011	039	011 - Travel Expense	039 - TP - O/H Cond.	5,200	0	5,200
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	111,018	0	111,018
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	5,551	0	5,551
011	043	011 - Travel Expense	043 - TP - Substn Dev.	14,800	0	14,800
012	043	012 - Materials	043 - TP - Substn Dev.	556,000	0	556,000
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	36,000	0	36,000
041	043	041 - Meals & Entertainment	043 - TP - Substn Dev.	2,400	0	2,400
001	085	001 - T&CS Regular Labour	085 Design	38,116	0	38,116
001	085	001 - Regular Labour (No AO)	085 Design	5,560	0	5,560
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.	12,704	0	12,704
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	1,095,553	0	1,095,553
			Original Cost:	164,998		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 44980
Title: 2014 Switch & Breaker Replacements
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	PD	320	$ 346.93	$ 111,017.60		
1.2	PowerLine Technician	PD	48	$ 353.25	$ 16,956.00		
1.3	Site Supervision	PD	32	$ 397.00	$ 12,704.00		
1.4	Engineering	PD	72	$ 365.00	$ 26,280.00		
1.5	CADD	PD	44	$ 269.00	$ 11,836.00		
1.6	Project Support	lot	1	$ 5,560.00	$ 5,560.00		
				Sub-Total	$ 184,353.60		
2	**002 OT Labour**						
2.1	Electrician	PD	8	$ 693.86	$ 5,550.88		
2.2	PowerLine Technician	PD	3	$ 706.50	$ 2,119.50		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 7,670.38		
3	**012 Materials**						
3.1	69kV Dead Tank SF6 Breaker	ea	4	$ 55,000.00	$ 220,000.00		43226
3.2	138kV Dead Tank SF6 Breaker	ea	4	$ 75,000.00	$ 300,000.00		43226
3.3	Misc. Materials (Wires / Lugs)	Per breaker	8	$ 4,500.00	$ 36,000.00		
				Sub-Total	$ 556,000.00		
4	**013 Contracts**						
4.1	Crane / Boom Truck	Per breaker	8	$ 4,500.00	$ 36,000.00		
4.2	Civil - Concrete work	Per breaker	4	$ 12,000.00	$ 48,000.00		
4.3					$ -		
				Sub-Total	$ 84,000.00		
5	**011 Travel Expense**						
5.1					$ 20,000.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 20,000.00		
6	**041 Meals & Entertainment**						
6.1					$ 2,400.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 2,400.00		
7	**095 Administrative Overhead**						
7.1	095-COPS Regular Labour AO				$ 114,117.66		
7.2	095-COPS Overtime Labour AO				$ 3,111.08		
7.3	092-Vehicle T&D Reg. Labour AO				$ 80,369.14		
7.4	092-Vehicle T&D OT Labour AO				$ 2,191.04		
7.5	095-COPS Contracts AO				$ 23,444.40		
7.6	095 -T&CS Reg. Labour AO				$ 17,895.42		
				Sub-Total	$ 241,128.74		
				SUB-TOTAL (no AO, AFUDC)	$ 854,423.98		
				TOTAL (AO, AFUDC included)	$ 1,095,552.72		
8	**Original Cost**						
8.1					$ 164,988.14		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 43672

Title: 82V-T1 (Elmsdale) Transformer Rewind

Start Date: 2013/07
Final Cost Date: 2014/10
Function: Transmission
Forecast Amount: $936,380

DESCRIPTION:

This project is to proactively rewind 82V-T1 to prevent a forced outage resulting from mechanical failure of internal coil blocking.

Summary of Related CIs +/- 2 years: None

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 the 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.

The removal / installation of the transformer is expected to be completed by internal resources. The rewind is expected to be completed by an external contractor.

CI Number : 43672-T779 - 82V-T1 Transformer Rewind **Project Number** T779

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		19,925	0	19,925
094		094 - Interest Capitalized		4,640	0	4,640
095		095-COPS Regular Labour AO		31,568	0	31,568
095		095-COPS Contracts AO		143,737	0	143,737
095		095 - T&CS Regular Labour AO		5,050	0	5,050
001	044	001 - T&D Regular Labour	044 - TP - Substn.Transf.	33,689	0	33,689
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
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
			Total Cost:	936,380	0	936,380
			Original Cost:	218,775		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 43672
Title: 82V-T1 Transformer Rewind
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician (2013 Rate)	PD	55.9	$ 336.89	$ 18,844.50		
1.2	Electrician (2014 Rate)	PD	42.8	$ 346.93	$ 14,844.50		
1.3	Engineering	PD	37.6	$ 365.00	$ 13,720.02		
1.4	Procurement	Lot	1.0	$ 2,580.00	$ 2,580.00		
1.5	Site Supervision	PD	18.8	$ 397.00	$ 7,472.00		
				Sub-Total	$ 57,461.02		
2	**013 Contracts**						
2.1	Transformer Rewind	ea	1	[redacted]		Cost Support Item#1 - Attachment 1 - Page 3	
2.2	Additional Rewind Options	lot	1				
2.3	Rail Shipment	ea	2	40000	$ 80,000.00		
2.4	Crane Lifts	ea	2	10000	$ 20,000.00		
2.5	Sandblast & Paint	lot	1	15000	$ 15,000.00		
				Sub-Total	$ 515,000.00		
3	**012 Materials**						
3.1	New Bushings	set	1	40000	$ 40,000.00		
3.2	Reactor	ea	1	15000	$ 15,000.00		
3.3	Lead Arrangement	ea	1	18000	$ 18,000.00		
3.4	Gauges	set	1	6000	$ 6,000.00		
3.5	Oil	ea	1	50000	$ 50,000.00		
				Sub-Total	$ 129,000.00		
4	**028 Consulting**						
4.1	Misc. Consulting				$ 25,000.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 25,000.00		
5	**011 Travel**						
5.1					$ 5,000.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 5,000.00		
6	**094 Interest Capitalized**						
6.1					$ 4,640.13		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 4,640.13		
7	**095 Administrative Overhead**						
7.1	095 - T&CS Regular Labour AO				$ 5,049.63		
7.2	092-Vehicle T&D Reg. Labour AO				$ 19,924.98		
7.3	095-COPS Contracts AO				$ 143,736.50		
7.4	095-COPS Overtime Labour AO				$ -		
7.5	095-COPS Regular Labour AO				$ 31,567.56		
				Sub-Total	$ 200,278.67		
				SUB-TOTAL (no AO, AFUDC)	$ 731,461.02		
				TOTAL (AO, AFUDC included)	$ 936,379.82		
8	**Original Cost**						
8.1					$ 218,775.11		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 45033

Title: L7001 Maintenance – Phase 1

Start Date: 2014/05
Final Cost Date: 2014/12
Function: Transmission
Forecast Amount: $813,226

DESCRIPTION:

This project is required to replace 10 deteriorated structures on transmission line 7001 that have reached the end of their service life. Additionally, there are 44 spar arms to be changed. This work has been identified and prioritized as part of NSPI's transmission inspection program. Work of a similar nature is planned on 96 additional structures on this line between 2015 and 2017.

Summary of Related CIs +/- 2 years:
2015 – CI TBD – L7001 Maintenance – Phase 2
2016 – CI TBD – L7001 Maintenance – Phase 3

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Maintenance

Why do this project?

The structures and spar arms scheduled for replacement have reached the end of their service lives. This work will enhance the overall reliability performance of L7001 which is considered a backbone line.

Why do this project now?

This work has been prioritized based on transmission inspection results, with the most critical repairs slated for 2014.

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 this work is expected to be completed by an external contractor.

CI Number : 45033 - L7001 Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		7,106	0	7,106
094		094 - Interest Capitalized		8,677	0	8,677
095		095-COPS Contracts AO		146,516	0	146,516
095		095 - T&CS Regular Labour AO		3,427	0	3,427
095		095-COPS Regular Labour AO		10,091	0	10,091
013	007	013 - COPS Contracts	007 - TP - Environmental	11,748	0	11,748
012	035	012 - Materials	035 - TP - Wood Poles	78,184	0	78,184
013	035	013 - COPS Contracts	035 - TP - Wood Poles	368,604	0	368,604
012	038	012 - Materials	038 - TP - Insulators	12,711	0	12,711
013	038	013 - COPS Contracts	038 - TP - Insulators	56,856	0	56,856
013	039	013 - COPS Contracts	039 - TP - O/H Cond.	87,750	0	87,750
001	085	001 - Regular Labour (No AO)	085 Design	1,818	0	1,818
001	085	001 - T&CS Regular Labour	085 Design	7,300	0	7,300
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	12,439	0	12,439
			Total Cost:	813,226	0	813,226
			Original Cost:	177,561		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 45033
Title: L7001 Maintenance - Phase 1
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Engineering	PD	20.00	$ 365.00	$ 7,300.00		
1.2	Site Supervision	PD	31.33	$ 397.00	$ 12,439.00		
1.3	Project Support	Lot	1.00	$ 1,818.00	$ 1,818.00		
1.4					$ -		
1.5					$ -		
				Sub-Total	$ 21,557.00		
2	**012 Materials**						
2.1	Poles & Insulators	Lot	1		$ 90,895.31		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 90,895.31		
3	**013 Contracts**						
3.1	PLT Labour	hr	[redacted]		$ 496,710.03		
3.2	Environment Mats & Bridgges	Lot	1	$ 11,747.50	$ 11,747.50		
3.3	Pole Haulage & Rock Breaker	Lot	1	$ 16,500.00	$ 16,500.00		
				Sub-Total	$ 524,957.53		
4	**094 Interest Capitalized**						
4.1					$ 8,676.71		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 8,676.71		
5	**095 Administrative Overhead**						
5.1	095-COPS Regular Labour AO				$ 10,090.52		
5.2	095-COPS Overtime Labour AO				$ -		
5.3	092-Vehicle T&D Reg. Labour AO				$ 7,106.40		
5.4	095 - T&CS Reg Labour AO				$ 3,427.36		
5.5	095-COPS Contracts AO				$ 146,515.66		
				Sub-Total	$ 167,139.94		
				SUB-TOTAL (no AO, AFUDC)	$ 637,409.84		
				TOTAL (AO, AFUDC included)	$ 813,226.49		
6	**Original Cost**						
6.1					$ 177,561.41		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 44977

Title: 3W-Big Falls Breaker, Switch and Cable Replacements

Start Date: 2014/07
Final Cost Date: 2014/12
Function: Transmission
Forecast Amount: $401,463

DESCRIPTION:

This project is required to replace the 3W-502 breaker, 3W-502A&B switches, 3W-511 disconnect switch, 8 pole structures, AC-DC supplies, control cables, protection modifications and civil remediation around 3W-502.

Summary of Related CIs +/- 2 years: None

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

The existing breaker, switches, pole structure and control cables have all reached the end of their life and are becoming deteriorated.

Why do this project now?

If the 3W-502 breaker or the 8-pole structure were to fail it would cause significant customer outages on transmission line L5532, which serves distribution substations along Highway 8.

Why do this project this way?

Coordinating the replacement of multiple substation assets at the same time is the most cost effective way to complete this work.

This work is expected to be completed by internal resources.

CI Number : 44977 - 3W Breaker, Switch & Cable Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		30,464	0	30,464
092		092-Vehicle T&D OT Labour AO		1,600	0	1,600
095		095-COPS Overtime Labour AO		2,272	0	2,272
095		095-COPS Regular Labour AO		43,256	0	43,256
095		095 - T&CS Regular Labour AO		7,089	0	7,089
095		095-COPS Contracts AO		13,257	0	13,257
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	25,000	0	25,000
001	035	001 - T&D Regular Labour	035 - TP - Wood Poles	21,195	0	21,195
002	035	002 - T&D Overtime Labour	035 - TP - Wood Poles	2,826	0	2,826
011	035	011 - Travel Expense	035 - TP - Wood Poles	1,508	0	1,508
012	035	012 - Materials	035 - TP - Wood Poles	28,000	0	28,000
013	035	013 - COPS Contracts	035 - TP - Wood Poles	4,500	0	4,500
041	035	041 - Meals & Entertainment	035 - TP - Wood Poles	195	0	195
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	22,204	0	22,204
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	2,775	0	2,775
011	043	011 - Travel Expense	043 - TP - Substn Dev.	1,392	0	1,392
012	043	012 - Materials	043 - TP - Substn Dev.	147,000	0	147,000
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	18,000	0	18,000
041	043	041 - Meals & Entertainment	043 - TP - Substn Dev.	180	0	180
001	085	001 - T&CS Regular Labour	085 Design	15,100	0	15,100
001	085	001 - Regular Labour (No AO)	085 Design	3,500	0	3,500
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	225	0	225
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	9,925	0	9,925
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	401,463	0	401,463
			Original Cost:	48,866		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 44977
Title: 3W Breaker, Switch and Cable Replacements
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	PD	64.00	$ 346.93	$ 22,203.52		
1.2	PowerLine Technician	PD	60.00	$ 353.25	$ 21,195.00		
1.3	Site Supervision	PD	25.00	$ 397.00	$ 9,925.00		
1.4	Engineering	PD	34.00	$ 365.00	$ 12,410.00		
1.5	CADD	PD	10.00	$ 269.00	$ 2,690.00		
1.6	Project Support	Lot	1.00	$ 3,500.00	$ 3,500.00		
				Sub-Total	$ 71,923.52		
2	**002 OT Labour**						
2.1	Electrician	PD	4.00	$ 693.86	$ 2,775.44		
2.2	PowerLine Technician	PD	4.00	$ 706.50	$ 2,826.00		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 5,601.44		
3	**012 Materials**						
3.1	69kV Dead Tank SF6 Breaker	ea	1	$ 55,000.00	$ 55,000.00		
3.2	69kV Disconnect Switch	ea	3	$ 13,000.00	$ 39,000.00		
3.3	Wood Poles	ea	8	$ 3,500.00	$ 28,000.00		
3.4	AC - DC Supplies & Enclosure	Lot	1	$ 15,000.00	$ 15,000.00		
3.5	Panel Modifications	Lot	1	$ 10,000.00	$ 10,000.00		
3.6	Control Cable	Lot	1	$ 10,000.00	$ 10,000.00		
3.7	Misc. Materials Wire & Lugs	ea	4	$ 4,500.00	$ 18,000.00		
				Sub-Total	$ 175,000.00		
4	**013 Contracts**						
4.1	Crane / Boom Truck	ea	5	$ 4,500.00	$ 22,500.00		
4.2	Civil Works - Grading remediation	Lot	1	$ 25,000.00	$ 25,000.00		
4.3					$ -		
				Sub-Total	$ 47,500.00		
5	**011 Travel Expense**						
5.1	Travel / Lodging				$ 3,125.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 3,125.00		
6	**041 Meals & Entertainment**						
6.1	Meals				$ 375.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 375.00		
7	**095 Administrative Overhead**						
7.1	095-COPS Regular Labour AO				$ 43,256.04		
7.2	095-COPS Overtime Labour AO				$ 2,271.94		
7.3	092-Vehicle T&D Reg. Labour AO				$ 30,463.74		
7.4	092-Vehicle T&D OT Labour AO				$ 1,600.06		
7.5	095-COPS Contracts AO				$ 13,257.26		
7.6	095 - T&CS Reg Labour				$ 7,089.46		
				Sub-Total	$ 97,938.50		
				SUB-TOTAL (no AO, AFUDC)	$ 303,524.96		
				TOTAL (AO, AFUDC included)	$ 401,463.46		
8	**Original Cost**						
8.1					$ 48,866.00		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 44983

Title: Reactor Bank Breaker Replacements

Start Date: 2014/03
Final Cost Date: 2014/12
Function: Transmission
Forecast Amount: $385,032

DESCRIPTION:

This project consists of proactively replacing three (3) low voltage reactor bank breakers; 103H-411, 67N-311 and 79N-412.

Summary of Related CIs +/- 2 years: None

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Service Voltage

Why do this project?

Reactor bank breakers have been experiencing current-carrying contact erosion, compressor receiver tank leaks and drive rod failures. In addition, the 79N-411 reactor bank breaker recently failed. Based on these issues with low voltage reactor bank breakers and the failure of 79N-411 breaker this year, these three targeted reactor breakers will be proactively replaced, prior to failure.

Why do this project now?

The targeted reactor bank breakers are of similar vintage and style to the 79N-411 breaker that failed in 2013. These reactor bank breakers have upwards of 4,000 to 5,000 operations. Their mechanical mechanisms are deteriorating, and are susceptible to the same operational issues described above.

Why do this project this way?

Failure of reactor bank breakers results in the reduced ability to control system voltage. Planned replacement of reactor bank breakers allows us to remove them from service under controlled conditions, and is the most effective way to minimize power quality implications.

This work is expected to be completed by internal resources.

CI Number : 44983 - Reactor Bank Breaker Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		25,955	0	25,955
092		092-Vehicle T&D OT Labour AO		897	0	897
094		094 - Interest Capitalized		1,868	0	1,868
095		095-COPS Overtime Labour AO		1,274	0	1,274
095		095-COPS Contracts AO		13,815	0	13,815
095		095-COPS Regular Labour AO		36,853	0	36,853
095		095 - T&CS Regular Labour AO		3,328	0	3,328
013	003	013 - COPS Contracts	003 - TP - Bldg.,Struct.Grnd.	36,000	0	36,000
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	4,239	0	4,239
002	039	002 - T&D Overtime Labour	039 - TP - O/H Cond.	1,060	0	1,060
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	36,428	0	36,428
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	2,082	0	2,082
011	043	011 - Travel Expense	043 - TP - Substn Dev.	6,750	0	6,750
012	043	012 - Materials	043 - TP - Substn Dev.	183,804	0	183,804
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	13,500	0	13,500
041	043	041 - Meals & Entertainment	043 - TP - Substn Dev.	900	0	900
001	085	001 - T&CS Regular Labour	085 Design	7,089	0	7,089
001	085	001 - Regular Labour (No AO)	085 Design	3,676	0	3,676
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	750	0	750
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	4,764	0	4,764
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	385,032	0	385,032
			Original Cost:	184,519		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 44983
Title: Reactor Bank Breaker Replacements
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	PD	105.00	$ 346.93	$ 36,427.65		
1.2	PowerLine Technician	PD	12.00	$ 353.25	$ 4,239.00		
1.3	Site Supervision	PD	12.00	$ 397.00	$ 4,764.00		
1.4	Engineering	PD	15.00	$ 365.00	$ 5,475.00		
1.5	CADD	PD	6.00	$ 269.00	$ 1,614.00		
1.6	Project Support	Lot	1.00	$ 3,676.08	$ 3,676.08		
				Sub-Total	$ 56,195.73		
2	**002 OT Labour**						
2.1	Electrician	PD	3.00	$ 693.86	$ 2,081.58		
2.2	PowerLine Technician	PD	1.50	$ 706.50	$ 1,059.75		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 3,141.33		
3	**012 Materials**						
3.1	25kV Dead Tank Breaker	ea	3	$ 48,668.00	$ 146,004.00		
3.2	25kV Disconnect Switch	ea	3	$ 8,100.00	$ 24,300.00		
3.3	Misc Materials - Wire & Lugs	ea	3	$ 4,500.00	$ 13,500.00		
				Sub-Total	$ 183,804.00		
4	**013 Contracts**						
4.1	Crane / Boom Truck	ea	3	$ 4,500.00	$ 13,500.00		
4.2	Civil Work	ea	3	$ 12,000.00	$ 36,000.00		
4.3					$ -		
				Sub-Total	$ 49,500.00		
5	**011 Travel Expense**						
5.1					$ 7,500.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 7,500.00		
6	**041 Meals & Entertainment**						
6.1					$ 900.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 900.00		
7	**094 Interest Capitalized**						
7.1					$ 1,868.20		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 1,868.20		
8	**095 Administrative Overhead**						
8.1	095-COPS Regular Labour AO				$ 36,853.36		
8.2	095-COPS Overtime Labour AO				$ 1,274.12		
8.3	092-Vehicle T&D Reg. Labour AO				$ 25,954.54		
8.4	092-Vehicle T&D OT Labour AO				$ 897.33		
8.5	095-COPS Contracts AO				$ 13,815.46		
8.6	095 - T&CS Reg Labour				$ 3,328.29		
				Sub-Total	$ 82,123.10		
				SUB-TOTAL (no AO, AFUDC)	$ 301,041.06		
				TOTAL (AO, AFUDC included)	$ 385,032.36		
9	**Original Cost**						
9.1					$ 184,518.85		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 44985

Title: Replace 230kV Kearney Disconnect Switch Assemblies

Start Date: 2014/05
Final Cost Date: 2014/12
Function: Transmission
Forecast Amount: $319,246

DESCRIPTION:

This project consists of replacing eleven switch assemblies at the 120H Brushy Hill transmission substation.

Summary of Related CIs +/- 2 years: None

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

In 2013, there were six 230kV Kearney disconnect switches at 120H Brushy Hill that were found to be inoperable. The 230kV Kearney disconnect switches targeted in 2014 are of similar style and vintage, and are experiencing the same operational issues.

Why do this project now?

Seized and inoperable switches can make operating the transmission system extremely difficult - equipment cannot be isolated in order to be maintained or replaced.

Why do this project this way?

Replacement of the existing switch assembly, rather than the entire switch, with an upgraded assembly is the most cost effective way to ensure reliable operation in the future.

This work is expected to be completed by internal resources.

CI Number : 44985 - Replace 230kV Kearney Disconnect Switch Assemblies **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		1,467	0	1,467
092		092-Vehicle T&D Reg. Labour AO		22,786	0	22,786
095		095-COPS Overtime Labour AO		2,083	0	2,083
095		095 - T&CS Regular Labour AO		7,044	0	7,044
095		095-COPS Regular Labour AO		32,354	0	32,354
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	3,886	0	3,886
002	039	002 - T&D Overtime Labour	039 - TP - O/H Cond.	2,591	0	2,591
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	22,897	0	22,897
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	2,544	0	2,544
011	043	011 - Travel Expense	043 - TP - Substn Dev.	3,713	0	3,713
012	043	012 - Materials	043 - TP - Substn Dev.	187,000	0	187,000
041	043	041 - Meals & Entertainment	043 - TP - Substn Dev.	495	0	495
001	085	001 - Regular Labour (No AO)	085 Design	1,870	0	1,870
001	085	001 - T&CS Regular Labour	085 Design	15,004	0	15,004
011	085	011 - Travel Expense	085 Design	413	0	413
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	13,101	0	13,101
			Total Cost:	319,246	0	319,246
			Original Cost:	136,892		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 44985
Title: Replace 230kV Kearney Disconnect Switch Assemblies
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	PD	66.00	$ 346.93	$ 22,897.38		
1.2	PowerLine Technician	PD	11.00	$ 353.25	$ 3,885.75		
1.3	Site Supervision	PD	33.00	$ 397.00	$ 13,101.00		
1.4	Engineering	PD	33.00	$ 365.00	$ 12,045.00		
1.5	CADD	PD	11.00	$ 269.00	$ 2,959.00		
1.6	Procurement	Lot	1.00	$ 1,870.00	$ 1,870.00		
				Sub-Total	$ 56,758.13		
2	**002 OT Labour**						
2.1	Electrician	PD	3.67	$ 693.86	$ 2,544.15		
2.2	PowerLine Technician	PD	3.67	$ 706.50	$ 2,590.50		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 5,134.65		
3	**012 Materials**						
3.1	230kV Disconnect Switch	Per Breaker	11	$ 15,000.00	$ 165,000.00		
3.2	Misc materials (Wire & Lugs)	Per Breaker	11	$ 2,000.00	$ 22,000.00		
3.3					$ -		
				Sub-Total	$ 187,000.00		
4	**011 Travel Expense**						
4.1					$ 4,125.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 4,125.00		
5	**041 Meals & Entertainment**						
5.1					$ 495.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 495.00		
6	**095 Administrative Overhead**						
6.1	095-COPS Regular Labour AO				$ 32,354.02		
6.2	095-COPS Overtime Labour AO				$ 2,082.62		
6.3	092-Vehicle T&D Reg. Labour AO				$ 22,785.80		
6.4	092-Vehicle T&D OT Labour AO				$ 1,466.72		
6.5	095-T&CS Reg. Labour AO				$ 7,044.38		
				Sub-Total	$ 65,733.54		
				SUB-TOTAL (no AO, AFUDC)	$ 253,512.78		
				TOTAL (AO, AFUDC included)	$ 319,246.32		
7	**Original Cost**						
7.1					$ 136,891.51		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 44973

Title: 2014 Substation Recloser Replacements

Start Date: 2014/03
Final Cost Date: 2015/03
Function: Transmission
Forecast Amount: $307,115

DESCRIPTION:

In 2012 and 2013 an extensive replacement effort was undertaken to address equipment failures that had occurred on the NS Power system. This capital item provides for reliability improvements for substation equipment by replacing 10 substation reclosers throughout the province. The estimated useful life of substation reclosers is approximately 30 to 35 years.

Summary of Related CIs +/- 2 years:
2012 CI 41430 Substation Recloser Replacements $2,120,686
2013 CI 43237 Substation Recloser Replacements $1,863,378

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

In late 2010 and 2011, following a number of substation recloser failures, it was identified that some substation reclosers are reaching the end of their useful life, causing a reliability and safety issue. In 2014, 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 35 years. The 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 effects 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 with new equipment ensures improved reliability of NS Power's system.

This work is expected to be completed by internal resources.

CI Number : 44973 - 2014 Substation Recloser Replacements **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		1,982	0	1,982
092		092-Vehicle T&D Reg. Labour AO		9,069	0	9,069
095		095 - T&CS Regular Labour AO		632	0	632
095		095-COPS Overtime Labour AO		2,814	0	2,814
095		095-COPS Regular Labour AO		12,878	0	12,878
095		095-COPS Contracts AO		1,954	0	1,954
012	004	012 - Materials	004 - TP - Misc.Equipment	0	0	0
001	039	001 - T&D Regular Labour	039 - TP - O/H Cond.	1,766	0	1,766
002	039	002 - T&D Overtime Labour	039 - TP - O/H Cond.	0	0	0
001	043	001 - T&D Regular Labour	043 - TP - Substn Dev.	6,939	0	6,939
002	043	002 - T&D Overtime Labour	043 - TP - Substn Dev.	6,939	0	6,939
012	043	012 - Materials	043 - TP - Substn Dev.	240,420	0	240,420
013	043	013 - COPS Contracts	043 - TP - Substn Dev.	7,000	0	7,000
001	085	001 - Regular Labour (No AO)	085 Design	4,808	0	4,808
001	085	001 - T&D Regular Labour	085 Design	3,650	0	3,650
001	085	001 - T&CS Regular Labour	085 Design	1,345	0	1,345
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.	3,520	0	3,520
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
011	087	011 - Travel Expense	087 Field Super.& Ops.	1,250	0	1,250
041	087	041 - Meals & Entertainment	087 Field Super.& Ops.	150	0	150
			Total Cost:	307,115	0	307,115
			Original Cost:	149,618		

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 44973
Title: 2014 Substation Recloser Replacements
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	PD	20.00	$ 346.93	$ 6,938.60		
1.2	PowerLine Technician	PD	5.00	$ 353.25	$ 1,766.25		
1.3	Site Supervision	PD	10.00	$ 352.00	$ 3,520.00		
1.4	Engineering	PD	10.00	$ 365.00	$ 3,650.00		
1.5	CADD	PD	5.00	$ 269.00	$ 1,345.00		
1.6	Project Support	Lot	1.00	$ 4,808.40	$ 4,808.40		
				Sub-Total	$ 22,028.25		
2	**002 OT Labour**						
2.1	Electrician	PD	10.00	$ 693.86	$ 6,938.60		
2.2					$ -		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 6,938.60		
3	**012 Materials**						
3.1	Reclosers	ea	10.00	$ 21,872.00	$ 218,720.00		43237
3.2	Recloser Stands	ea	10.00	$ 720.00	$ 7,200.00		
3.3	Misc. Materials.	ea	10.00	$ 1,200.00	$ 12,000.00		
3.4	Current Transformer	ea	10.00	$ 250.00	$ 2,500.00		
				Sub-Total	$ 240,420.00		
4	**013 Contracts**						
4.1	Crane / Boom Truck	per Device	10	700	$ 7,000.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 7,000.00		
5	**011 Travel Expense**						
5.1					$ 1,250.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 1,250.00		
6	**041 Meals & Entertainment**						
6.1					$ 150.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 150.00		
7	**095 Administrative Overhead**						
7.1	095-COPS Regular Labour AO				$ 12,877.66		
7.2	095-COPS Overtime Labour AO				$ 2,814.30		
7.3	092-Vehicle T&D Reg. Labour AO				$ 9,069.27		
7.4	092-Vehicle T&D OT Labour AO				$ 1,982.01		
7.5	095-COPS Contracts AO				$ 1,953.70		
7.6	T&CS Reg. Labour AO				$ 631.50		
				Sub-Total	$ 29,328.44		
				SUB-TOTAL (no AO, AFUDC)	$ 277,786.85		
				TOTAL (AO, AFUDC included)	$ 307,115.29		
8	**Original Cost**						
8.1					$ 149,617.98		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

2014 Substation Recloser Replacements

Region	Device	Type
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
Northeast	4N-311	WVE
Northeast	4N-312	WVE
Northeast	4N-313	CWVE

CI Number: 44982

Title: New Spare Transformer to Replace 20W-T51

Start Date: 2014/03
Final Cost Date: 2015/03
Function: Transmission
Forecast Amount: $291,660

DESCRIPTION:

This project is required to purchase a new spare transformer to replace the unit at 20W-T1 Lower East Pubnico.

Summary of Related CIs +/- 2 years: None

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Equipment Replacement

Why do this project?

A system spare transformer was used to replace the failed 20W-T1 transformer in 2013. In the event of a transformer failure occurring, with no spare transformer, NS Power is forced to operate a mobile transformer in its place for the 9-12 months it takes to order a replacement transformer. These mobile transformers are only intended for use of 3-4 weeks (the expected time to install/commission a spare transformer). A mobile transformer has protection & voltage limitations that NS Power does not consider acceptable for such a long period in service. With one of the five system mobile transformers installed long-term for a failure, it greatly affects the annual maintenance work plan, which is built around utilizing mobile transformers to by-pass substation transformers in order to perform major maintenance.

Why do this project now?

The system spare has been used and now needs to be replaced so that NS Power has adequate spare transformer coverage.

Why do this project this way?

Replacement of the spare transformer is necessary as NS Power cannot reliably utilize mobile transformers for extended periods of time, in the event of transformer failures.

CI Number : 44982 - New Spare Transformer to Replace 20W-T51 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		3,116	0	3,116
092		092-Vehicle T&D OT Labour AO		198	0	198
094		094 - Interest Capitalized		490	0	490
095		095-COPS Overtime Labour AO		281	0	281
095		095-COPS Contracts AO		11,164	0	11,164
095		095-COPS Regular Labour AO		4,425	0	4,425
001	044	001 - T&D Regular Labour	044 - TP - Substn.Transf.	3,469	0	3,469
002	044	002 - T&D Overtime Labour	044 - TP - Substn.Transf.	694	0	694
012	044	012 - Materials	044 - TP - Substn.Transf.	208,750	0	208,750
013	044	013 - COPS Contracts	044 - TP - Substn.Transf.	40,000	0	40,000
001	085	001 - Regular Labour (No AO)	085 Design	2,088	0	2,088
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
028	085	028 - Consulting	085 Design	15,000	0	15,000
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	1,985	0	1,985
002	087	002 - T&D Overtime Labour	087 Field Super.& Ops.	0	0	0
			Total Cost:	291,660	0	291,660
			Original Cost:			

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 44982
Title: New Spare Transformer to Replace 20W-T51
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	PD	10.00	$ 346.93	$ 3,469.30		
1.2	Procurement	Lot	1	$ 2,087.50	$ 2,087.50		
1.3	Site supervision	PD	5.00	$ 397.00	$ 1,985.00		
1.4					$ -		
1.5					$ -		
				Sub-Total	$ 7,541.80		
2	**013 Contracts**						
2.1	Crane Lifts	ea	2	20000	$ 40,000.00		
2.2					$ -		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 40,000.00		
3	**012 Materials**						
3.1	New 5/6.7 MVA Transformer	ea	1	183750	$ 183,750.00		
3.2	Oil	ea	1	25000	$ 25,000.00		
3.3					$ -		
				Sub-Total	$ 208,750.00		
4	**028 Consulting**						
4.1	Misc. Consulting				$ 15,000.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 15,000.00		
5	**002 OT Labour**						
5.1	Electrician	MD	1.00	693.86	$ 693.86		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 693.86		
6	**094 Interest Capitalized**						
6.1					$ 490.04		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 490.04		
7	**095 Administrative Overhead**						
7.1	092-Vehicle T&D OT Labour AO				$ 198.20		
7.2	092-Vehicle T&D Reg. Labour AO				$ 3,116.04		
7.3	095-COPS Contracts AO				$ 11,164.00		
7.4	095-COPS Overtime Labour AO				$ 281.43		
7.5	095-COPS Regular Labour AO				$ 4,424.53		
				Sub-Total	$ 19,184.20		
				SUB-TOTAL (no AO, AFUDC)	$ 271,985.66		
				TOTAL (AO, AFUDC included)	$ 291,659.90		
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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 44975

Title: 2014 Sacrificial Anode Installation Program

Start Date: 2014/05
Final Cost Date: 2014/12
Function: Transmission
Forecast Amount: $290,047

DESCRIPTION:

Sacrificial anodes are highly active metals that are used for cathodic protection to prevent a less active material surface from corroding. This project will systematically install sacrificial anodes on steel transmission structures and key anchors identified as corroding or at a high risk for corrosion. This program, along with a specialized transmission steel towers inspection and the steel tower refurbishment program will identify, quantify and address corrosion issues on steel assets throughout the province.

Summary of Related CIs +/- 2 years:
CI 44970 – 2014 Steel Tower Refurbishments $492,271
2015 CI TBD – 2015 Sacrificial Anode Installation Program $TBD
2016 CI TBD – 2016 Sacrificial Anode Installation Program $TBD

JUSTIFICATION:

Justification Criteria: Transmission Plant

Sub Criteria: Maintenance

Why do this project?

Based on transmission line inspections, the age of NS Power infrastructure and the corrosion rate of steel once galvanization is breached, sacrificial anodes have been recommended by the T&D Engineering group and have been proven effective in other jurisdictions to protect steel transmission structure assets and slow the rate of corrosion.

Why do this project now?

Due to the age of NS Power steel transmission structure assets, the galvanization is at or near the end of the anticipated life. The cathodic protection provided by the installation of sacrificial anode will effectively extend the life of the steel structure.

Why do this project this way?

The installation of sacrificial anodes protects the existing assets once the galvanization is ineffective, deferring or preventing costly replacement.

This project is expected to be completed by external resources.

CI Number : 44975 - Sacrificial Anode Installation Program Phase 1 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
012		012 - Materials		42,000	0	42,000
092		092-Vehicle T&D Reg. Labour AO		3,983	0	3,983
094		094 - Interest Capitalized		1,399	0	1,399
095		095-COPS Regular Labour AO		5,655	0	5,655
095		095-COPS Contracts AO		50,011	0	50,011
013	037	013 - COPS Contracts	037 - TP - Steel Towers	179,188	0	179,188
001	085	001 - T&D Regular Labour	085 Design	2,899	0	2,899
001	085	001 - Regular Labour (No AO)	085 Design	840	0	840
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	4,072	0	4,072
			Total Cost:	290,047	0	290,047
			Original Cost:			

Capital Project Detailed Estimate

Location: Transmission
CI# / FP#: 44975
Title: Sacrificial Anode Installation Program
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Engineering	PD	7.94	$ 365.00	$ 2,899.00		
1.2	Site Supervision	PD	10.26	$ 397.00	$ 4,072.00		
1.3	Project Support	Lot	1.00	$ 840.00	$ 840.00		
1.4					$ -		
1.5					$ -		
				Sub-Total	$ 7,811.00		
2	**012 Materials**						
2.1	Anodes				$ 42,000.00		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 42,000.00		
3	**013 Contracts**						
3.1	PLT Labour	hrs	[redacted]		$ 144,108.00		
3.2	Environmental	lot	1	$ 35,080.00	$ 35,080.00		
3.3					$ -		
				Sub-Total	$ 179,188.00		
4	**094 Interest Capitalized**						
4.1					$ 1,399.45		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 1,399.45		
5	**095 Administrative Overhead**						
5.1	095-COPS Regular Labour AO				$ 5,654.88		
5.2	095-COPS Overtime Labour AO				$ -		
5.3	092-Vehicle T&D Reg. Labour AO				$ 3,982.52		
5.4	092-Vehicle T&D OT Labour AO				$ -		
5.5	095-COPS Contracts AO				$ 50,011.36		
				Sub-Total	$ 59,648.76		
				SUB-TOTAL (no AO, AFUDC)	$ 228,999.00		
				TOTAL (AO, AFUDC included)	$ 290,047.21		
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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CATHODIC PROTECTION OF TRANSMISSION LINE TOWERS

R.G. Wakelin
Correng Consulting Service Inc.
369 Rimrock Road,
Downsview, Ontario
M3J 3G2

ABSTRACT

This paper discusses some of the corrosion problems typically experienced by the underground portions of electrical transmission line towers, and examines cathodic protection as a method by which tower footing corrosion can be prevented. A case history of one power company's cathodic protection experiences is also presented.

Keywords: transmission line towers, cathodic protection, galvanized steel.

INTRODUCTION

The corrosion of transmission line tower footings has been recognized as a possible problem since at least as early as 1936, when the Detroit Edison Company began examining the condition of the galvanizing on the underground portions of their steel lattice towers.[1] Furthermore, from as early as 1946 when the California Electric Power Company installed magnesium anodes on a number of their steel towers,[2] and more recently as described in other literature,[3,4] cathodic protection has been used as a means of preventing tower footing corrosion.

Despite these and other published experiences spanning almost 50 years, most power companies still place little emphasis on the importance of tower footing corrosion. In a 1983 survey, only 4 out of 18 Canadian companies involved in power transmission reported that they were aware of any corrosion on their tower footings.[5] To the author's knowledge, in Canada, only SaskPower and Ontario Hydro have

Presented November 2, 1993 at the Premiere Eastern Canadian Conference of NACE International, Toronto, Canada.

11208 0894

undertaken extensive programs to cathodically protect tower footings. Hydro Québec[6] and Trans-Alta Utilities have cathodically protected tower footings on a more limited basis, and in British Columbia, cathodic protection has been applied in only one instance where corrosion damage was observed on the footings of some towers which had been knocked over by a snowslide. It is believed that the electrical power companies in Manitoba and the maritime provinces have never used cathodic protection to control tower footing corrosion.

As an illustration of the importance of preserving the integrity of these structures, Ontario Hydro estimates the value of their 45,000 transmission line towers at several billions of dollars,[7] and that furthermore, by the year 2000, 80% of these structures will have exceeded their original design life of 55 years, and will need to be protected against corrosion.

CORROSION THEORY

Corrosion of Galvanized Steel

The majority of transmission line towers are of the steel lattice type, constructed of hot-dip galvanized structural steel members. In earlier installations, the footings of these towers were direct-buried in the soil and anchored to galvanized steel grillages as shown in Figure 1. While the galvanizing normally provides the above-grade portions of the towers with excellent protection from atmospheric corrosion, it is generally less effective in protecting the buried footings, which are exposed to an electrolyte on a continuous basis, and are exposed to more aggressive corrosion mechanisms as well.

The effectiveness of galvanizing as a corrosion prevention measure is twofold. The galvanizing acts as a mechanical barrier, isolating the steel from the electrolyte; however, unlike a dielectric coating, when bare steel becomes exposed as a result of corrosion or mechanical damage to the galvanizing, the remaining zinc coating acts as a sacrificial anode and provides cathodic protection to the steel.

Tests conducted in a variety of soils have shown that zinc experiences an average corrosion rate of 0.3 grams/m^2/day.[8] For a typical galvanized steel tower footing having a zinc coating thickness of 5 mils (3 oz/ft^2), this translates to a life of only 8 years before the galvanizing has been completely consumed. In fact, this life would be considerably less if the galvanic effect between the zinc and exposed bare steel was considered, not to mention the other corrosion mechanisms present on an actual power line installation.

The corrosion rate of zinc is also affected by pH. As shown in Figure 2, zinc experiences a pitting rate in the range of from 1 to 4 mils/year in weakly alkaline solutions, but in acidic or strongly alkaline solutions, the rate is dramatically higher.[9] One case is described in the literature in which grillages installed in acidic soils having a pH of 3 had lost their galvanizing and begun to corrode in less than 2-1/2 years[3].

There is evidence to suggest that the mechanical protection provided by hot-dip galvanizing is greater than what is afforded by a pure zinc coating alone. When steel is hot-dipped in zinc, a series of zinc-iron alloys form at the interface between the base metal and the zinc surface layer. In tests conducted by Romanoff and others (as reported by the NBS[8]), the pure zinc surface layer was electrolytically stripped

to expose the alloy layer, and the alloy layer was found to be as much as 100 mV cathodic to steel. In these tests, the alloy was found to continue to corrode at approximately the same rate as either pure zinc or bare steel, and furthermore, it was found to be ineffective in providing cathodic protection to the bare steel. However, in subsequent tests where the zinc layer was allowed to corrode away naturally, the zinc-iron alloy was often found to experience negligible corrosion rates due to the formation of a passive film, perhaps zinc silicate. Nevertheless, the NBS report concludes that *in any environment in which the protection of steel depends entirely on the sacrificial corrosion of the zinc coating, a galvanized coating could provide only temporary protection at best.*

Corrosion of Tower Footings

In addition to general corrosion, tower footings may experience more severe corrosion as the result of localized corrosion cells existing at individual towers, or long-line corrosion cells existing along the length of the transmission line.

Considering first the case of an individual tower, or even a single tower footing, corrosion may be accelerated by any number of common corrosion mechanisms. Differences in soil conditions (resistivity, pH, soil type, aeration, etc.) between one tower footing and another, or between the upper portion of the tower leg and the grillage, can set up localized anodes and cathodes. A potentially more aggressive corrosion cell is caused by the interconnection of dissimilar metals to the tower footing. Copper counterpoise wires, copper-clad ground rods, and reinforcing steel in concrete are all cathodic with respect to bare steel as well as galvanized steel, and will accelerate the depletion of the galvanizing and the eventual corrosion of the base metal .

Where transmission line towers are electrically connected by either a skywire or counterpoise, the tower footings become susceptible to long-line corrosion cells in the same manner as a pipeline. Again, variations in soil conditions along the transmission line route, and dissimilar metal couples arising from copper grounding grids at substations are both factors which can accelerate the corrosion of tower footings. Furthermore, both man-made stray currents (e.g. DC transit systems, impressed current cathodic protection systems) and geomagnetic stray currents can contribute to corrosion as well. Fortunately, these long-line corrosion problems can often be mitigated by the electrical isolation of the skywire from the towers.

In most newer installations, steel lattice towers, as well as coated-steel pole towers, are installed on reinforced concrete pads. As long as the metallic components of the towers are supported above grade by these pads, they will only be subjected to atmospheric corrosion. However, should the tower leg come into contact with the soil, either because of changes in grade or because of surface flooding, then the tower leg becomes susceptible to all of the same corrosion mechanisms as before, including the additional galvanic influence of the reinforcing steel in the concrete pad (Figure 3).

APPLICATION OF CATHODIC PROTECTION

General

Cathodic protection can be easily applied to tower footings by the installation of packaged sacrificial anodes. Typically, one anode is installed per footing, but the particular type of anode required for a certain application will vary depending upon soil conditions and current requirements.

Normally, a current density of at least 10 mA/m^2 is required to protect a steel tower footing in most soil conditions. A small 1m x 1m grillage of the type shown in Figure 1, connected to a tower leg 2m long, might therefore require a current of approximately 30 mA for protection. In most Canadian soils, this current would be difficult to attain using a zinc anode, because of zinc's relatively low open-circuit potential of -1100 mV. Under most conditions, magnesium anodes are preferred, because the higher open-circuit potential of magnesium (-1750 mV) allows it to produce approximately three times as much current as a comparable zinc anode. In cases where cathodic protection current requirements are low, such as on towers coated with a dielectric material, or where soil resistivities are known to be low (e.g. <1000 Ω-cm), zinc anodes may be preferred, because of their higher current efficiency and longer life.

There may be cases where the cathodic protection current requirements of tower footings are too high to be realistically met using sacrificial anodes. In such instances, impressed current cathodic protection may be used. The primary drawback associated with an impressed current system is the cost of powering and maintaining the impressed current rectifier.

Prioritization of Cathodic Protection of Existing Towers

The most accurate means of determining the extent of corrosion experienced by a tower footing is to excavate and physically examine the footings. Because this is an extremely laborious and costly procedure, structure-to-soil potential measurements are often used to estimate the condition of the galvanizing on the tower footings, which in turn provides a rough indication of the structural integrity of the footings.

Galvanized steel typically exhibits an electro-chemical potential in soil of approximately -1100 mV with respect to a saturated $Cu|CuSO_4$ reference electrode. The potential of bare steel, on the other hand, may be in the order of -500 to -600 mV. As a galvanized steel tower footing corrodes, the potential exhibited by the footing gradually shifts in the positive direction, as more and more of the zinc galvanizing is lost and the bare steel becomes exposed.

Various methods of interpreting these potential measurements have been published, a number of which are summarized in Table 1.

A drawback when using potentials to estimate the condition of tower footings is that these measurements actually represent mixed potentials; that is, they are an average of the potentials exhibited by both the galvanized and bare steel portions of the tower leg and grillage, as well as the potentials of counterpoise wires, ground rods, and any other electrically continuous structure in the immediate vicinity of the tower (see Figure 4). As an example of how this mixed potential may not be representative of the tower footing's condition, the literature describes a case where surface potential readings of -900 mV failed to

indicate that the grillage was corroding[3]. In this case, the grillage was located in a lower layer of acidic soil and exhibited potentials in the -600 to -700 mV range, whereas the upper portion of the tower leg exhibited a potential of -1000 mV, since it was located in neutral soil having a higher resistivity.

CATHODIC PROTECTION CASE HISTORY

In 1978, SaskPower initiated a program to monitor and control the corrosion of their transmission line tower footings. At the time, SaskPower was responsible for the transmission and distribution of both electrical power and natural gas throughout the Province of Saskatchewan, and so this program arose from a general corrosion awareness from a gas piping point of view, rather than because of any particular corrosion problems being experienced by the tower footings.

Cathodic Protection of Existing Lattice Steel Towers

SaskPower's program involves the regular monitoring of tower footing potentials, and the application of cathodic protection at locations where these potentials are less negative than -600 mV. The potentials measured on approximately 540 galvanized steel tower legs illustrates how these potentials become more electro-positive over time as the galvanizing is consumed (Figure 5).

SaskPower has provided survey data for four transmission lines installed since the 1960's for analysis. Out of more than 900 towers surveyed, approximately 8% were found to exhibit potentials less negative than -600 mV and were subsequently cathodically protected. The majority of towers had potentials in the -800 mV to -850 mV range as shown in Figure 6.

A standard method of cathodically protecting these structures was adopted, and involves the installation of a 17-pound packaged magnesium anode on each tower leg. Each anode is installed approximately 1.5m out from where the tower leg enters the ground, and is permanently connected to the tower leg. A shunt installed in the anode lead allows the current to be monitored without the need to disconnect the anode.

The distribution of potentials recorded for approximately 80 towers which were protected in this manner is plotted in Figure 7. The plot shows an immediate shift in tower potentials from the -400 to -600 mV range, to the -1600 to -1800 mV range after cathodic protection is applied. The most recent survey data indicates that these potentials have become less negative over the last 9 or 10 years, but the towers remain protected and exhibit average potentials in the -1000 to -1200 mV range.

There may be two or more explanations for this apparent decline in potentials. Firstly, the potentials measured during the first year of operation are similar to what would be expected for open-circuit potential measurements on the magnesium anodes. It is therefore suspected that the reference electrode was placed so that it was looking primarily at the anode rather than the tower footing. Secondly, anode current outputs have declined over this period of time from an average of 25 mA to roughly 14 mA, as illustrated in Figures 8 and 9. This may be due to either anode consumption or cathode polarization.

Cathodic Protection of New Coated-Steel Towers

In addition to the program adopted for the existing steel lattice towers, all new 138/230 kV steel H-frame towers are cathodically protected at the time of installation. These structures are constructed using two 400 mm diameter steel poles installed to a depth of between 4.0 and 4.7 m in a crushed rock backfill. The below-grade portions of the poles are coated with 30 mils of polyurethane, and are cathodically protected using a single 32-pound magnesium anode located midway between the two poles at a depth of about 2 m (Figure 10).

Since these towers are relatively new, having only been installed in the last five years, only one set of cathodic protection data has been collected to date. Figure 11 gives the potentials measured on over 600 steel pole towers, and plots them against anode current. Once again, these potentials have been measured with the protective current applied, but because these structures are well-coated, and the reference electrodes have been placed close to the poles and remote from the anodes, IR drop errors are expected to be small.

The data shows that 85% of the towers are cathodically protected to SaskPower's criterion of -850 mV. On average, the towers which are adequately protected receive 24 mA of current, whereas those which are under-protected receive only 12 mA of current.

Based on an average current output of 22 mA, the anodes installed on the steel pole towers are expected to last approximately 40 years. At an estimated installed cost of 500^{00} per anode (150^{00} materials, 350^{00} labour), and assuming an annual interest rate of 8%, the equivalent annual cost[11] of cathodically protecting a tower is approximately 40^{00} per year.

RECOMMENDATIONS

The following recommendations for the effective implementation and monitoring of cathodic protection systems for transmission line towers are based primarily on what has been learned from the review of the SaskPower experience:

1) A more uniform level of protection could be achieved for all towers by measuring the soil resistivity at each tower where anodes are to be installed. Either the Wenner Four-Pin Method or a single probe resistivity device could be used to quickly and easily obtain the approximate soil resistivity at anode depth, thereby allowing a quick calculation of the most suitable anode for use at each tower.

2) In order to eliminate IR drop errors when measuring the potentials of protected footings (such as those measured during the first year of the lattice tower program), the anodes on a tower should all be simultaneously disconnected to facilitate a true polarized potential measurement. This 'off' potential can be compared to the tower's static potential to determine if it meets the NACE -100 mV shift criterion, rather than relying only on the present -850 mV criterion.

3) In order to permit the simultaneous interruption of anode current recommended above, the anodes at each tower should be connected to a common header cable rather than individually to each tower leg. The header cable should then be bonded to a lead wire from the tower inside a test station. This also ensures that there is no exposed wiring or connections which could otherwise suffer mechanical damage on the outside of the tower leg.

SUMMARY

Although the corrosion of direct-buried transmission line tower footings is generally not perceived to be a major problem, the majority of these structures have reached an age at which it is doubtful that their original galvanized coatings are of much benefit in preventing below-grade corrosion. Cathodic protection is a cost-effective means of extending the life of the tower footings, and considering the immense value of these structures, it should be an essential element of any tower rehabilitation program.

ACKNOWLEDGMENTS

The author would like to thank SaskPower and Ontario Hydro for providing cathodic protection information to supplement this paper.

REFERENCES

1. Piper, Walter J., and John D. Piper. *Tower Footing Corrosion.* Corrosion, April, 1951.

2. Kerstein and Gibson. *Deterioration of Tower Galvanizing Checked Periodically.* Electrical World, October, 1946.

3. Fitzgerald, John H., and William H. Kolb. *Cathodic Protection of High Voltage Transmission Tower Footings.* Materials Performance, December, 1985.

4. Kirkpatrick, Earl L. *Cathodic Protection of Power Line Structure Foundations.* Materials Performance, August, 1988.

5. Gummow, R.A., and J. Carr. *Power System Corrosion.* Canadian Electrical Association Report Nº 091 D 188, Montreal, Québec, 1983.

6. Duquette, Réal. *Cathodic Protection of Tower Footings.* Canadian Electrical Association Conference, Edmonton, 1977.

7. Pellegrini, A.D. *Transmission Line Structures Coating Study.* Ontario Hydro Task Group Report, November, 1991.

8. Romanoff, M. *Underground Corrosion.* U.S. National Bureau of Standards Circ. Nº 579, 1957.

9. Uhlig, Herbert H. *The Corrosion Handbook.* (New York, N.Y.: John Wiley & Sons, 1948), p.335.

10. Ogorodnikov, V.E. *Manual on Corrosion Prevention of Steel Towers.* Ontario Hydro Operating Manual.

11. Webster, Harry A. *Economics of Cathodic Protection.* Materials Performance, March, 1992.

TABLE 1 - GUIDELINES FOR ESTIMATING CORROSION ACTIVITY ON GALVANIZED STEEL TOWER FOOTINGS

Source	Potential Range (mV to $Cu\|CuSO_4$)	Interpretation
Ogorodnikov[10]	-0.85 to -1.2	Zinc coating acts as cathodic protection.
	-0.6 to -0.8	No corrosion. Zinc oxide is acting as a protective coating.
	≥ -0.62	Galvanizing does not protect the steel, and corrosion progresses.
Ogorodnikov[10]	-1.0 to -1.75	Galvanizing acting as cathodic protection. Tower protected.
	-0.8 to -1.0	Galvanizing is acting as protective coating. Tower protected.
	-0.6 to -0.8	New tower partly protected, or ungalvanized tower not protected.
	-0.4 to -0.6	Galvanized tower not protected, or ungalvanized tower being corroded.
	-0.2 to -0.4	Tower being corroded.
CEA[5]	< -1.1	Tower leg is a cathode if dc current flows from tower to skywire.
	-0.8 to -1.1	Corrosion can be occurring.
	> -0.8	Zinc galvanizing has either corroded away or ennobled, and tower leg is an anode if dc current flows from skywire to tower.
Duquette[6]	-0.85 to -1.75	Galvanizing acts as cathodic protection.
	-0.7 to -0.84	Galvanizing acts as protective layer.
	-0.5 to -0.69	Tower without galvanizing.
	-0.3 to -0.49	Corroded tower without galvanizing.
	-0.1 to -0.39	Highly corroded tower.

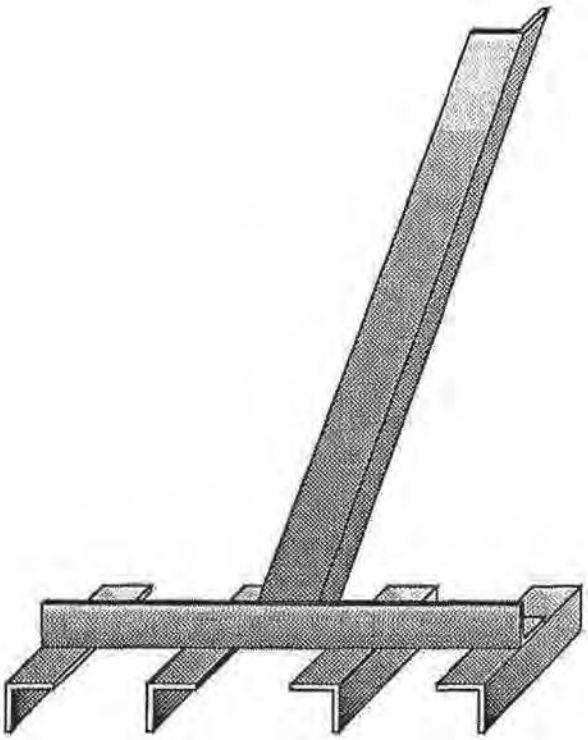


Figure 1 - Typical Galvanized Steel Grillage

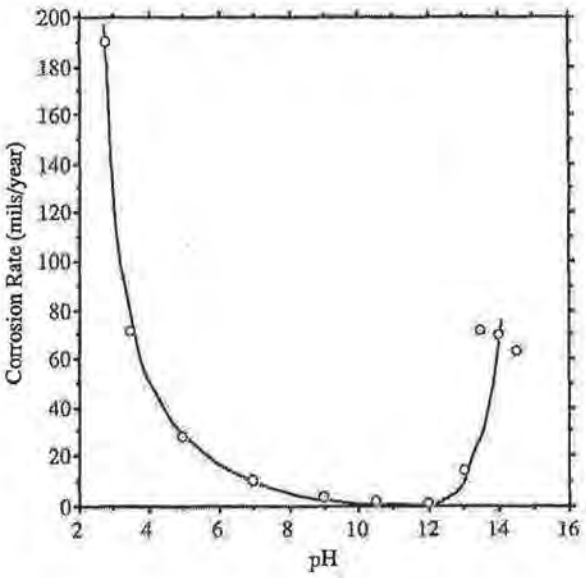


Figure 2 -
Effect of pH on Corrosion Rate of Zinc[9]

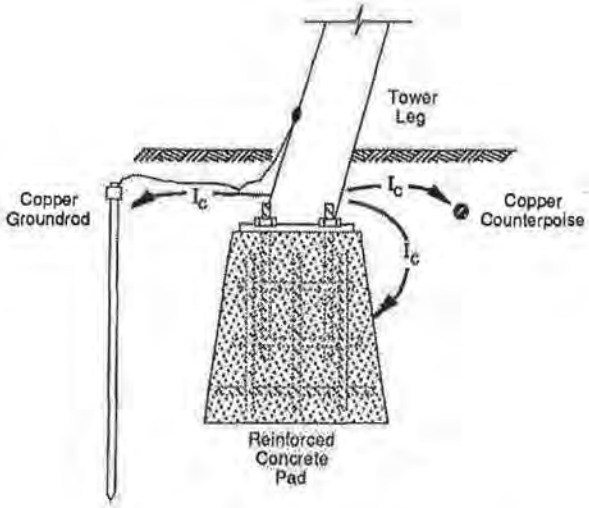


Figure 3 - Possible Corrosion Currents
Associated With a Tower Footing

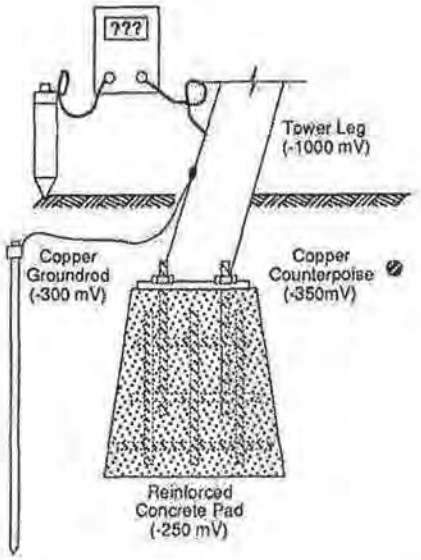


Figure 4 - Measurement of a Mixed Potential

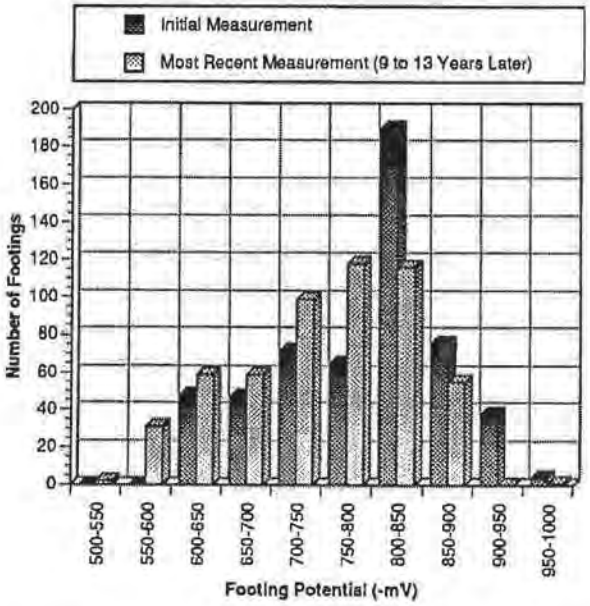


Figure 5 -
Change in Potential Distribution Over Time for Unprotected Galvanized Steel Lattice Towers

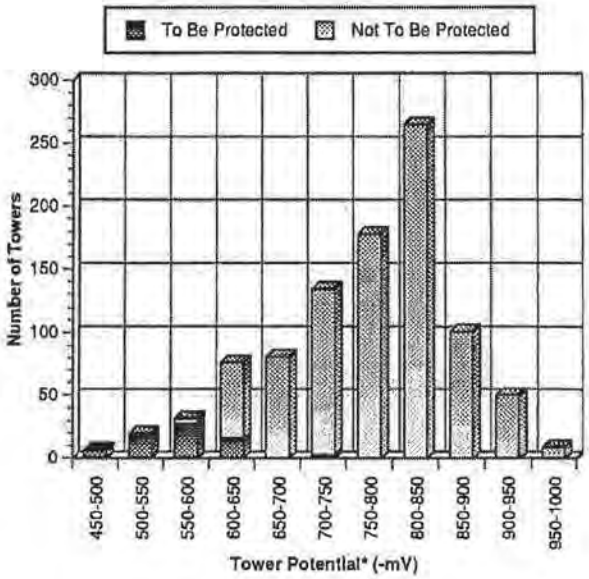


Figure 6 -
Initial Potential* Distribution of Galvanized Steel Lattice Towers Showing Potentials of Towers to be Protected
*Average potential of four footings per tower

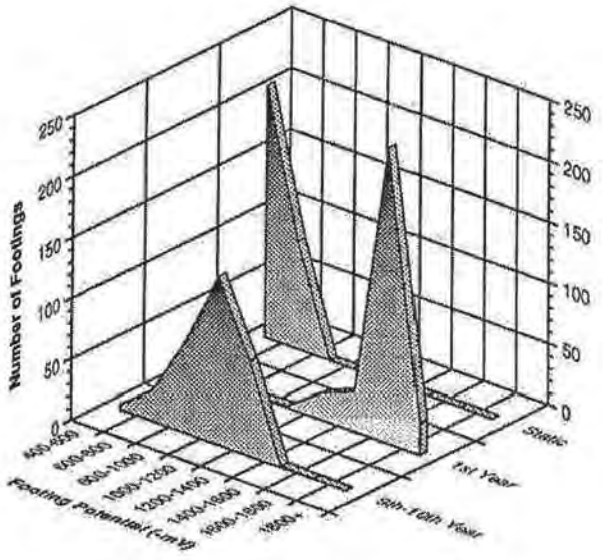


Figure 7 -
Change in Potential Distribution Over Time for Protected Galvanized Steel Lattice Towers

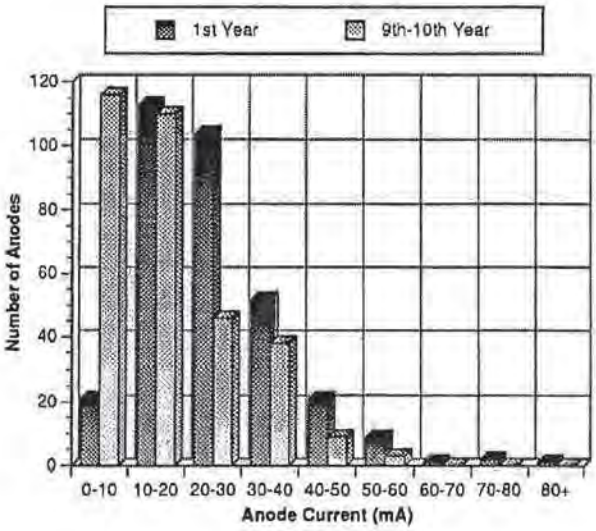


Figure 8 -
Change in Anode Currents Over Time for Galvanized Steel Lattice Towers

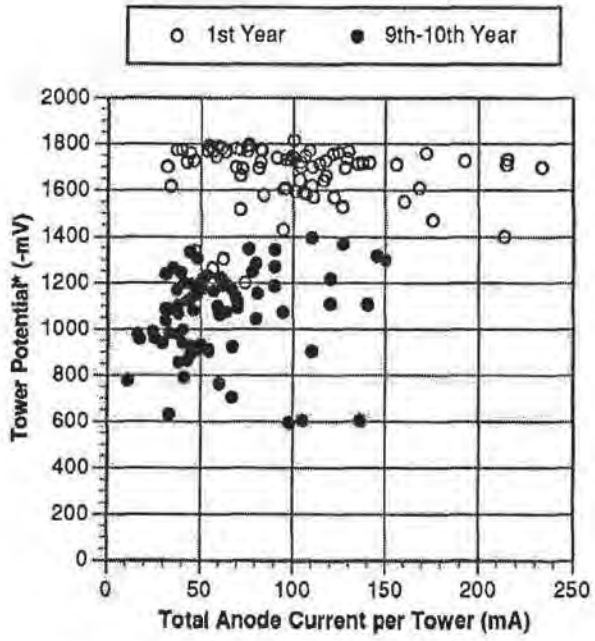


Figure 9 -
Tower Potential* Versus Anode Current for Galvanized Steel Lattice Towers
*Average 'on' potential of all four tower footings

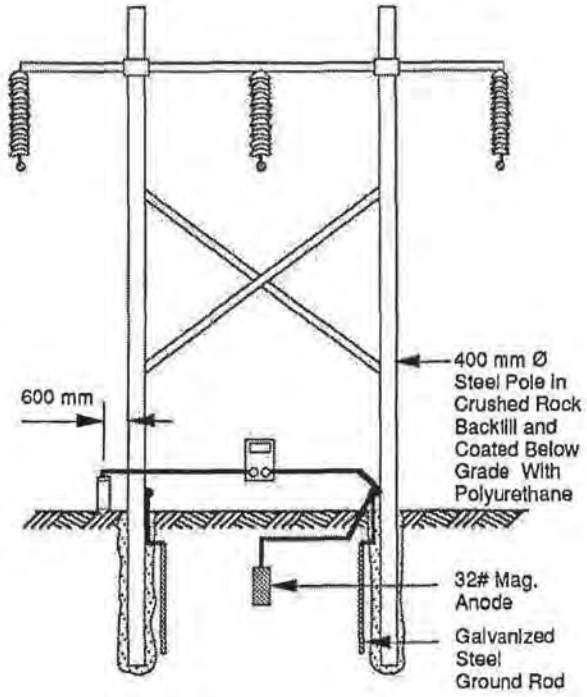


Figure 10 -
Cathodic Protection of Coated-Steel Pole Tower

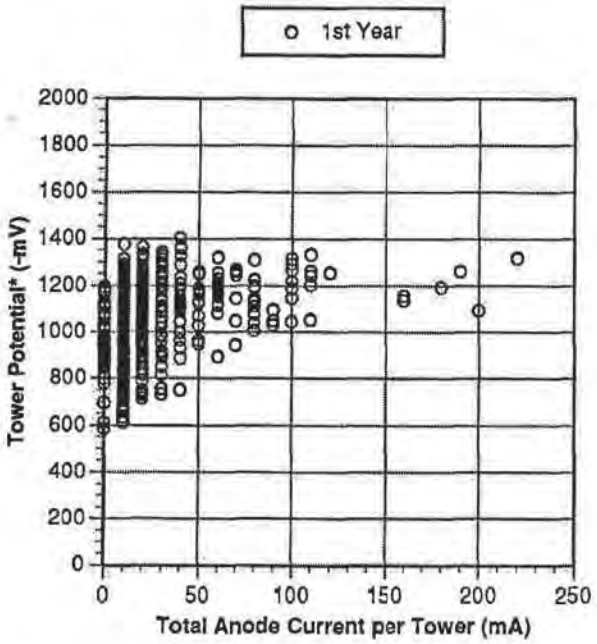


Figure 11 -
Tower Potential* Versus Anode Current for Coated Steel Pole Towers
*Average 'on' potential of both tower legs

Distribution

CI Number: 43217

Title: 24C-442G Highway 16 Rebuild Phase 1

Start Date: 2014/03
Final Cost Date: 2015/02
Function: Distribution
Forecast Amount: $800,769

DESCRIPTION:

This project is for the costs associated with rebuilding 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 ACSR (Aluminum Conductor Steel Reinforced) 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 CI's +/- 2 years:
CI TBD 24C-442G Highway 16 Rebuild Phase 2 - 2015
CI TBD 24C-442G Highway 16 Rebuild Phase 3 - 2016

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 with a rotten core. 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 holes throughout. The conductor is steel core ACSR and has reached the end of its life. Due to the coastal location (high exposure of this line) and material make-up of this conductor, the steel core has corroded. As a result, this line is in poor condition with many splices and is unable to be worked on live.

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 possiblility of conductor breakage will be reduced and crews will have the ability to work on this section of line under live conditions. This project is sustaining capital investment for distribution deteriorated equipment identified throughout previous years and prioritized based on a number of factors including the condition of the equipment and the risk with not doing the work.

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 is project is expected to be completed by external resources.

CI Number : 43217 - 24C-442G Hwy 16 Rebuild Phase 1 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		8,009	0	8,009
094		094 - Interest Capitalized		18,252	0	18,252
095		095-COPS Regular Labour AO		11,372	0	11,372
095		095-COPS Contracts AO		134,445	0	134,445
013	002	013 - COPS Contracts	002 - DP - Land Rights	56,000	0	56,000
012	035	012 - Materials	035 - DP - Wood Poles	77,621	0	77,621
013	035	013 - COPS Contracts	035 - DP - Wood Poles	207,529	0	207,529
012	038	012 - Materials	038 - DP - Insulators	52	0	52
013	038	013 - COPS Contracts	038 - DP - Insulators	766	0	766
012	039	012 - Materials	039 - DP - O/H Cond.	46,521	0	46,521
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	204,725	0	204,725
012	040	012 - Materials	040 - DP - O/H Cond.Devices	5,379	0	5,379
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	3,064	0	3,064
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	4,340	0	4,340
013	050	013 - COPS Contracts	050 - DP - Street Lights	766	0	766
012	052	012 - Materials	052 - DP - Services	550	0	550
013	052	013 - COPS Contracts	052 - DP - Services	4,519	0	4,519
001	085	001 - Regular Labour (No AO)	085 Design	2,840	0	2,840
001	087	001 - T&D Regular Labour	087 Field Super.& Ops.	14,019	0	14,019
			Total Cost:	800,769	0	800,769
			Original Cost:	103,781		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 43217
Title: 24C-442G Highway 16 Rebuild
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Supervisor	lot	1	$ 14,018.90	$ 14,018.90		
1.2	Project Support	lot	1	$ 2,840.37	$ 2,840.37		
				Sub-Total	$ 16,859.27		
2	**012 Materials**						
2.1	Poles, Insulators and Overhead Materials	Lot	1	$ 130,123.65	$ 130,123.65	Work Order Generated	
2.2					$ -		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 130,123.65		
3	**013 Contracts**						
3.1	PLT Labour	hrs	[redacted]		$ 420,708.23		
3.2	Tree Trimming				$ 56,000.00		
3.3	Rockbreak				$ 5,000.00		
				Sub-Total	$ 481,708.23		
4	**094 Interest Capitalized**						
4.1					$ 18,251.75		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 18,251.75		
5	**095 Administrative Overhead**						
5.1	092-Vehicle T&D OT Labour AO						
5.2	092-Vehicle T&D Reg. Labour AO				$ 8,009.00		
5.3	095-COPS Contracts AO				$ 134,444.78		
5.4	095-COPS Overtime Labour AO						
5.5	095-COPS Regular Labour AO				$ 11,372.13		
				Sub-Total	$ 153,825.91		
				SUB-TOTAL (no AO, AFUDC)	$ 628,691.15		
				TOTAL (AO, AFUDC included)	$ 800,768.81		
6	**Original Cost**						
6.1					$ 103,780.94		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

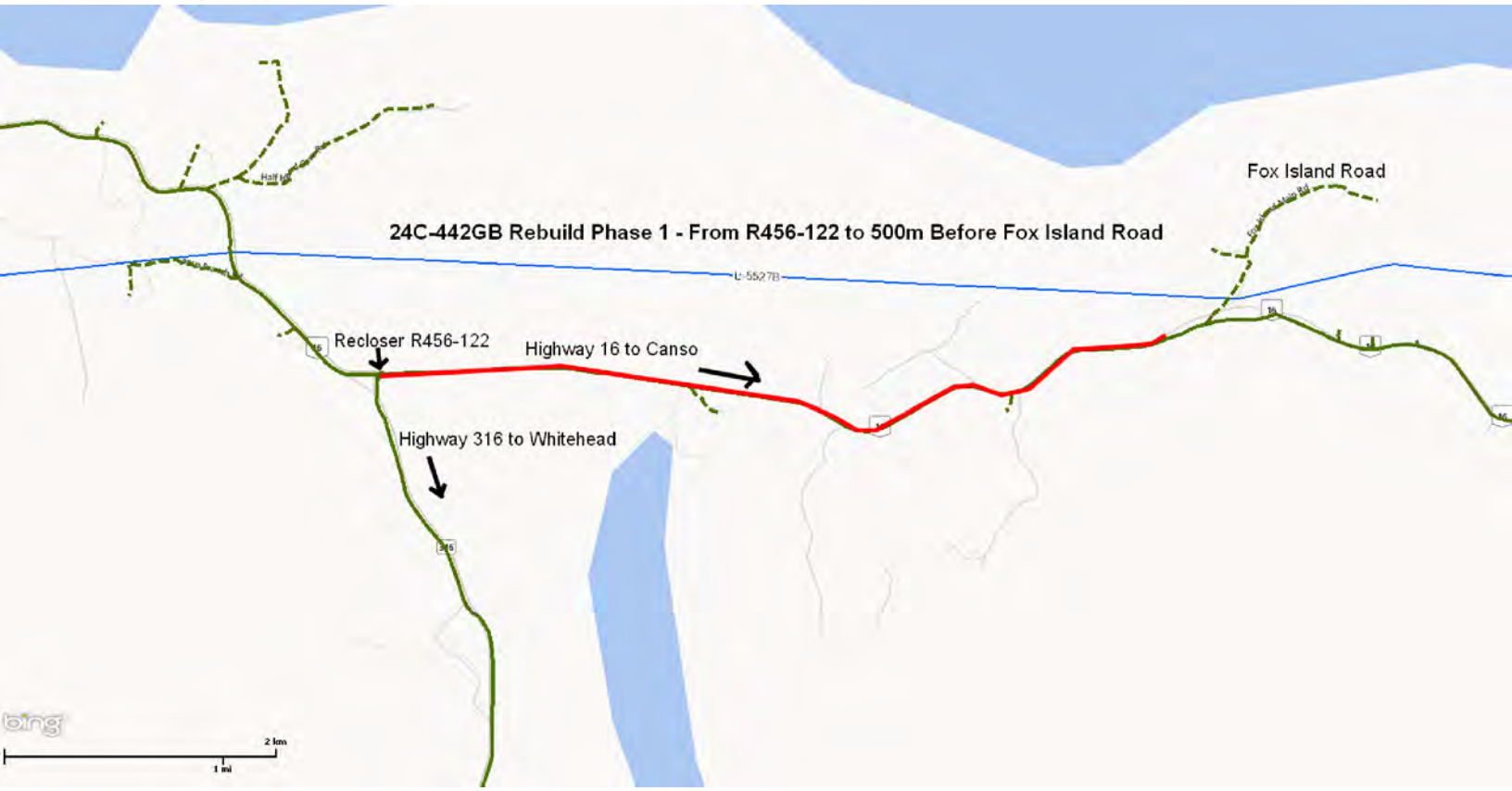
The reliability statistics for this feeder section for the last 5 years are included below.

Year	CI	CH	Cust	SAIFI	SAIDI
2009	3348	27615.938	409	8.19	67.52
2010	4516	21112.989	405	11.15	52.13
2011	5070	16861.614	406	12.49	41.53
2012	1644	3123.39	405	4.06	7.71
2013	3217	12985.904	401	8.02	32.38

CI - # of Customer Interruptions
CH - # of Customer Hours of Interruptions
Cust - # of Customers
SAIFI - System Average Interruption Frequency Index
SAIDI - System Average Interruption Duration Index

2014 Capital

24C-442GB Highway 16 Rebuild Phase 1



Copyright 2011 NSPI. All rights reserved. Wed Oct 30 2013 01:09:56 PM.

CI Number: 44826

Title: 2014 Build-to-Roadside Program

Start Date: 2013/07
Final Cost Date: 2014/10
Function: Distribution
Forecast Amount: $791,268

DESCRIPTION:

The Build-to-Roadside program is a multi-year program to move off road distribution lines to roadside. 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 would have favourable reliability impacts if they were brought to roadside, and will be executed over the life of the program:

57C-426J Country Harbour Phase 2 - 4.1 km
57C-426GA Goldboro Phase 3 - 4.6 km
100C-422 Mulgrave Phase 2 - 3 km
58C-405 Margaree Forks - 4.5km
73W-411 Upper Branch Rd/Wagner Rd - 3.15 km
70V-312 Thorne Rd - 0.5 km
57C-426J Country Harbour Phase 3 - 1.5 km
57C-422 Salmon River Lake - 1.2 km
4C-432G St. Andrews - 2 km
515S-311 Goose Cove - 2 km
25W-302 Sandy Point Rd - 1.6 km

Summary of Related CIs +/- 2 years:
2012 CI 41349 - 2012 Build-to-Roadside $884,869
2013 CI 43258 - 2013 Build-to-Roadside $1,081,638
2015 CI TBD 2015 Build-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 increases the cost effectiveness of regular maintenance activities.

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.

This project is expected to be completed by an external contractor.

CI Number : 44826 - 2014 Build-to-Roadside **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		1,585	0	1,585
094		094 - Interest Capitalized		15,813	0	15,813
095		095-COPS Regular Labour AO		2,251	0	2,251
095		095-COPS Contracts AO		145,154	0	145,154
013	002	013 - COPS Contracts	002 - DP - Land Rights	18,162	0	18,162
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	7,265	0	7,265
012	035	012 - Materials	035 - DP - Wood Poles	30,270	0	30,270
013	035	013 - COPS Contracts	035 - DP - Wood Poles	175,671	0	175,671
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	1,413	0	1,413
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	21,189	0	21,189
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	122,969	0	122,969
012	040	012 - Materials	040 - DP - O/H Cond.Devices	12,108	0	12,108
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	70,268	0	70,268
066	040	066 - Other Goods & Services	040 - DP - O/H Cond.Devices	2,724	0	2,724
012	041	012 - Materials	041 - DP - O/H Line Transf.	21,189	0	21,189
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	122,969	0	122,969
012	052	012 - Materials	052 - DP - Services	1,816	0	1,816
013	052	013 - COPS Contracts	052 - DP - Services	10,038	0	10,038
001	085	001 - T&D Regular Labour	085 Design	1,362	0	1,362
001	085	001 - Regular Labour (No AO)	085 Design	3,275	0	3,275
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
002	085	002 - T&D Overtime Labour	085 Design	0	0	0
011	085	011 - Travel Expense	085 Design	500	0	500
028	085	028 - Consulting	085 Design	3,027	0	3,027
041	085	041 - Meals & Entertainment	085 Design	250	0	250
			Total Cost:	791,268	0	791,268
			Original Cost:	84,807		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 44826
Title: 2014 Build to Roadside
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	PowerLine Technician	PD	4.00	$ 353.25	$ 1,413.00		
1.2	Project Support	Lot			$ 3,274.72		
1.3	T&D Engineering	Lot			$ 1,362.13		
1.4					$ -		
1.5					$ -		
				Sub-Total	$ 6,049.85		
2	**028 Consulting**						
2.1	Design				$ 3,026.97		
2.2					$ -		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 3,026.97		
3	**012 Materials**						
3.1	Conductor				$ 21,188.77		
3.2	OH Conductor Devices				$ 12,107.87		
3.3	Transformers				$ 21,188.77		
3.4	Poles, Services				$ 32,085.85		
3.5							
				Sub-Total	$ 86,571.25		
4	**013 Contracts**						
4.1	PLT Labour	hr			$ 501,915.36		
4.2	Tree Trimming	lot	1	$ 18,162	$ 18,161.80		
4.3					$ -		
				Sub-Total	$ 520,077.16		
5	**011 Travel Expense**						
5.1	Engineer Site Visit				$ 500.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 500.00		
6	**041 Meals & Entertainment**						
6.1	Engineer Site Visit				$ 250.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 250.00		
7	**066 Other Goods & Services**						
7.1	Misc. Goods				$ 2,724.27		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 2,724.27		
8	**020 Royalties, Easements, App**						
8.1	Easements				$ 7,264.72		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 7,264.72		
9	**094 Interest Capitalized**						
9.1					$ 15,812.85		
9.2					$ -		
9.3					$ -		
				Sub-Total	$ 15,812.85		
10	**095 Administrative Overhead**						
10.1	095-COPS Regular Labour AO				$ 2,251.17		
10.2	095-COPS Overtime Labour AO				$ -		
10.3	092-Vehicle T&D Reg. Labour AO				$ 1,585.41		
10.4	092-Vehicle T&D OT Labour AO				$ -		
10.5	095-COPS Contracts AO				$ 145,153.67		
				Sub-Total	$ 148,990.25		
				SUB-TOTAL (no AO, AFUDC)	$ 626,464.22		
				TOTAL (AO, AFUDC included)	$ 791,267.32		
11	**Original Cost**						
11.1					$ 84,806.84		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 45046

Title: 2014 PCB Phase-Out for Pole Top Transformer Program

Start Date: 2014/02
Final Cost Date: 2015/03
Function: Distribution
Forecast Amount: $779,620

DESCRIPTION:

This project provides for the systematic removal of the first phase of potentially polychlorinated biphenyls (PCBs) contaminated material in 2014 in accordance with federal and provincial guidelines. Regulations state that all pole top equipment containing PCBs in a concentration greater than 50 mg/kg must be removed from service by December 31, 2025. NS Power estimates that there are 45,000 pole top transformers that potentially contain PCBs in this concentration. The 2014 project will test 2,250 pole top transformers that have been identified as potentially PCB contaminated and is expected to change out approximately 100 of these transformers.

Summary of Related CIs +/- 2 years:
CI TBD 2015 PCB Phase-Out for Pole Top Transformer Program $TBD
CI TBD 2016 PCB Phase-Out for Pole Top Transformer Program $TBD

JUSTIFICATION:

Justification Criteria: Environment

Sub Criteria: Requirement to Serve

Why do this project?

The Canadian Council of Ministers of the Environment (CCME) has committed to a policy of phasing out the use of all PCBs in Canada. In support of this policy, NS Power will be focusing on eliminating all pole-top electrical transformers and their pole-top auxiliary electrical equipment containing PCBs in a concentration of 50 mg/kg or more before December 31, 2025.

Why do this project now?

The volume of potentially PCB contaminated pole top transformers in our system is estimated at approximately 45,000. Proceeding with this work over a 12 year timeframe will allow the work to be incorporated into our existing work plan and resources.

Why do this project this way?

An inventory of pole top assets will be completed to identify the location and number of potentially contaminated transformers. NS Power will engage a testing contractor to obtain oil samples from these units. All units that test greater than the 50 mg/kg limit will be documented and placed on the list of transformers to be changed out. This project provides for testing and destruction of materials as required.

This work is expected to be completed by internal resources.

CI Number : 45046 - 2014 PCB Phase-out for Pole Top Transformers **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		26,256	0	26,256
095		095-COPS Regular Labour AO		37,282	0	37,282
095		095-COPS Contracts AO		109,179	0	109,179
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	38,088	0	38,088
012	041	012 - Materials	041 - DP - O/H Line Transf.	164,499	0	164,499
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	391,183	0	391,183
001	085	001 - Regular Labour (No AO)	085 Design	5,261	0	5,261
001	085	001 - T&D Regular Labour	085 Design	7,871	0	7,871
			Total Cost:	779,620	0	779,620
			Original Cost:	125,763		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 45046
Title: 2014 PCB Phase-out for Pole Top Transformers
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	PowerLine Technicians	PD	107.82	$ 353.25	$ 38,088.00		
1.2	Project Support	Lot	1.00	$ 3,289.99	$ 3,289.99		
1.3	Scoping	PD	1.00	$ 1,970.55	$ 1,970.55		
1.4	Design - Engineering	PD	21.56	$ 365.00	$ 7,870.98		
1.5					$ -		
				Sub-Total	$ 51,219.52		
2	**012 Materials**						
2.1	Pole Top Transformers	unit	100	$ 1,644.99	$ 164,499.36		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 164,499.36		
3	**013 Contracts**						
3.1	PCB Testing	unit	2250	$ 32.77	$ 73,738.35		
3.2	PCB Oil Sampling	unit	2250	$ 125.00	$ 281,250.00		
3.3	PCB Destruction	unit	100	$ 252.45	$ 25,245.00		
3.4	Traffic Control	lot	1	$ 10,950.00	$ 10,950.00		
				Sub-Total	$ 391,183.35		
5	**095 Administrative Overhead**						
5.1	095-COPS Regular Labour AO				$ 37,281.95		
5.2	095-COPS Overtime Labour AO				$ -		
5.3	092-Vehicle T&D Reg. Labour AO				$ 26,256.35		
5.4	092-Vehicle T&D OT Labour AO				$ -		
5.5	095-COPS Contracts AO				$ 109,179.22		
				Sub-Total	$ 172,717.52		
				SUB-TOTAL (no AO, AFUDC)	$ 606,902.23		
				TOTAL (AO, AFUDC included)	$ 779,619.75		
6	**Original Cost**						
6.1					$ 125,762.68		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 43177

Title: 103W-311 Gold River Reconductor 3

Start Date: 2014/03
Final Cost Date: 2014/12
Function: Distribution
Forecast Amount: $377,721

DESCRIPTION:

This project is to reconductor 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 3 of a 4-year project to upgrade 12 km of conductor on the 103W-311 feeder out of the Gold River Substation. The first year of the project, which was included as part of the 2011 ACE Plan, involved reconductoring approximately 2.9 km of feeder from Delbury Road along Highway 3 South. The second phase completed in 2012 involved reconductoring approximately 3.2 km of feeder along Highway 3 to Pine Drive.

Summary of Related CIs +/- 2 years:
2012 – CI 41327 103W-311 Gold River Phase 2 - $200,058
2015 – 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 deteriorated. This conductor is a combination of #4 Copper, 1/0 ACSR and 2/0 ACSR - and does not allow for load transfer with its adjacent feeders due to smaller sizes. By reconductoring with 336ACSR, a larger conductor with more capacity, the conductor will be the appropriate size for increased load conditions, and we will be able to transfer load to and from this feeder to others.

Why do this project now?

The existing conductor is at end of life. There have been 30 conductor related outage events on this feeder since 2009.

Why do this project this way?

The wire needs to be replaced due to deterioration, reconductoring allows for the re-use of the existing right of way, and poles. Increasing the wire size is the most effective method for increasing contingency loading in the area. The added capacity provided by the increased conductor size allows us to transfer load in emergency and maintenance situations.

CI Number : 43177 - 103W-311 Gold River Reconductor Phase 3 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		50,011	0	50,011
094		094 - Interest Capitalized		4,243	0	4,243
095		095-COPS Contracts AO		20,084	0	20,084
095		095-COPS Regular Labour AO		71,011	0	71,011
013	002	013 - COPS Contracts	002 - DP - Land Rights	29,608	0	29,608
012	004	012 - Materials	004 - DP - Misc.Equipment	0	0	0
020	007	020 - Royalties, Easements, App	007 - DP - Environmental	10,000	0	10,000
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	16,795	0	16,795
002	035	002 - T&D Overtime Labour	035 - DP - Wood Poles	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	14,386	0	14,386
013	035	013 - COPS Contracts	035 - DP - Wood Poles	42,351	0	42,351
001	038	001 - T&D Regular Labour	038 - DP - Insulators	166	0	166
002	038	002 - T&D Overtime Labour	038 - DP - Insulators	0	0	0
012	038	012 - Materials	038 - DP - Insulators	62	0	62
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	51,944	0	51,944
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	37,524	0	37,524
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	2,691	0	2,691
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	2,082	0	2,082
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	2,042	0	2,042
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.	7,543	0	7,543
001	050	001 - T&D Regular Labour	050 - DP - Street Lights	221	0	221
002	050	002 - T&D Overtime Labour	050 - DP - Street Lights	0	0	0
001	052	001 - T&D Regular Labour	052 - DP - Services	3,792	0	3,792
002	052	002 - T&D Overtime Labour	052 - DP - Services	0	0	0
012	052	012 - Materials	052 - DP - Services	204	0	204
001	085	001 - Regular Labour (No AO)	085 Design	1,073	0	1,073
001	085	001 - T&D Regular Labour	085 Design	1,490	0	1,490
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.	8,399	0	8,399

CI Number : 43177 - 103W-311 Gold River Reconductor Phase 3 **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 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:	377,721	0	377,721
			Original Cost:	29,854		

Capital Project Detailed Estimate

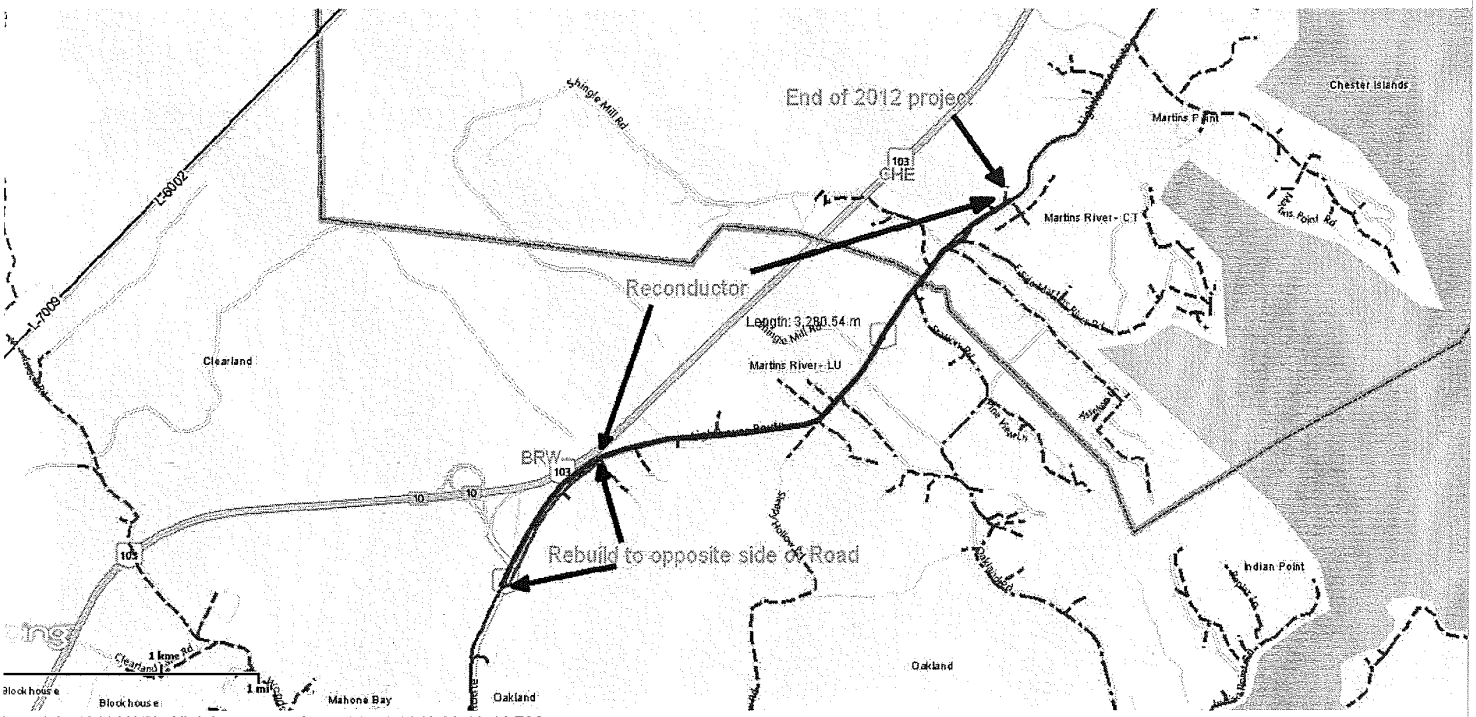
Location: Distribution
CI# / FP#: 43177
Title: 103W-311 Gold River Reconductor 3
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	PowerLine Technician	PD	224.03	$ 353.25	$ 79,139.91		
1.2	Project Support				$ 1,073.03		
1.3	Supervisor				$ 8,398.69		
1.4					$ -		
1.5					$ -		
				Sub-Total	$ 88,611.63		
2	**013 Contracts**						
2.1	Tree Trimming				$ 29,607.75		
2.2	Traffic Control and Backhoe				$ 42,351.00		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 71,958.75		
3	**012 Materials**						
3.1	Poles, Insulators and Overhead Materials				$ 61,800.91	Work Order Generated	
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 61,800.91		
4	**020 - Royalties & Easements**						
4.1	Easement				$ 10,000.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 10,000.00		
5	**094 Interest Capitalized**						
5.1					$ 4,243.44		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 4,243.44		
6	**095 Administrative Overhead**						
6.1	092-Vehicle T&D OT Labour AO				$ -		
6.2	092-Vehicle T&D Reg. Labour AO				$ 50,010.81		
6.3	095-COPS Contracts AO				$ 20,083.67		
6.4	095-COPS Overtime Labour AO				$ -		
6.5	095-COPS Regular Labour AO				$ 71,011.33		
				Sub-Total	$ 141,105.81		
				SUB-TOTAL (no AO, AFUDC)	$ 232,371.29		
				TOTAL (AO, AFUDC included)	$ 377,720.54		
7	**Original Cost**						
7.1					$ 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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

Gold River Recondcutor

Phase 3



Copyright 2011 NSPI. All rights reserved. Thu Mar 8 2012 03:12:14 PM.

CI Number: 44759

Title: 16N-301 Stewiacke – Load Transfer

Start Date: 2014/03
Final Cost Date: 2014/12
Function: Distribution
Forecast Amount: $258,816

DESCRIPTION:

The 16N-301 feeder is approaching overload and the 16N-302 feeder is lightly loaded. This project provides for the transfer of load between the 16N-301 and 16N-302 feeders that serve Stewiacke. The design is for a new line to be built that taps off the feeder 16N-302 and will follow Highway 2 south until it intersects with the current supply into Joffre St. At this point, the existing line will be rebuilt to 3 phase 336 ACSR following the Joffre Street extension, then down Dunrovin Ave. to where 16N-301 feeds the town center at East Main St. A set of normally open inline cutouts will be installed to the west of where this new line will connect and the town center will then be served by 16N-302 and thereby reducing the load carried by 16N-301.

Summary of Related CI's +/- 2 years: None

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Overloaded Equipment

Why do this project?

The 16N-301 feeder currently serves the town centre of Stewiacke. Additional expansion in the area could push the feeder into an overload situation. A newly planned residential and commercial development on the south side of town will aggravate this issue.

Why do this project now?

There are development plans that will add customer load to the centre of Stewiacke in the upcoming months which will further aggravate the present loading of equipment.

Why do this project this way?

Three options were considered to supply the town centre of Stewiacke. This was the most economic option.

The other two options were:

(1) Build double circuit line along the existing path.

(2) Convert the existing single phase line that circles to the North of town to three phase.

This project is expected to be completed by an external contractor.

CI Number : 44759 - 16N-301 - Stewiacke - Load Transfer **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
094		094 - Interest Capitalized		3,548	0	3,548
095		095-COPS Contracts AO		45,344	0	45,344
013	002	013 - COPS Contracts	002 - DP - Land Rights	1,940	0	1,940
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	6,500	0	6,500
012	004	012 - Materials	004 - DP - Misc.Equipment	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	17,571	0	17,571
013	035	013 - COPS Contracts	035 - DP - Wood Poles	52,914	0	52,914
066	035	066 - Other Goods & Services	035 - DP - Wood Poles	2,500	0	2,500
012	038	012 - Materials	038 - DP - Insulators	65	0	65
013	038	013 - COPS Contracts	038 - DP - Insulators	958	0	958
012	039	012 - Materials	039 - DP - O/H Cond.	14,162	0	14,162
013	039	013 - COPS Contracts	039 - DP - O/H Cond.	93,061	0	93,061
012	040	012 - Materials	040 - DP - O/H Cond.Devices	931	0	931
013	040	013 - COPS Contracts	040 - DP - O/H Cond.Devices	4,659	0	4,659
013	041	013 - COPS Contracts	041 - DP - O/H Line Transf.	1,532	0	1,532
013	050	013 - COPS Contracts	050 - DP - Street Lights	1,532	0	1,532
013	052	013 - COPS Contracts	052 - DP - Services	5,872	0	5,872
001	085	001 - Regular Labour (No AO)	085 Design	1,228	0	1,228
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
028	088	028 - Consulting	088 Survey/Mapping	4,500	0	4,500
			Total Cost:	258,816	0	258,816
			Original Cost:	20,912		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 44759
Title: 16N-301 Stewiacke Load Transfer
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Project Support	Lot	1.00	$ 1,228.28	$ 1,228.28		
1.2					$ -		
1.3					$ -		
1.4					$ -		
1.5					$ -		
				Sub-Total	$ 1,228.28		
2	**012 Materials**						
2.1	Poles, Overhead Conductor & Devices				$ 32,729.21		
2.2					$ -		
2.3					$ -		
				Sub-Total	$ 32,729.21		
3	**013 Contracts**						
3.1	PLT Labour	Hrs	[redacted]		$ 160,526.64		
3.2	Tree Trimming	Lot	1	1940	$ 1,940.00		
3.3					$ -		
				Sub-Total	$ 162,466.64		
4	**028 Consulting**						
4.1	Survey				$ 4,500.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 4,500.00		
5	**020 Royalties & Easements**						
5.1	Easement				$ 6,500.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 6,500.00		
6	**066 Other Goods & Services**						
6.1	Permit				$ 2,500.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 2,500.00		
7	**094 Interest Capitalized**						
7.1					$ 3,548.00		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 3,548.00		
8	**095 Administrative Overhead**						
8.1	095-COPS Regular Labour AO				$ -		
8.2	095-COPS Overtime Labour AO				$ -		
8.3	092-Vehicle T&D Reg. Labour AO				$ -		
8.4	092-Vehicle T&D OT Labour AO				$ -		
8.5	095-COPS Contracts AO				$ 45,344.00		
				Sub-Total	$ 45,344.00		
				SUB-TOTAL (no AO, AFUDC)	$ 209,924.13		
				TOTAL (AO, AFUDC included)	$ 258,816.13		
9	**Original Cost**						
9.1					$ 20,912.11		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 44833

Title: 99V-312 Highbury - New Feeder

Start Date: 2014/05
Final Cost Date: 2015/03
Function: Distribution
Forecast Amount: $256,828

DESCRIPTION:

This project is to construct a new feeder from the 99V Highbury substation to Belcher Street in Kentville in order to transfer load from the New Minas substation feeder 22V-322 and permit load balancing in three eastern valley substations as per Distribution Planning Study 315-1115-W69. This line will extend from where 99V-312 is currently terminated (across from the Irving on Prospect Street in New Minas) and head north along the New Minas Connector Road crossing Commercial Street and the Cornwallis River and will connect to 22V-322 on Belcher Street.

Summary of Related CIs +/- 2 years:
CI 41540 D423 99V-Highbury Rd-New Feeders 2012

JUSTIFICATION:

Justification Criteria: Distribution System

Sub Criteria: Requirement to Serve

Why do this project?

This project will help to balance the loading between the three Valley substations of 36V Hillaton, 22V New Minas and the new 99V Highbury. It will allow for the transfer of load on 22V to allow for some of the 36V load to be shifted to 22V.

Why do this project now?

Planning Study 315-1115-W69 highlighted the need to transfer load from the 36V transformer as it is heavily loaded. Offloading the transformer now will help extend its life and reduce costs associated with replacement due to deterioration and overloading.

Why do this project this way?

In order to pick up the 22V-322 load, a feeder from 99V will have to be extended. The chosen alignment will have lower economic impact than continuing with current alignments and requiring construction of a double or triple circuit. The 99V-312 feeder was planned to extend north for this reason and provisions were made in the 2012 project so that this alignment could be used.

This work is expected to be completed by internal resources.

CI Number : 44833 - 99V-312 - Highbury New Feeder **Project Number**

Parent CI Number : -

Cost Centre : 800 - 800-Services - Admin. **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		17,972	0	17,972
094		094 - Interest Capitalized		4,453	0	4,453
095		095-COPS Regular Labour AO		25,519	0	25,519
095		095-COPS Contracts AO		19,625	0	19,625
013	002	013 - COPS Contracts	002 - DP - Land Rights	37,800	0	37,800
020	002	020 - Royalties, Easements, App	002 - DP - Land Rights	5,000	0	5,000
028	002	028 - Consulting	002 - DP - Land Rights	3,500	0	3,500
001	035	001 - T&D Regular Labour	035 - DP - Wood Poles	19,278	0	19,278
002	035	002 - T&D Overtime Labour	035 - DP - Wood Poles	0	0	0
012	035	012 - Materials	035 - DP - Wood Poles	44,610	0	44,610
013	035	013 - COPS Contracts	035 - DP - Wood Poles	32,514	0	32,514
066	035	066 - Other Goods & Services	035 - DP - Wood Poles	2,500	0	2,500
001	039	001 - T&D Regular Labour	039 - DP - O/H Cond.	11,173	0	11,173
002	039	002 - T&D Overtime Labour	039 - DP - O/H Cond.	0	0	0
012	039	012 - Materials	039 - DP - O/H Cond.	27,646	0	27,646
001	040	001 - T&D Regular Labour	040 - DP - O/H Cond.Devices	593	0	593
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	1,589	0	1,589
001	041	001 - T&D Regular Labour	041 - DP - O/H Line Transf.	166	0	166
002	041	002 - T&D Overtime Labour	041 - DP - O/H Line Transf.	0	0	0
001	050	001 - T&D Regular Labour	050 - DP - Street Lights	28	0	28
001	052	001 - T&D Regular Labour	052 - DP - Services	166	0	166
002	052	002 - T&D Overtime Labour	052 - DP - Services	0	0	0
001	085	001 - Regular Labour (No AO)	085 Design	2,152	0	2,152
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
001	090	001 - T&D Regular Labour	090 - DP - LED Street Lights	55	0	55
002	090	002 - T&D Overtime Labour	090 - DP - LED Street Lights	0	0	0
012	090	012 - Materials	090 - DP - LED Street Lights	491	0	491
			Total Cost:	256,828	0	256,828
			Original Cost:	3,293		

Capital Project Detailed Estimate

Location: Distribution
CI# / FP#: 44833
Title: 99V-312 - Highbury New Feeder
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	PLT Labour	PD	89.05	$ 353.25	$ 31,458.52		
1.2	Project Support	Lot	1	$ 2,152.12	$ 2,152.12		
1.3					$ -		
1.4					$ -		
1.5					$ -		
				Sub-Total	$ 33,610.64		
2	**013 Contracts**						
2.1	Backhoe				$ 20,000.00		
2.2	Flaggers				$ 12,513.66		
2.3	Tree Trimming				$ 37,800.00		
2.4					$ -		
				Sub-Total	$ 70,313.66		
3	**012 Materials**						
3.1	Poles, Overhead Materials & Street Lights				$ 74,335.47		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 74,335.47		
4	**028 Consulting**						
4.1	Survey				$ 3,500.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 3,500.00		
5	**066 Other Goods & Services**						
5.1	Permit				$ 2,500.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 2,500.00		
6	**020 Royalties, Easements, App**						
6.1	Land Easement				$ 5,000.00		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 5,000.00		
7	**094 Interest Capitalized**						
7.1					$ 4,452.69		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 4,452.69		
8	**095 Administrative Overhead**						
8.1	092-Vehicle T&D OT Labour AO				$ -		
8.2	092-Vehicle T&D Reg. Labour AO				$ 17,972.26		
8.3	095-COPS Contracts AO				$ 19,624.56		
8.4	095-COPS Overtime Labour AO				$ -		
8.5	095-COPS Regular Labour AO				$ 25,519.13		
				Sub-Total	$ 63,115.95		
				SUB-TOTAL (no AO, AFUDC)	$ 189,259.77		
				TOTAL (AO, AFUDC included)	$ 256,828.41		
9	**Original Cost**						
9.1					$ 3,293.49		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.



New Minas Feeder Reconfiguration
DISTRIBUTION PLANNING STUDY

Report number 315-1115-W69

Revision		Date	Prepared by	Reviewed by	Approved by
0	Issued for Study	15-Nov-2012	JMQ		
1	Issued for Release	21-Oct-2013	JMQ	JC	

EXECUTIVE SUMMARY

This study was initiated by the construction of the new 99V-Highbury substation, constructed on Highbury School Road, outside of New Minas. This study is an update of the New Minas Planning Study, report 261-0608-W66.5. This study will outline the feeder extents for the new 99V-Highbury substation, created by transferring load from 22V-New Minas to 99V-Highbury.

The study will revise the feeder configurations of 99V-Highbury, 22V-New Minas, as well as 36V-Hillaton to reduce transformer loading.

A future study will be required to investigate the feasibility of introducing automatic transfer schemes. These schemes are recommended to be introduced in the 2015 capital year.

TABLE OF CONTENTS

EXECUTIVE SUMMARY i
LIST OF TABLES iii
LIST OF FIGURES iv
1.0 SCOPE 1
2.0 EXISTING SYSTEMS 1
2.1 Transmission 1
2.2 Sub-Transmission 1
2.3 Distribution 2
2.3.1 22V-New Minas 2
2.3.2 36V-Hillaton 2
2.3.3 99V-Highbury 2
3.0 LOAD HISTORY AND FORECAST 3
3.1 Load History 3
3.2 Load Forecast 4
4.0 OVERLOADS AND OTHER CONSIDERATIONS 5
4.1 Substation Transformer Overloads 5
4.2 Feeder Overloads 5
5.0 SOLUTIONS AND EVALUATION 6
5.1 99V-Highbury Feeder Extents 6
5.2 36V-Hillaton Load Reduction 7
5.2.1 Alternative A Replace 36V-T1 8
5.2.2 Alternative B 36V-Hillaton Load Reduction via 22V-New Minas 8
5.2.3 Alternative C 36V-Hillaton Load Reduction via 50V-Klondike 8
5.2.4 Recommended Alternative 8
6.0 RECOMMENDATIONS 9
6.1 2013 Capital Year 9
6.1.1 99V-Highbury Feeder Extents Part-1 9
6.1.2 99V-Highbury Feeder Extents Part-2 10
6.2 2014 Capital Year 11
6.2.1 99V-Highbury New Feeder 11
6.2.2 22V-322 Load Transfer 12
6.2.3 36V-301 Load Transfer 12
6.3 2015 Capital Year 13
6.4 2018 Capital Year 13
6.4.1 36V-302 Load Transfer Part-1 13
6.4.2 36V-302 Load Transfer Part-2 14
6.4.3 36V-303 Load Transfer Part-1 15
6.4.4 36V-303 Load Transfer Part-2 16

APPENDIX A 17
System Operating Diagrams 17
APPENDIX B 24
Load History and Forecast 24
APPENDIX C 43
Economic Analysis 43
Summary of Alternatives 44
NPV Comparison 45
Alternative 1- Replace 36V-T1 46
Alternative 2- 99V-Highbury, 22V-New Minas, and 36V-Hillaton Load Transfers 47
Alternative 3- 50V-Klondike 4kV Conversions, 36V-Hillaton Load Transfers 48

LIST OF TABLES

Table 1 Valley Area Sub-Transmission 1
Table 2 New Minas Area Distribution Transformers 2
Table 3 Growth Rates; 1998 - 2013 3
Table 4 90th Percentile Load Forecast for 22V-New Minas feeders 4
Table 5 90th Percentile Load Forecast 36V-Hillaton feeders 4
Table 6 90th Percentile Load Forecast for Eastern Valley Transformers 5
Table 7 Alternative 1- Replace 36V-T1 46
Table 8 Alternative 2- 12kV Load Transfers 47
Table 9 Alternative 3- 50V-Klondike 4kV Conversions, 36V-Hillaton Load Transfers 48

LIST OF FIGURES

Figure 1 New 99V-Highbury Feeder, 99V-3X1 9
Figure 2 99V-3X2 and 99V-3X3 feeder extents 10
Figure 3 99V-3X4 New Feeder Construction Part-1 11
Figure 4 99V-3X4 New Feeder Construction Part-2 11
Figure 5 22V-322 Load Transfer 12
Figure 6 36V-301 Load Transfer 12
Figure 7 36V-302 Load Transfer Part-1 13
Figure 8 36V-302 Load Transfer Part-2 14
Figure 9 36V-302 / 36V-301 Tie 14
Figure 10 36V-303 Load Transfer Part-1 15
Figure 11 36V-303 Load Transfer Part2 16
Figure 12 System Operating Diagram 43V-Canaan Road 18
Figure 13 System Operating Diagram 22V-New Minas 19
Figure 14 System Operating Diagram 36V-Hillaton 20
Figure 15 System Operating Diagram 50V-Klondike 21
Figure 16 System Operating Diagram 55V-Waterville 22
Figure 17 System Operating Diagram 99V-Highbury 23
Figure 18 L-5033 Load History 25
Figure 19 L-5033 Load Forecast 25
Figure 20 22V-New Minas Load History 26
Figure 21 22V-New Minas 12kV Load History 26
Figure 22 22V-T51 Load History 27
Figure 23 22V-T51 Load Forecast 27
Figure 24 22V-T52 Load History 28
Figure 25 22V-T52 Load Forecast 28
Figure 26 22V-312 Load History 29
Figure 27 22V-312 Load Forecast 29
Figure 28 22V-313 Load History 30
Figure 29 22V-313 Load Forecast 30
Figure 30 22V-314 Load History 31
Figure 31 22V-314 Load Forecast 31
Figure 32 22V-321 Load History 32
Figure 33 22V-321 Load Forecast 32
Figure 34 22V-322 Load History 33
Figure 35 22V-322 Load Forecast 33
Figure 36 22V-323 Load History 34
Figure 37 22V-323 Load Forecast 34

Figure 38 36V-T1 Load History....35
Figure 39 36V-T1 Load Forecast....35
Figure 40 36V-301 Load History....36
Figure 41 36V-301 Load Forecast....36
Figure 42 36V-302 Load History....37
Figure 43 36V-302 Load Forecast....37
Figure 44 36V-303 Load History....38
Figure 45 36V-303 Load Forecast....38
Figure 46 50V-Klondike Load History....39
Figure 47 50V-Klondike Load Forecast....39
Figure 48 50V-T1 Load History....40
Figure 49 50V-T51 Load History....40
Figure 50 50V-401 Load History....41
Figure 51 50V-401 Load Forecast....41
Figure 52 50V-402 Load History....42
Figure 53 50V-402 Load Forecast....42
Figure 54 Economic Assessment Model NPV....45

1.0 SCOPE

This study was initiated as a result of the construction of the new 99V-Highbury substation, outside of New Minas. The construction of this substation had been recommended by a previous study, 261-0608-W66.5. Given the time between completion of the initial study and the construction of the substation, a review of the new and existing distribution feeders was required.

This study will define the feeder extents for the new feeders, supplied by 99V-Highbury as well as the reallocation of the existing feeders to more evenly distribute load in the area. The reduction in load will be realized at the transformers located at the 22V-New Minas and 36V-Hillaton substations.

A future protection study will be required, to determine the location and application of down-line reclosers and to investigate the application of automatic transfer schemes that could be created between the 22V-New Minas, 36V-Hilaton and 99V-Highbury feeders.

2.0 EXISTING SYSTEMS

The existing system has been fully described in the previous study. A brief summary has been included, in the following sections of the report.

2.1 Transmission

The existing 138kV, at 43V-Canaan Road, is supplied via L-6012 from 17V-St.Croix and L-6004 from 90H-Sackville. The 138kV at 43V-Canaan Road is stepped down to 69kV, via the two autotransformers, 43V-T61 and 43V-T62.

Both 22V-New Minas and 36V-Hillaton are supplied via L-5033 from 43V-Canaan Road. The 50V-Klondike substation is supplied via L-5021, from 43V-Canaan Road. The 55V-Waterville substation is supplied via the 56V-Waterville Tap, off of L-5053.

A new 138kV transmission line, L-6052, has been constructed from 43V-Canaan Road, to the new substation, 99V-Highbury.

2.2 Sub-Transmission

The eastern Annapolis Valley is supplied at 69kV via the two autotransformers at 43V-Canaan Road. The new 99V-Highbury substation will be supplied via 138kV. The System Operating Diagrams are attached in Appendix A.

Table 1 Valley Area Sub-Transmission

Substation	Auto-Transformer Data				
	ID	MAN	kV	Rating	Age
43V-Canaan Road	T61	Westinghouse	138-72	30/40/50//56	1969
43V-Canaan Road	T62	Maloney Electric	138-72	33.6/44.8//56	1990

2.3 Distribution

The distribution system being studied, in this report is the area supplied by 22V-New Minas and 36V-Hillaton. Load data from 50V-Klondike and 55V-Waterville has been included in this study as these substations were considered as potential areas where load could be transferred, for contingency purposes.

These substations have also been included because of their close proximity to the 99V-Highbury substation.

Table 2 New Minas Area Distribution Transformers

Substation	Transformer Data				
	ID	MAN	kV	Rating	Age
22V-New Minas	T51	Federal Pioneer	69-13.2	7.5/10/12.5	1987 R
22V-New Minas	T52	Westinghouse	69-13.2	7.5/10/12.5//14	1987
36V-Hillaton	T1	Federal Pioneer	69-12.47	7.5/10//11.2	1974
50V-Klondike	T51	ABB	69-26.4	15/20//25	1993
55V-Waterville	T51	Federal Pioneer	69-13.2	7.5/10/12.5//14	1976
55V-Waterville	T52	Westinghouse	69-12.47	7.5/10//11.2	1972

2.3.1 22V-New Minas

The 22V-New Minas substation is supplied via L-5033, from 43V-Canaan Road. The two transformers, 22V-T51 and 22V-T52, have both been trending at or above their nameplate ratings for the past several years winter peak (refer to Appendix B). In addition to the transformers trending above nameplate, three of the feeders from this substation have been trending above 300A during winter peak. With the construction of the new substation, 99V-Highbury, the reallocation of the 22V-New Minas load will alleviate the heavily loaded transformers and feeders.

2.3.2 36V-Hillaton

Currently, 36V-Hillaton is radially fed via an extension of L-5033 from 22V-New Minas. The load supplied via this substation mostly radiates outward from the substation with few opportunities to transfer load between feeders. The substation transformer, 36V-T1 has been trending above its nameplate rating, in each of the last 10 winters (where load check data has been available).

2.3.3 99V-Highbury

The new 99V-Highbury Road substation is located adjacent to Highway 101 near Highbury School Road. This location places this new source in a central location to a large portion of the load currently supplied via 22V-New Minas allowing for the transfer of load to the new substation.

3.0 LOAD HISTORY AND FORECAST

The loading for those feeders being studied is largely residential, with a small number of commercial customers. As illustrated in the load history for these feeders (Appendix B), the feeders being studied have had a larger winter peak than summer peak. Historical load data for the feeders and transformers being studied was collected from the Distribution Load Check Database and presented in Table 3 below. SCADA data is available for the 69kV line (L-5033) supplying both 22V-New Minas and 36V-Hilaton substations. The combined load and associated load growth rate from this data is also included below for comparison purposes.

3.1 Load History

Customer load has been generally consistent in this portion of the Annapolis Valley, with a slight increase due to increased residential developments. Load growth projections for the area have been outlined below in Table 3. Overall growth rates have been determined based on 15 years of load data, as presented in the table below:

Table 3 Growth Rates; 1998 - 2013

Transformer	2013 Load in MVA	Load Growth	Notes
22V-T51	13.0	1.75%	
22V-T52	18.4	1.28%	
22V Total	30.4	1.62%	Total Substation Load
36V-T1	13.5	0.83%	
L-5033	45.6	0.72%	Radial supply to 22V and 36V
55V-T51	8.6	-4.28%	2nd Transformer added in 2009
55V-T52	10.4		Not enough data to forecast
55V Total	18.7	2.09%	Total Substation Load
50V-T51	21.4	0.44%	New 25kV Transformer installed 2008
43V-505	21.0	0.32%	Breaker supplying L-5021 to 50V-Klondike
Feeder	**2013 Load in AMPS**	**Load Growth**	**Notes**
22V-312	303	0.83%	
22V-313	183	0.75%	
22V-314	128	-0.27%	
22V-321	276	1.39%	
22V-322	325	-0.54%	
22V-323	317	1.51%	
36V-301	191	-1.50%	
36V-302	191	0.39%	
36V-303	177	-1.21%	
55V-313	224	3.03%	
55V-314	189	-4.07%	
55V-322	235		New feeder added in 2009
55V-323	223		New feeder added in 2009
50V-401	184	-2.44%	25kV Feeder
50V-402	254	0.49%	25kV Feeder

3.2 Load Forecast

The 90th percentile load forecasts for the 12kV feeders at 22V-New Minas and 36V-Hillaton are presented in the following tables. The overall growth, in the area, is forecasted to be approximately 0.72%, as determined by the radial 69kV line (L-5033) supplying both the 22V-New Minas and 36V-Hilaton substations. The tables below illustrate the overall projected load growth, by feeders and transformers.

Table 4 **90th Percentile Load Forecast for 22V-New Minas feeders**

	22V-312	22V-313	22V-314	22V-321	22V-322	22V-323
2012 / 2013	315	214	148	265	303	348
2013 / 2014	318	216	148	269	302	354
2014 / 2015	321	218	148	274	300	360
2015 / 2016	324	219	147	278	298	366
2016 / 2017	326	221	147	282	297	372
2017 / 2018	329	223	147	286	295	377
2018 / 2019	332	224	146	290	294	383
2019 / 2020	335	226	146	294	292	389
2020 / 2021	337	228	145	298	290	395
2021 / 2022	340	230	145	302	289	401
2022 / 2023	343	231	145	306	287	407
2023 / 2024	347	233	144	310	286	412
2024 / 2025	348	234	144	314	284	418
2025 / 2026	351	236	144	318	283	424
2026 / 2027	354	238	143	322	281	430
2027 / 2028	357	240	143	326	279	436

Table 5 **90th Percentile Load Forecast 36V-Hillaton feeders**

	36V-301	36V-302	36V-303
2012 / 2013	189	236	239
2013 / 2014	187	237	236
2014 / 2015	184	238	234
2015 / 2016	182	239	231
2016 / 2017	179	240	228
2017 / 2018	176	240	226
2018 / 2019	174	242	223
2019 / 2020	171	242	220
2020 / 2021	169	243	218
2021 / 2022	166	244	215
2022 / 2023	164	245	212
2023 / 2024	161	246	210
2024 / 2025	158	247	207
2025 / 2026	156	248	204
2026 / 2027	153	249	202
2027 / 2028	151	250	199

Table 6 90th Percentile Load Forecast for Eastern Valley Transformers

	22V-T51 7.5/10/12.5	22V-T52 7.5/10/12.5//14	22V Total	36V-T1 7.5/10//11.2	L-5033	55V-T51 7.5/10/12.5//14	55V-T52 7.5/10//11.2	55V-Total	50V-T51 15/20//25
2012 / 2013	14.4	19.1	34.7	13.9	46.4	13.2	15.0	22.4	22.3
2013 / 2014	14.7	19.4	35.3	14.0	46.7	12.8	17.0	22.9	22.4
2014 / 2015	15.0	19.7	36.0	14.1	47.1	12.4	19.1	23.5	22.5
2015 / 2016	15.2	19.9	36.6	14.3	47.4	12.0	21.1	24.0	22.6
2016 / 2017	15.5	20.2	37.2	14.4	47.8	11.5	23.2	24.5	22.7
2017 / 2018	15.8	20.5	37.9	14.5	48.1	11.1	25.2	25.1	22.8
2018 / 2019	16.1	20.7	38.5	14.6	48.5	10.7	27.2	25.6	22.9
2019 / 2020	16.4	21.0	39.1	14.8	48.8	10.3	29.3	26.2	23.0
2020 / 2021	16.7	21.3	39.8	14.9	49.2	9.8	31.3	26.7	23.1
2021 / 2022	17.0	21.5	40.4	15.0	49.6	9.4	33.4	27.3	23.2
2022 / 2023	17.2	21.8	41.0	15.1	49.9	9.0	35.4	27.8	23.3
2023 / 2024	17.5	22.1	41.7	15.2	50.3	8.6	37.5	28.3	23.4
2024 / 2025	17.8	22.3	42.3	15.4	50.6	8.1	39.5	28.9	23.5
2025 / 2026	18.1	22.6	42.9	15.5	51.0	7.7	41.5	29.4	23.6
2026 / 2027	18.4	22.9	43.6	15.6	51.3	7.3	43.6	30.0	23.7
2027 / 2028	18.7	23.1	44.2	15.7	51.7	6.9	45.6	30.5	23.8

4.0 OVERLOADS AND OTHER CONSIDERATIONS

The following section identifies issues that warrant correction based on NSPI's *Capital Expenditure Justification Criteria*.

4.1 Substation Transformer Overloads

The following substation transformers have peaked above their nameplate ratings, but below 133% of their top rating, for the following years;

- 22V-T51 2013, 2011. 2010, 2009, 2008
- 22V-T52 2013, 2012, 2011, 2010, 2009, 2008, 2006, 2005, 2002
- 36V-T1 2013, 2012, 2011, 2010, 2009, 2008, 2006, 2005, 2004, 2003, 2002,

4.2 Feeder Overloads

The following list of feeders has peaked above 300A for the following years;

- 22V-312 2013, 2010, 2004
- 22V-322 2013, 2010, 2005, 2004, 2003, 2001
- 22V-323 2013, 2012, 2011, 2003, 2002

5.0 SOLUTIONS AND EVALUATION

This study is examining the eastern Annapolis Valley distribution system, with consideration of the new substation, 99V-Highbury. The alternatives outlined below will discuss various options to offload existing substations via the new source.

These alternatives focus on the transfer of existing load from 36V-Hillaton and 22V-New Minas onto the new 99V-Highbury substation. Feeders from these two 12kV substations are in close proximity to the new substation and the transformers at these substations have seen peak loading above nameplate rating in recent years.

The recommendations for the report will be compiled from the alternatives outlined below.

5.1 99V-Highbury Feeder Extents

There are a variety of feeder configurations possible with respect to the addition of the new source, 99V-T61. Given the location of the substation, and its proximity to a large portion of load currently serviced by 22V-New Minas, a large reduction of 22V-323 and 22V-312 load is possible without much difficulty.

22V-323 is the longest feeder supplied by 22V-New Minas, with a portion containing densely populated suburban residential load, as well as a large portion of rural residential load. This feeder can be divided at the intersection of New Minas Connector Road and Prospect Road. This will enable the separation of the suburban and rural customers on a feeder that is greater than 100kms in length.

Further subdividing the remaining portion of 22V-323 along Highbury Road to Commercial Street in New Minas will further reduce the load on 22V-T52.

The third new feeder to be supplied via 99V-Highbury is a large portion of the existing 22V-312 feeder from the intersection of Highbury Road and Prospect Road to Commercial Street. Reallocating this load to a new feeder will reduce the overall loading on 22V-T51.

The fourth feeder to be supplied via 99V-Highbury will be used to transfer load from 22V-322. Transferring load from 22V-322 by way of a line extension along the New Minas Connector Road via the Cornwallis River Crossing, to Belcher Street will enable the transferring of load from 22V-322 to further enable the offloading of 36V-301. The construction of this new express feeder also enables the creation of an additional feeder tie with 22V-314 at the intersection of Commercial Street and the New Minas Connector Road, at some point in the future.

5.2 36V-Hillaton Load Reduction

Reducing the loading on 36V-Hillaton needs to be addressed in the feeder reconfigurations associated with the new substation, 99V-Highbury. Given the loading on 36V-T1 has exceeded its nameplate rating in the past several winters, the opportunity to address these issues needs to be considered where a new source is being added in the area. The opportunity to transfer load to adjacent substations and the replacement of 36V-T1 is outlined below.

Replacing the existing 36V-T1, a 7.5/10//11.2MVA, with a larger 15/20/25MVA unit will meet the current loading requirements, for the future. The load growth, in the area is roughly 0.83% annually. In replacing the 36V-T1 with a larger unit, there would be a requirement to install a mobile substation for the duration of work required, to replace the substation transformer and base. The installation of a transfer bus and SCADA controls would also be required.

However given the proximity of 36V-Hillaton feeders with the feeders from adjacent substations, there exists the potential to transfer load from 36V-Hillaton, onto the adjacent feeders from 22V-New Minas and 50V-Klondike.

22V-New Minas has only one feeder currently crossing the Cornwallis River, 22V-322. This crossing consists of a double circuit with the 36V-Hillaton 69kV supply, L-5039. Currently, this feeder is approaching its loading limits during winter operations. Construction of another Cornwallis River crossing will require the construction of a new distribution line, as well as securing a new right of way (ROW). The locations for this new crossing are limited to the two existing road crossings at Highway 358 and Cornwallis River Crossing.

Of these two crossing alternatives, the Cornwallis River Crossing is the better choice. In that a new line constructed at this location offers the ability for the crossing to be supplied by a feeder from either 22V-New Minas or 99V-Highbury and the pole line is relatively straight in comparison to Highway 358 which has more curves which would require additional guying and anchoring. In either case, there will be a requirement to obtain environmental permits prior to construction.

An alternative to constructing a new river crossing would be to use the existing infrastructure, via 50V-Klondike by way of placing a stepdown at the end of the 50V-401, on Aldershot Road. In placing the stepdown at this location, the existing 12kV feeder, 36V-303 would need to have either a two phase addition or a partial conversion to the Lakewood Road intersection and place the stepdowns at that location. In adding these stepdowns, the overall load able to be transferred would be less than that available with a new river crossing and lightly loaded feeder.

5.2.1 Alternative A Replace 36V-T1

The existing 36V-Hillaton transformer, 36V-T1 has been exceeding its nameplate rating, 7.5/10//11.2MVA, during the winter peak, for the last several years. The three feeders supplied via 36V-T1 are not presently heavily loaded, with 36V-303 peaking beyond 250A, in the past two winters.

The top rating on the existing transformer, 36V-T1 is 11.2MVA. A larger 15/20/25MVA transformer would meet the current needs, as well as the future load growth, in the area. Additionally, the installation of a larger transformer will increase the contingency opportunities with the adjacent substations, in the area, including 55V-Waterville.

To implement this alternative, a variety of substation upgrades would be required, including the construction of a transfer bus and the installation of an RTU, for SCADA controls.

5.2.2 Alternative B 36V-Hillaton Load Reduction via 22V-New Minas

In conjunction with the construction of the 99V-Highbury substation, the construction of an express feeder from the Prospect Road to Belcher Street, will allow for the offloading of 22V-322. This load reduction would then be able to be cascaded to the 36V-Hillaton feeders, by way of a load transfers.

These load reductions would commence with transferring the load on 22V-322, east of the existing Cornwallis River crossing to the new 99V-Highbury feeder. Upon completion of this load transfer, load from 36V-301 would then be transferred to 22V-322.

The completion of these load transfers would reduce the overall loading on 36V-T1, such that the load peak would not exceed 133% of nameplate rating for the foreseeable future.

5.2.3 Alternative C 36V-Hillaton Load Reduction via 50V-Klondike

An additional alternative, to reduce the load on 36V-303, would be the addition of 3x500kVA stepdowns at the end of 50V-401, on Aldershot Road. These new stepdowns would assume the load from 36V-303, along Aldershot Road, to the intersection at Sherman Belcher Road. D316-110, on Lydiard Road would need to be opened.

To offset the load added to 50V-Klondike a conversion of the existing 4kV stepdowns, 652V and 653V, will be required.

5.2.4 Recommended Alternative

Alternative B has been selected as the recommended alternative because it is the least cost alternative; refer to the Economic Analysis Model in Appendix C. This alternative reduces the load on 36V-T1, while offering the greatest flexibility to supply future load growth in the Williamsport and Canning areas for the foreseeable future.

6.0 RECOMMENDATIONS

This study recommends the offloading of two 22V-New Minas feeders, 22V-323 and 22V-312, to three new feeders supplied from the new substation, 99V-Highbury. The study also recommends the construction of a new feeder from 99V-Highbury to Belcher Street via Cornwallis River Crossing. This new feeder will assume a portion of load from 22V-322. The load reduction will then be cascaded to adjacent 36V-Hilaton feeders, to reduce the overall load on 36V-T1. The details of these recommendations are outline below, by capital year.

Also included in the recommendations of this study are plans for future load transfers within the 36V-Hilaton feeders to further balance the loading across the three feeders.

6.1 2013 Capital Year

For the 2013 capital year, the construction of the 99V-Highbury Road substation will be completed. In conjunction with this, the determination of the feeder extents will be completed.

6.1.1 99V-Highbury Feeder Extents Part-1

This portion of the project will outline the feeder extents for one new feeder, 99V-3X1, to be supplied via the new 99V-Highbury substation. This feeder will assume all of load from the existing 22V-323 beyond the Prospect Road and New Minas Connector Road intersection (approximately 250A, under peak loading). Refer to Figure 1 below. This will be accomplished by:

- Using the existing routing for 22V-323, exit the 99V-Highbury substation and ensure that all existing taps are transferred to 99V-3X1 up to the Prospect Road and New Minas Connector Road intersection.
- Remove recloser R316-014 from its current location on Prospect Road.
- Remove capacitor P316-011.



Figure 1 New 99V-Highbury Feeder, 99V-3X1

6.1.2 99V-Highbury Feeder Extents Part-2

This portion of the project will outline the feeder extents for two feeders, 99V-3X2 and 99V-3X3, to be supplied via the new 99V-Highbury substation. These feeders will assume portions of load from the existing 22V-323 and 22V-312 (approximately 40A and 93A respectively, under peak loading). Refer to Figure 2 below. This will be accomplished by:

- Construct a double circuit on Prospect Road, from New Minas Connector Road to Highbury Road.
- Highbury Road, east of New Minas Connector Road will be supplied via 99V-3X2, on the newly constructed portion of the double circuit. A new open point will be installed at the intersection of Highbury Road and Commercial Street, in New Minas.
- Prospect Road, including the load currently being supplied via 22V-323, will be supplied via 99V-3X3. Open D316-356, on Prospect Road.



Figure 2 99V-3X2 and 99V-3X3 feeder extents

6.2 2014 Capital Year

The 2014 capital year will see the construction of a fourth feeder from 99V-Highbury, to Belcher Street, to enable the offloading of 36V-Hillaton resulting in a load reduction on 36V-T1

6.2.1 99V-Highbury New Feeder

This portion of the project will see the construction of a new feeder, 99V-3X4, from the underground to overhead transition on the New Minas Connector Road to Belcher Street. This new feeder will be used to offload 22V-322. Refer to Figure 3 and Figure 4 below. This will be accomplished by:

- Construct new three phase 336AASC and 4/0 neutral on the New Minas Connector Road from Prospect Road to Commercial Street.
- Construct new three phase 336AASC and 4/0 neutral on the Cornwallis River Crossing from Commercial Street to Belcher Street.
- Install a new recloser on Cornwallis River Crossing, at Belcher Street.

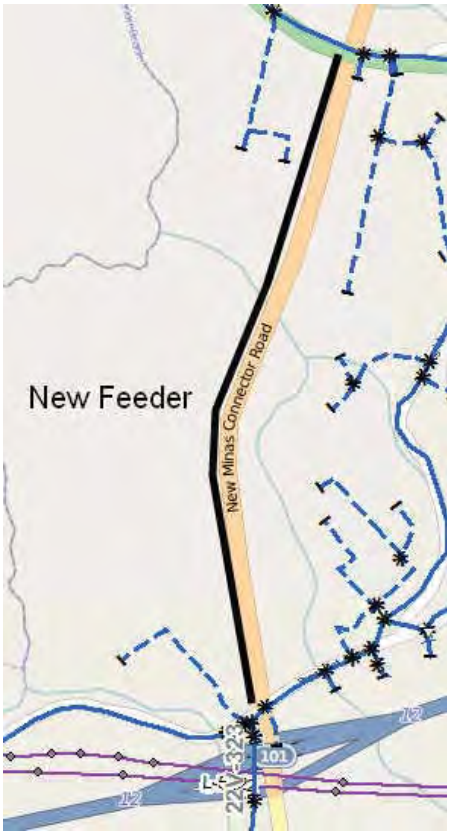


Figure 3 99V-3X4 New Feeder Construction Part-1



Figure 4 99V-3X4 New Feeder Construction Part-2

6.2.2 22V-322 Load Transfer

This portion of the project will outline the load transfer from 22V-322 to 99V-3X4 (approximately 167A, under peak loading). This will transfer the western portion of Belcher Street. Refer to Figure 5 below. This work will be accomplished by:

- Open R3A04201 on Belcher Street.



Figure 5 22V-322 Load Transfer

6.2.3 36V-301 Load Transfer

This portion of the project will outline the load transfer from 36V-301 to 22V-322. This will transfer a large portion of 36V-301 load (approximately 112A, under peak loading). Refer to Figure 6 below. This work will be accomplished by:

- Close switches D3A21690 and D316-045, on Highway 358, prior to Church Street.
- Install new open point on Highway 358, north of the intersection with Highway 341.



Figure 6 36V-301 Load Transfer

6.3 2015 Capital Year

For the 2015 capital year, the installation of new automatic transfer schemes between 22V-New Minas, 36V-Hilaton and 99V-Highbury feeders will be completed. These transfer schemes will reduce the number of Customer Hours of Interruption (CH) in the area, as well as increasing the contingencies between the three substations.

6.4 2018 Capital Year

The capital items outlined below are to be considered for advancement, in the event that the load increases at 36V-Hilaton in the coming years. A review of the requirement of these items will be required, in 2017.

6.4.1 36V-302 Load Transfer Part-1

This portion of the project will see the transfer of load from 36V-302 to 36V-301. To accomplish this, a double circuit will need to be constructed on Saxon Road (approximately 24A, under peak loading). Refer to Figure 7 below. This work will be accomplished by:

- Construct Double Circuit along Saxon Street, from 36V-Hillaton to Middle Dyke Road.
- Rebuild Highway 221 to three phase 4/0, on Highway 221, from Black Hole Road to Hillaton Road.
- Change Taps on Middle Dyke Road from 36V-303 to 36V-302.

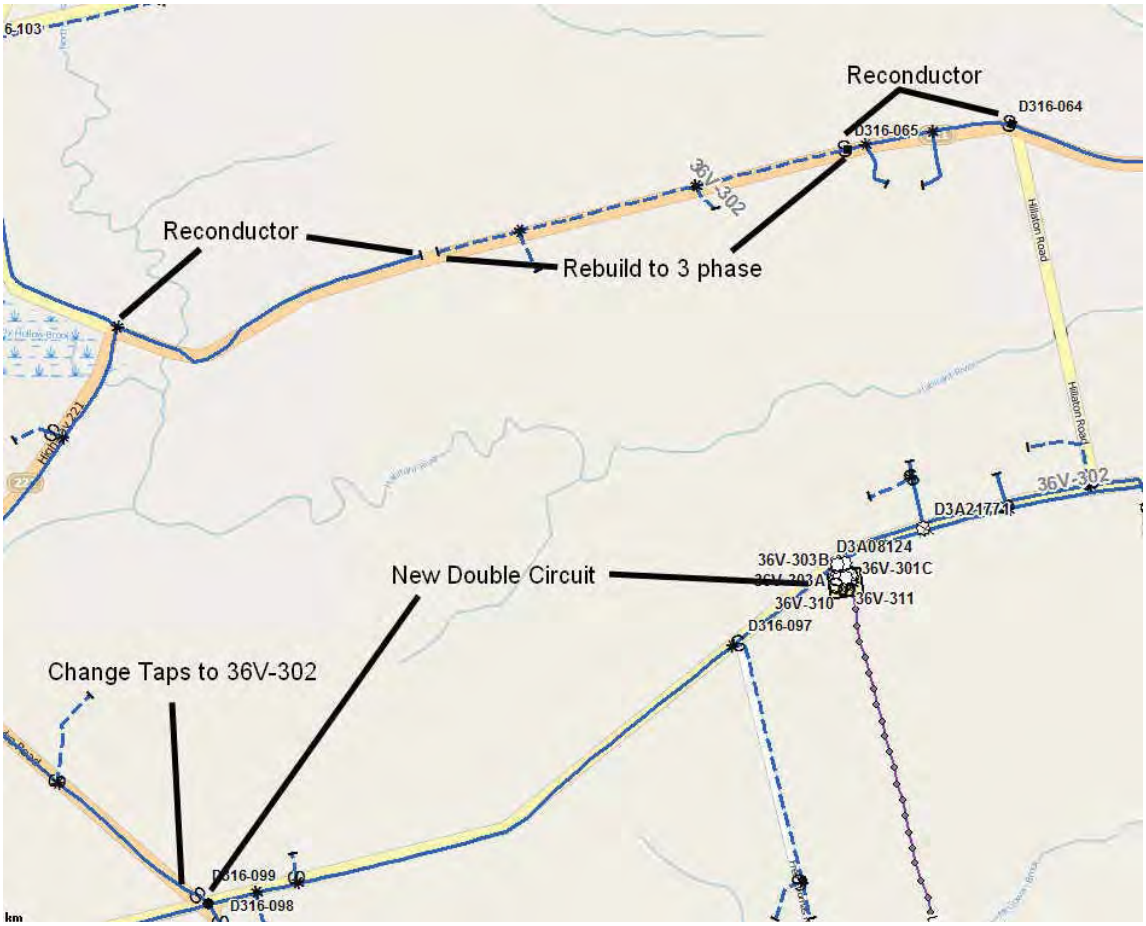


Figure 7 36V-302 Load Transfer Part-1

6.4.2 36V-302 Load Transfer Part-2

This portion of the project will see the completion of the remainder of work required to transfer load from 36V-302 to 36V-301 (approximately 112A, under peak loading). Refer to Figure 8 and Figure 9 below. This work will be accomplished by:

- Rebuild North Avenue from D316-094 to Bessie North Road, to three phase 4/0.
- Install new normally closed switch on Bessie North Avenue and North Avenue.
- Install new normally open switch at Rabbit Square Road and North Avenue.
- Open D316-469 at the intersection of Highway 221, Sheffield Road and Main Street.
- Create a new feeder tie between 36V-301 and 36V-302 on Highway 358, prior to the intersection with Saxon Street.
- Install new normally closed open point on Highway 358, between 36V-301 and 36V-302.
- Install new normally open point on Saxon Road, at the intersection to Highway 358.

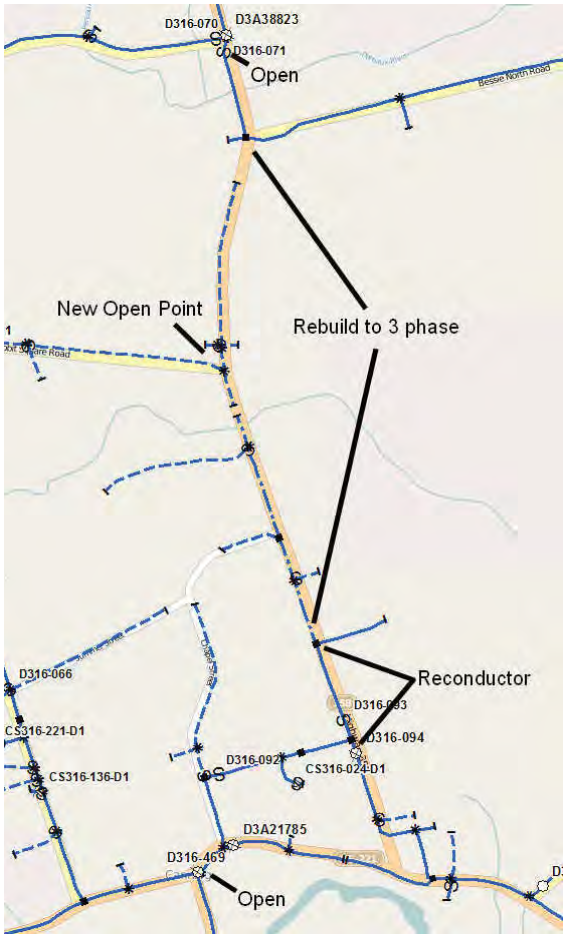


Figure 8 36V-302 Load Transfer Part-2



Figure 9 36V-302 / 36V-301 Tie

6.4.3 36V-303 Load Transfer Part-1

This portion of the project will transfer load from 36V-303 to 36V-302 (approximately 20A, under peak loading). Refer to Figure 10 below. This work will be accomplished by:

- Install a new open point on Highway 341, east of Middle Dyke Road.
- Rebuild Highway 341, from Middle Dyke Road to D316-108, Gibson Woods Road.
- Reconductor Middle Dyke Road from Saxon Street to Highway 341.
- Close D316-055 and D316-056.
- Install new normally open point at Saxon Street and Sherman Belcher Road.
- Change tap for Middle Dyke Road, at Saxon Street, from 36V-303 to 36V-302.

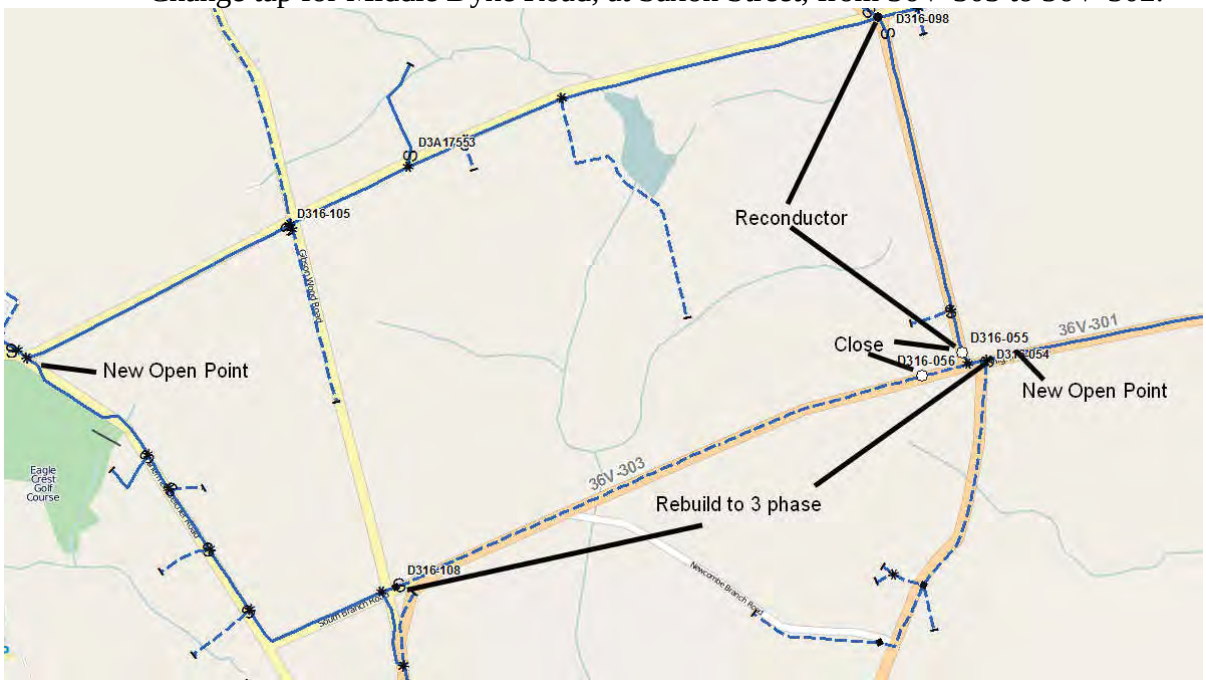


Figure 10 36V-303 Load Transfer Part-1

6.4.4 36V-303 Load Transfer Part-2

This portion of the project will complete the load transfer from 36V-303 to 36V-302 (approximately 32A, under peak loading). Refer to Figure 11 below. This work will be accomplished by:

- Reconductor Lakewood Road and filing in the gap with 2/0 ACSR, primary and neutral.
- Open D316-110 on Lydiard Road.



Figure 11 36V-303 Load Transfer Part2

APPENDIX A

System Operating Diagrams

Appendix A: System Operating Diagrams

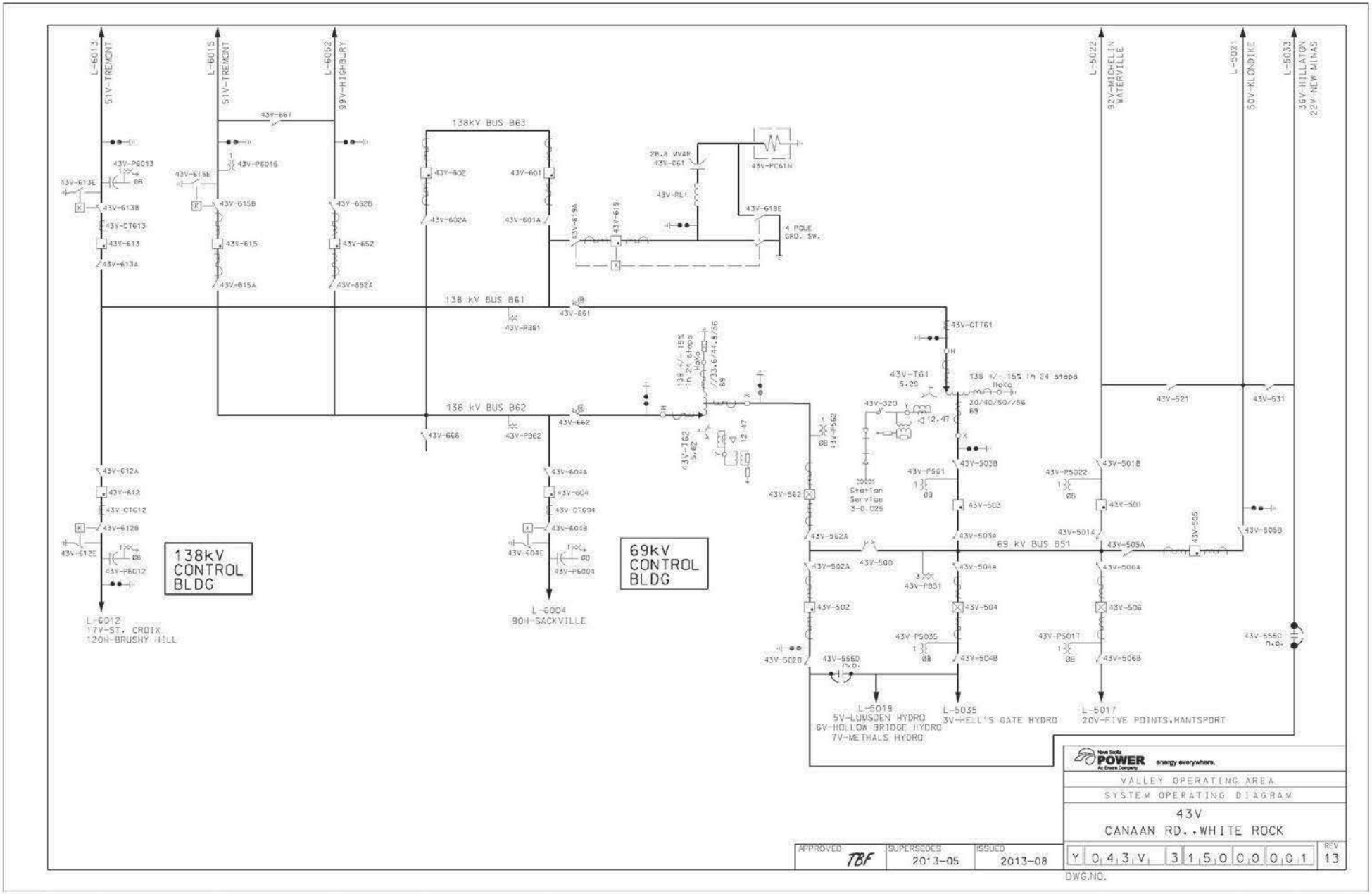


Figure 12 System Operating Diagram 43V-Canaan Road

Appendix A: System Operating Diagrams

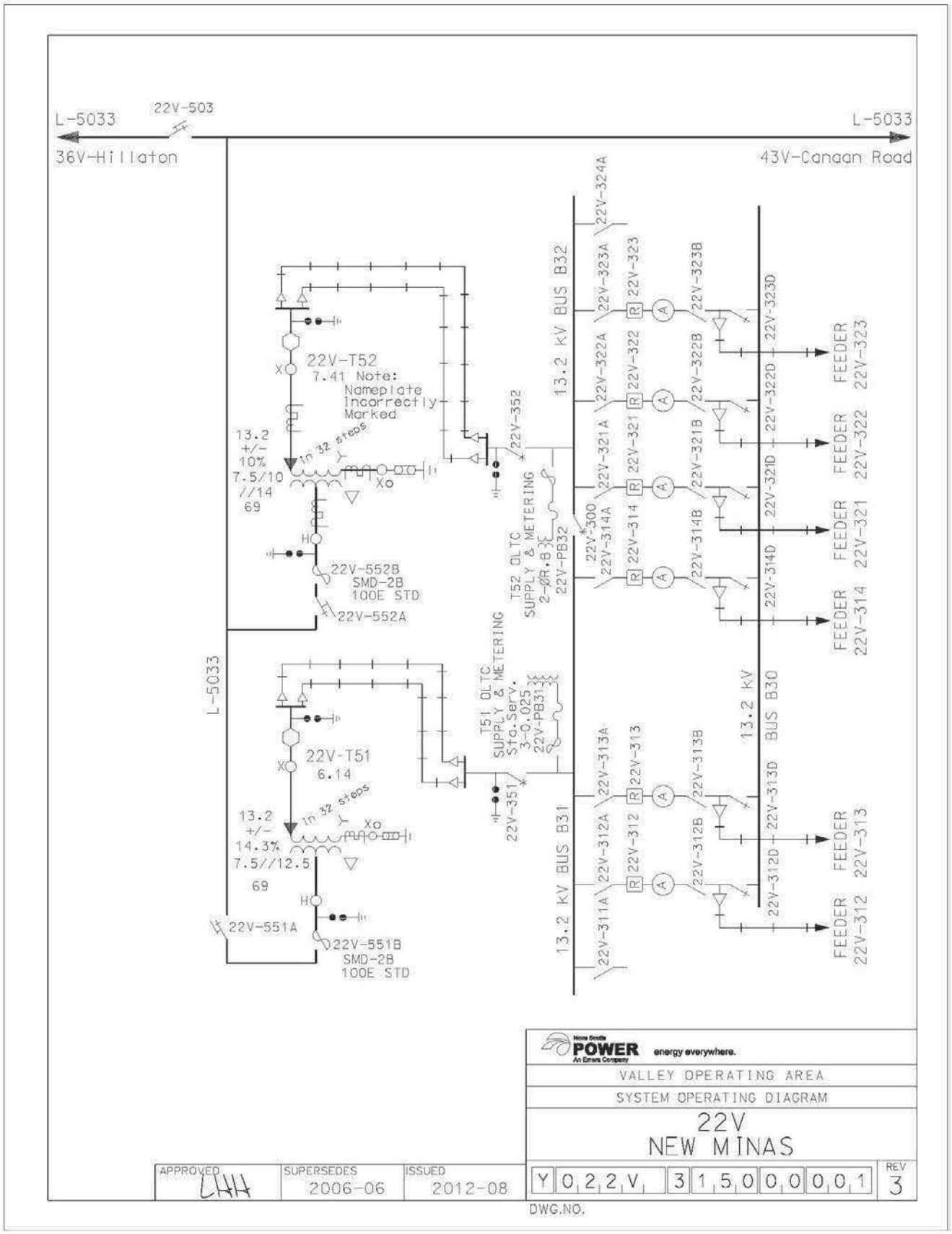


Figure 13 System Operating Diagram 22V-New Minas

Page 806 of 851
Date Refiled: December 13, 2013

Appendix A: System Operating Diagrams

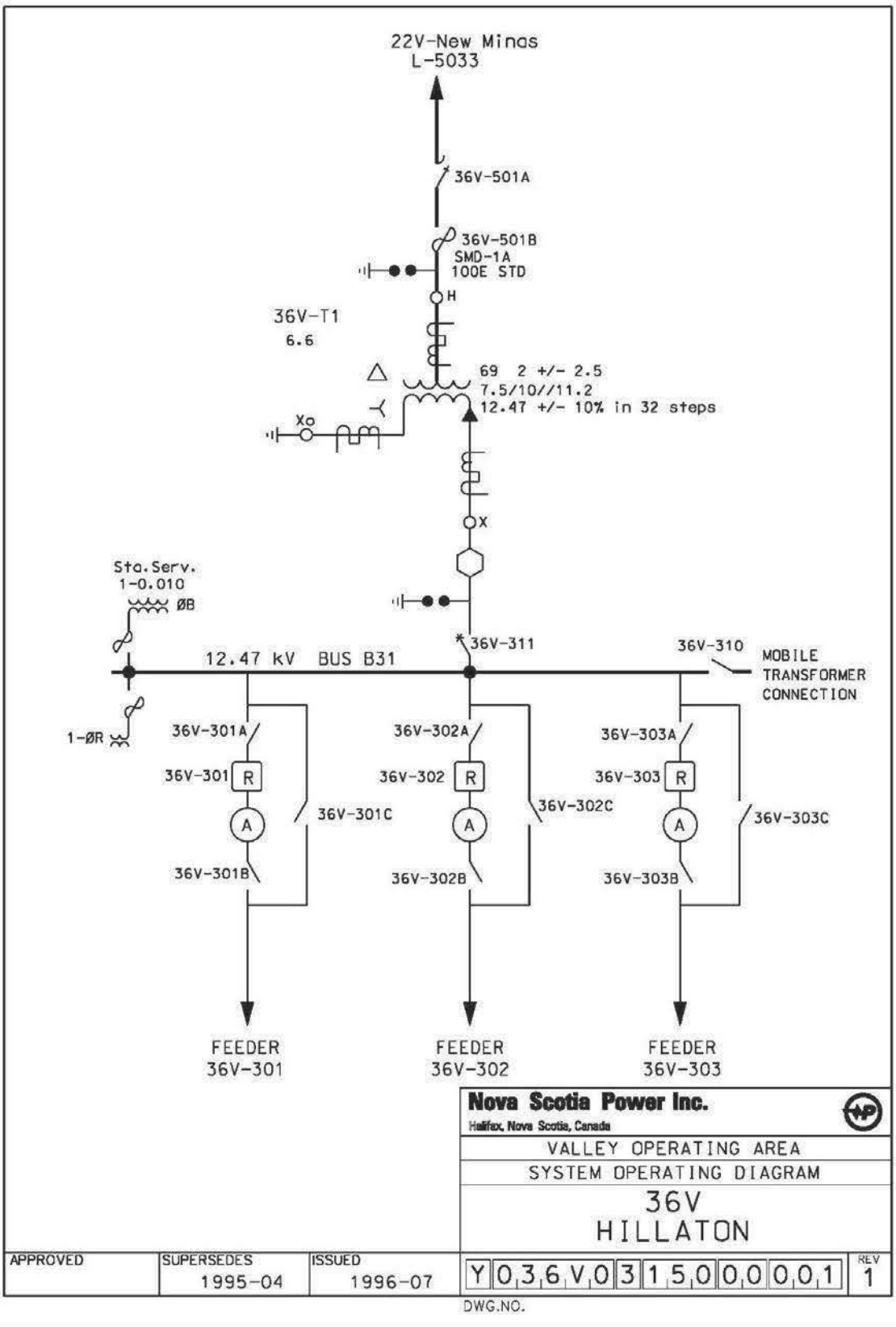


Figure 14 System Operating Diagram 36V-Hillaton

Appendix A: System Operating Diagrams

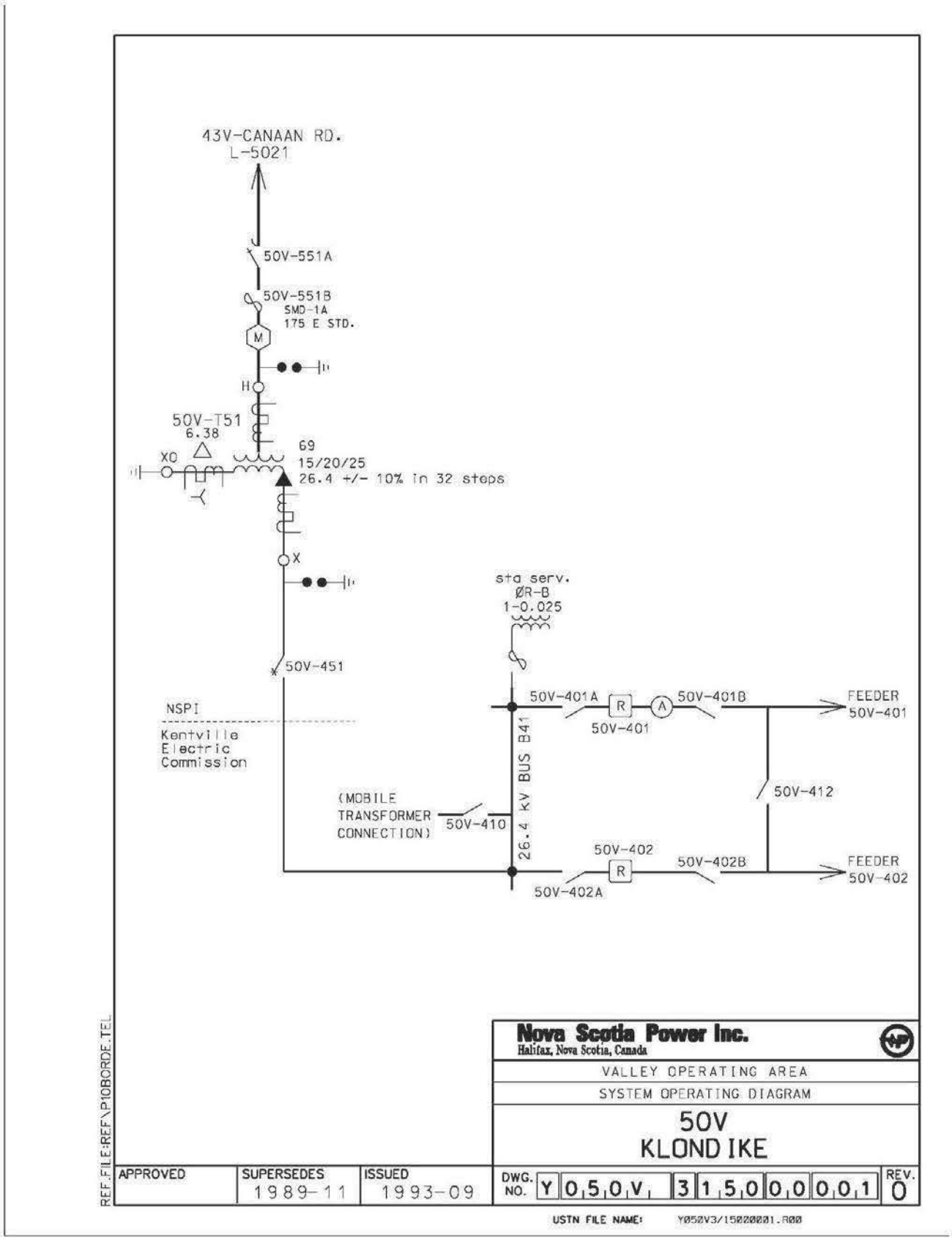


Figure 15 System Operating Diagram 50V-Klondike

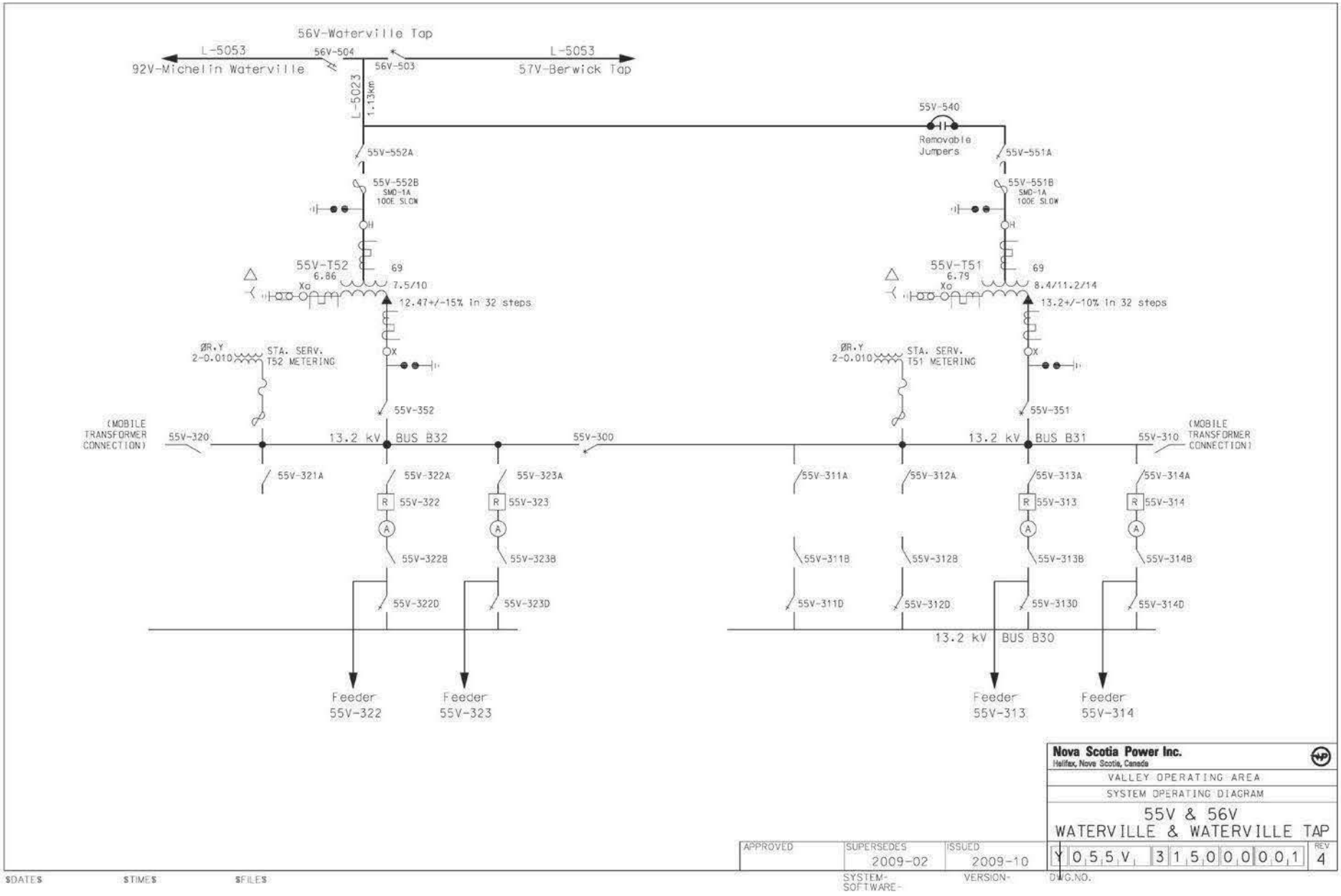


Figure 16 System Operating Diagram 55V-Waterville

Appendix A: System Operating Diagrams

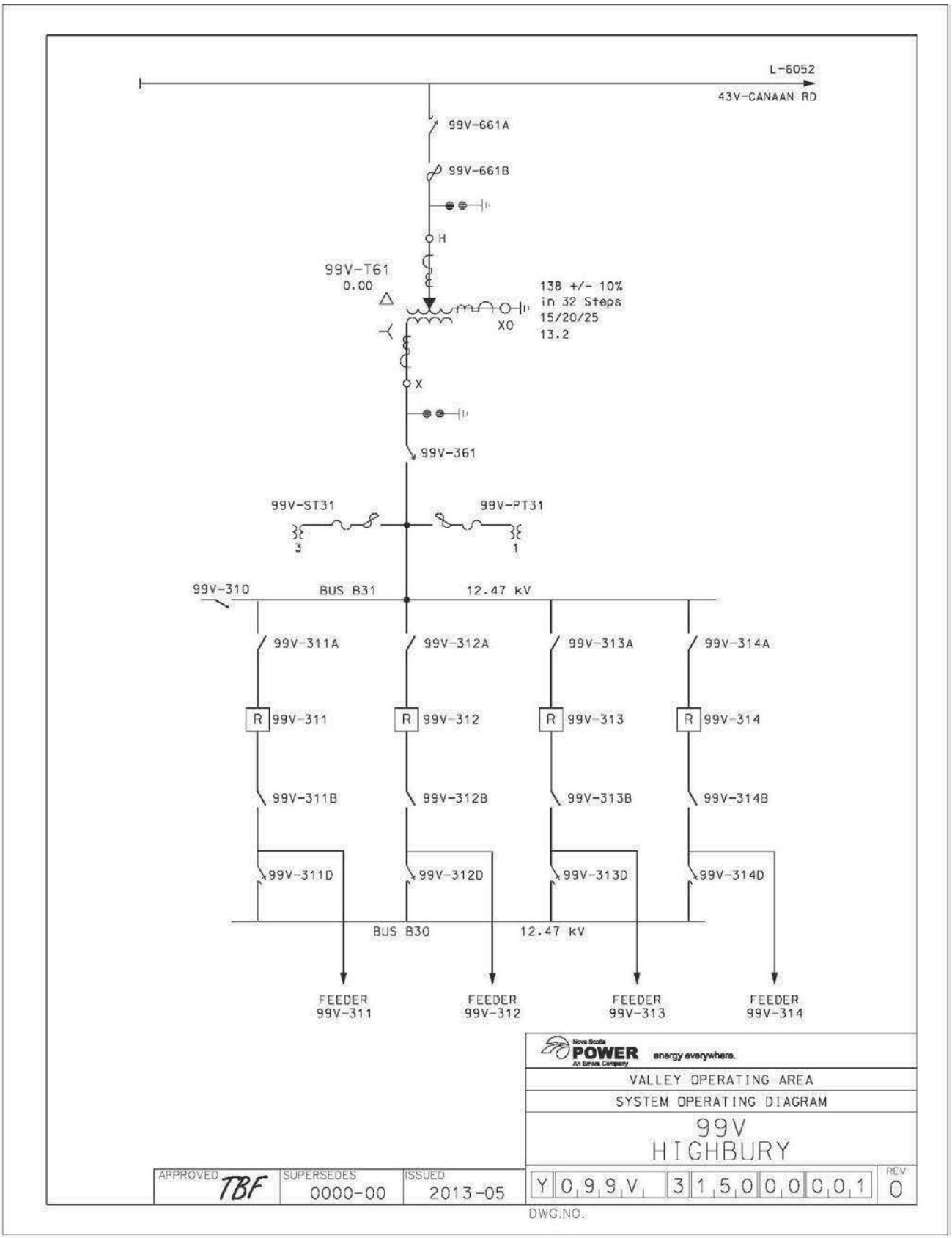


Figure 17 System Operating Diagram 99V-Highbury

APPENDIX B

Load History and Forecast

Appendix B: Load History and Forecast

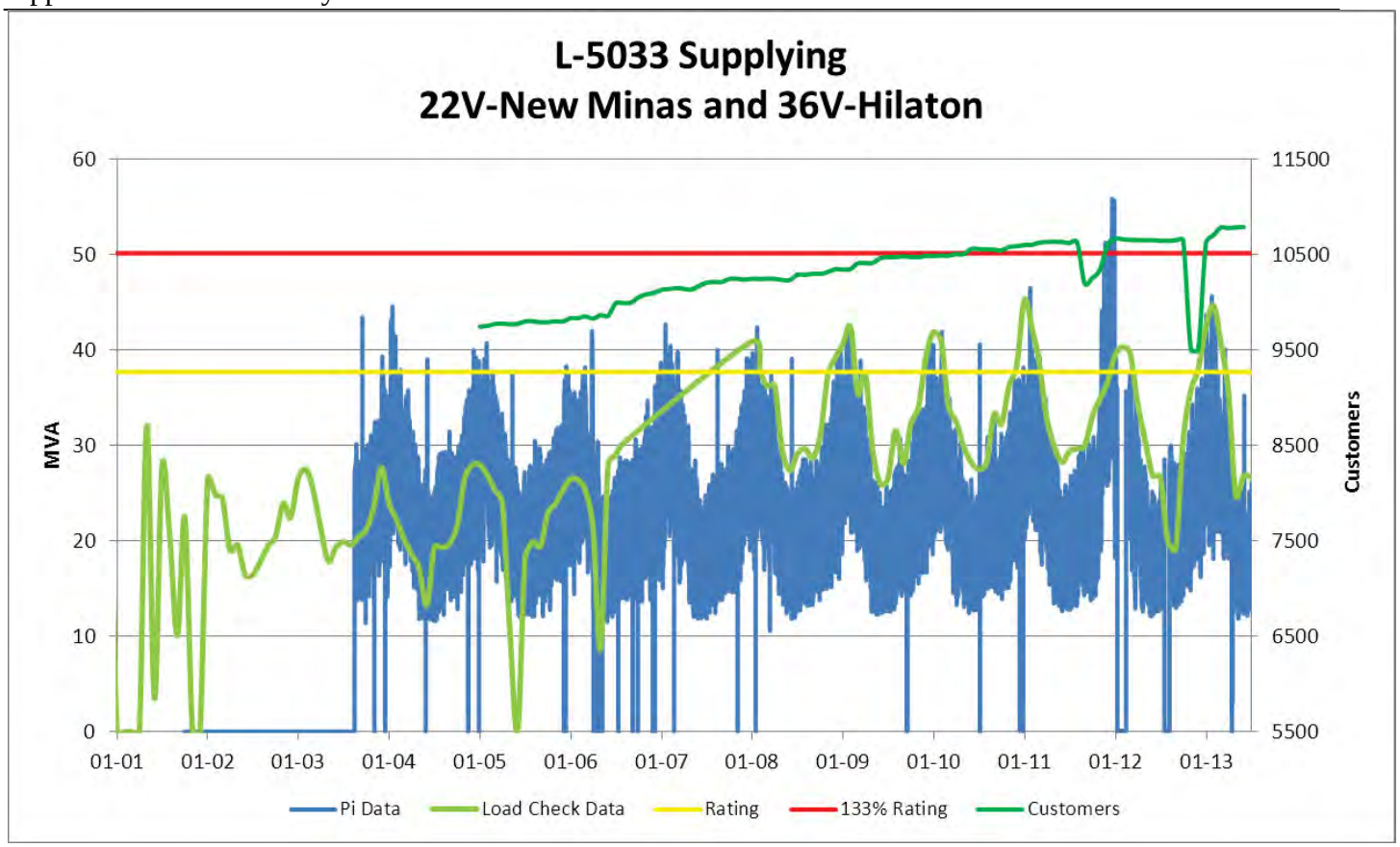


Figure 18 L-5033 Load History

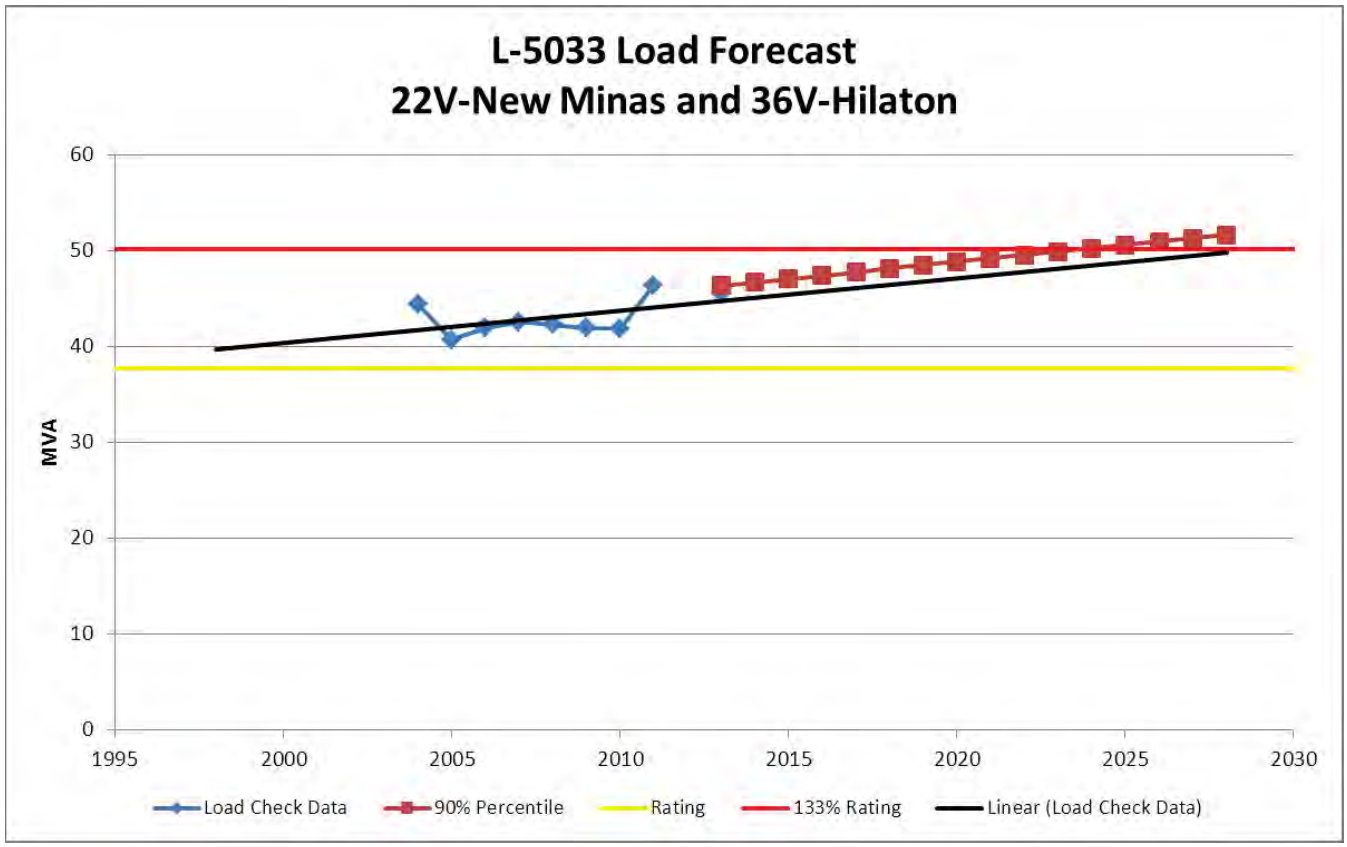


Figure 19 L-5033 Load Forecast

Appendix B: Load History and Forecast

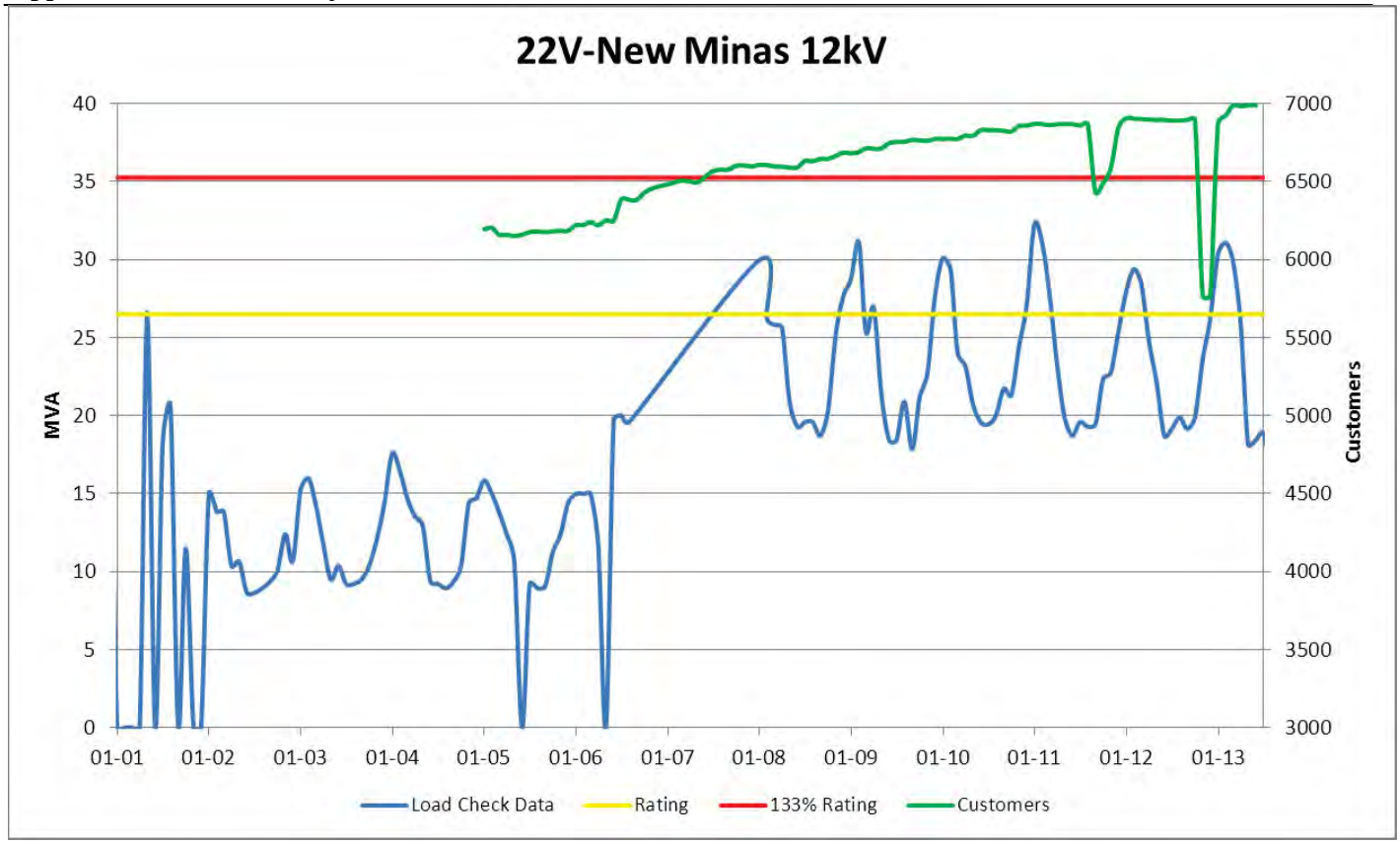


Figure 20 22V-New Minas Load History

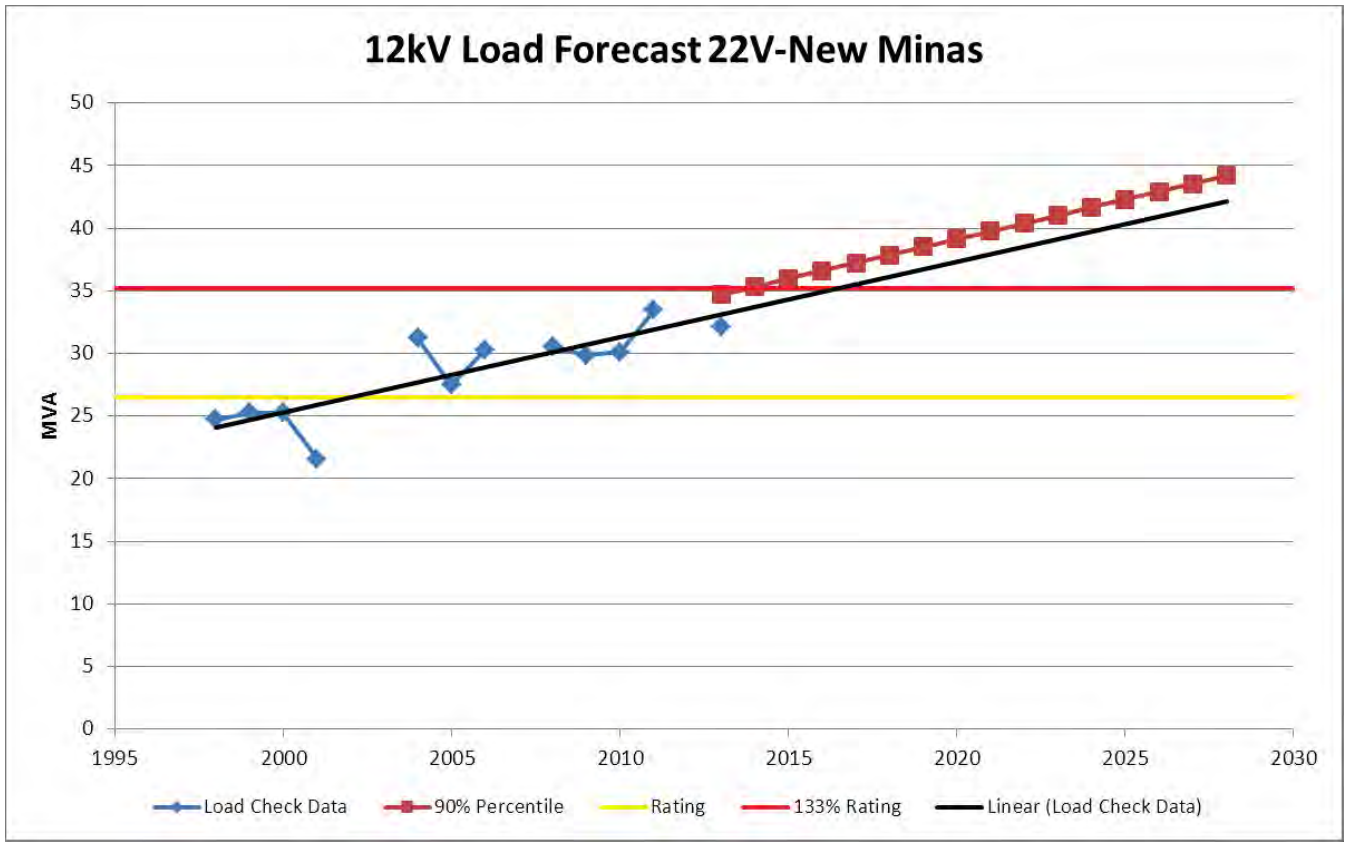


Figure 21 22V-New Minas 12kV Load History

Note: This load forecast is prior to the 99V-Highbury substation being in-service.

Appendix B: Load History and Forecast

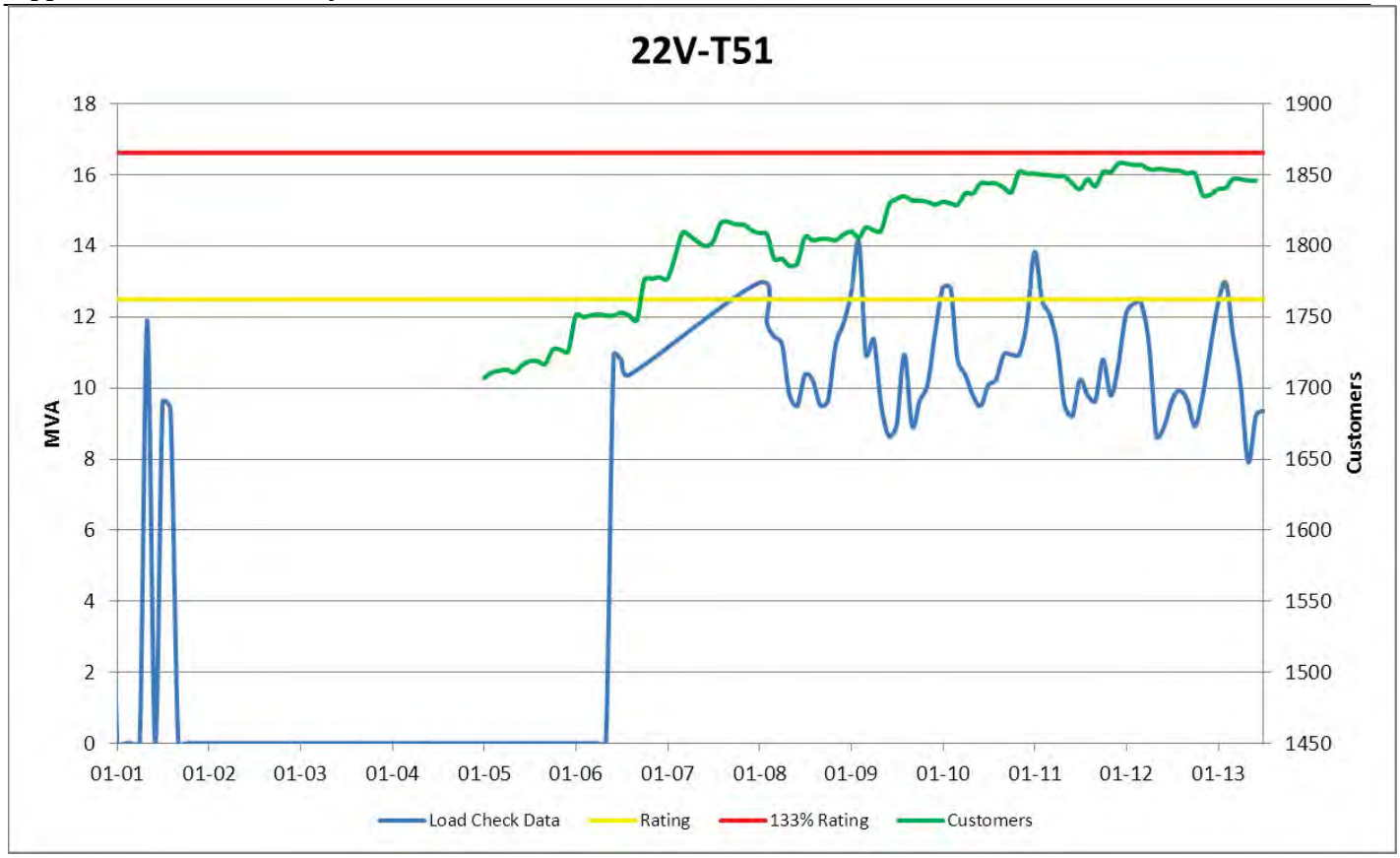


Figure 22 22V-T51 Load History

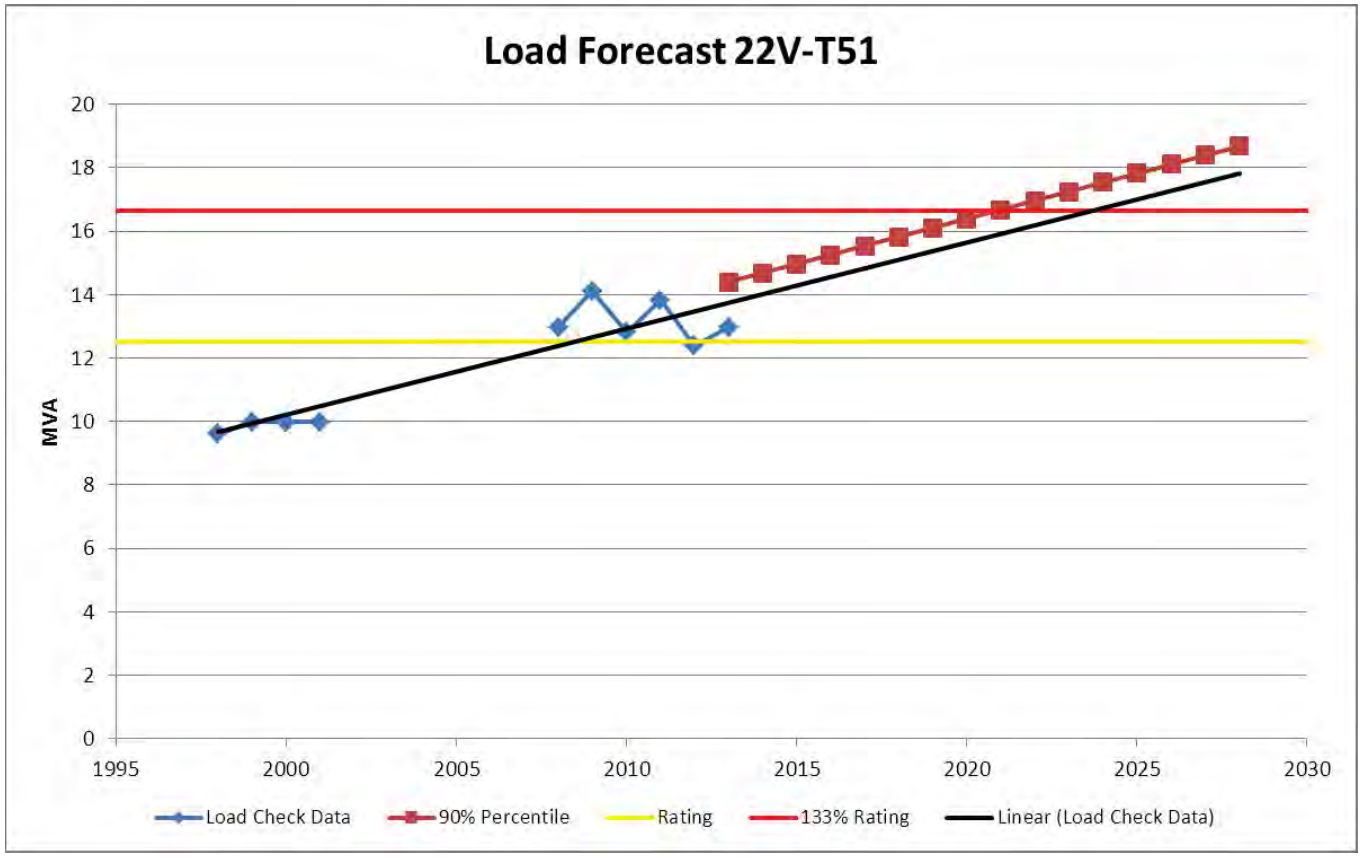


Figure 23 22V-T51 Load Forecast

Appendix B: Load History and Forecast

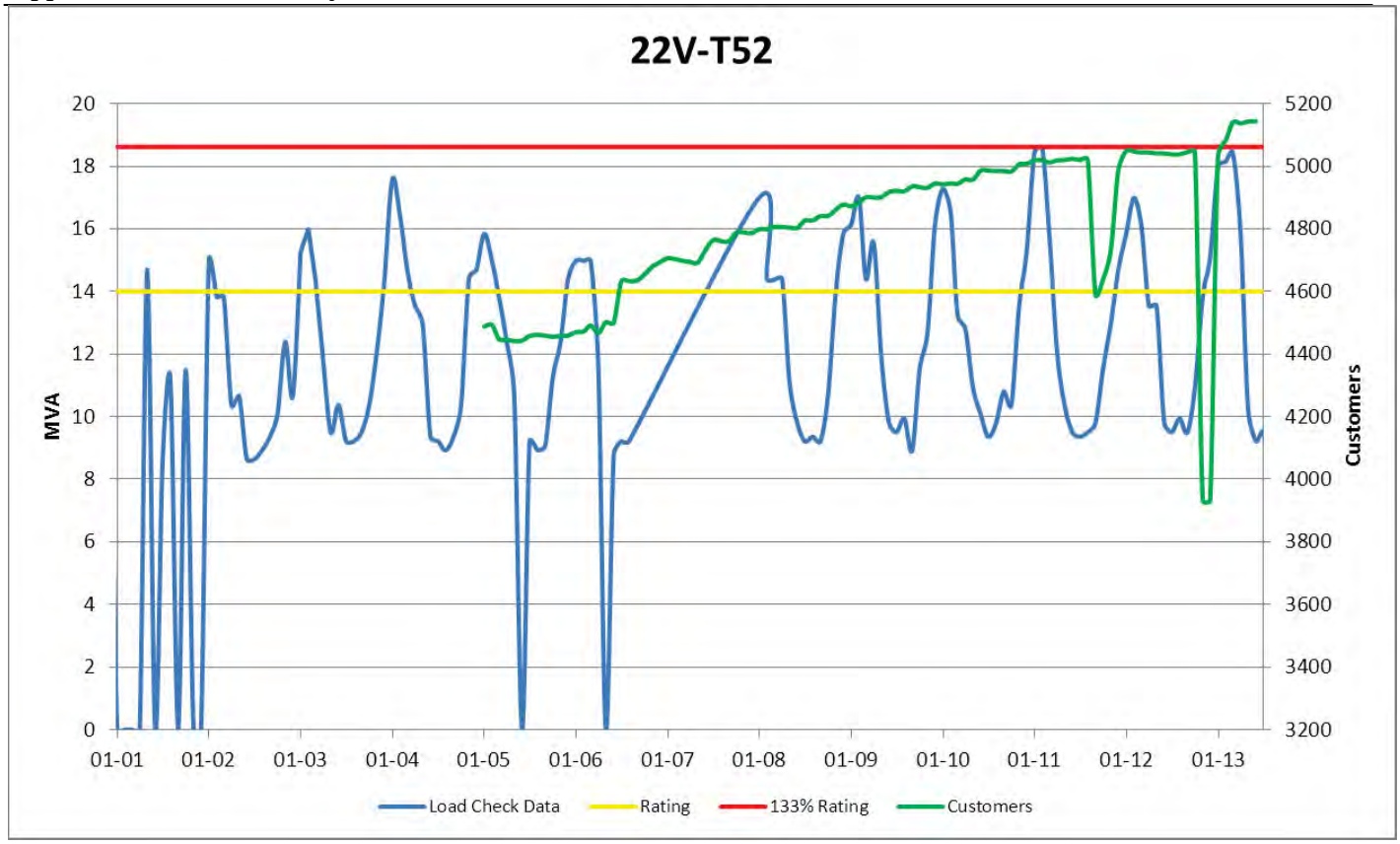


Figure 24 22V-T52 Load History

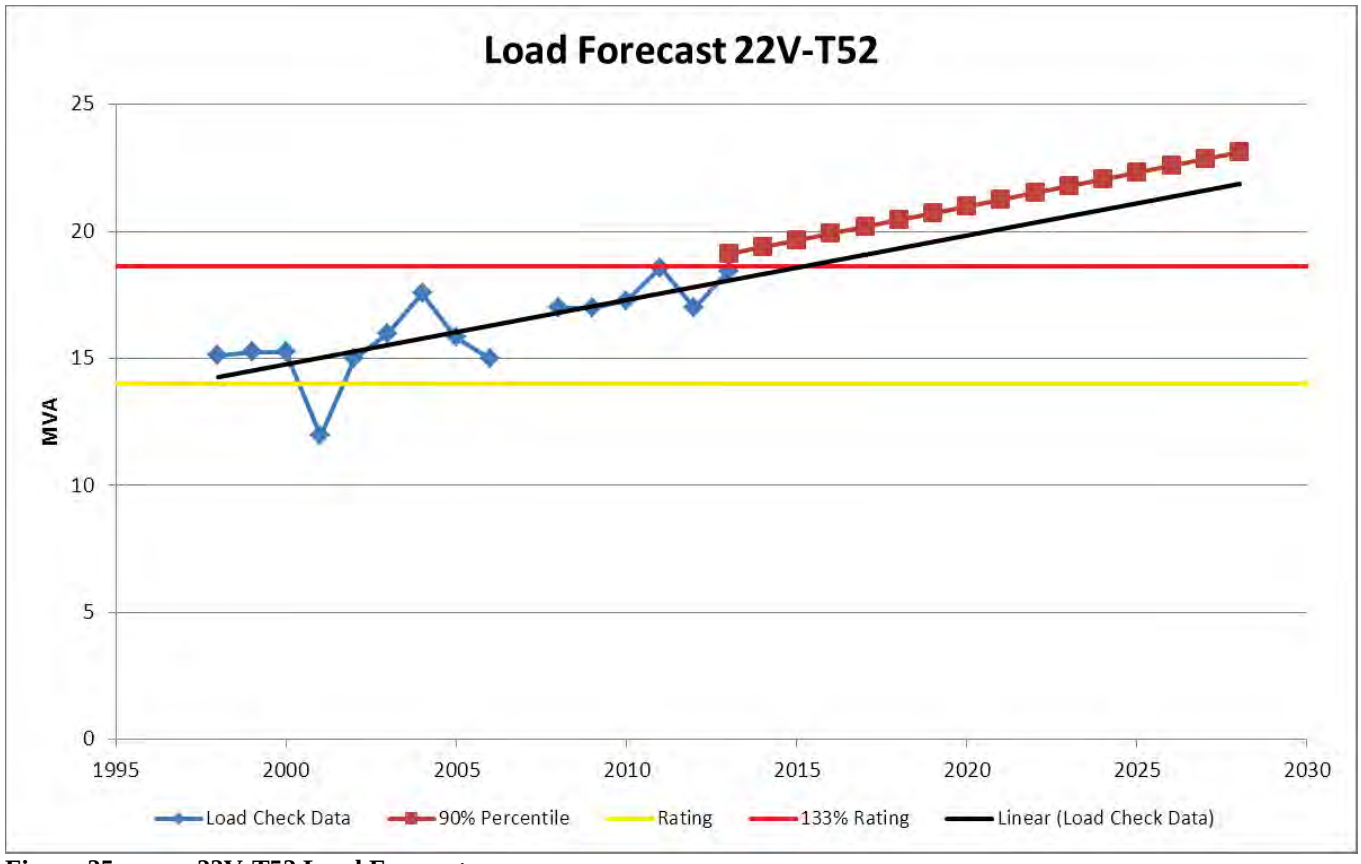


Figure 25 22V-T52 Load Forecast

Appendix B: Load History and Forecast

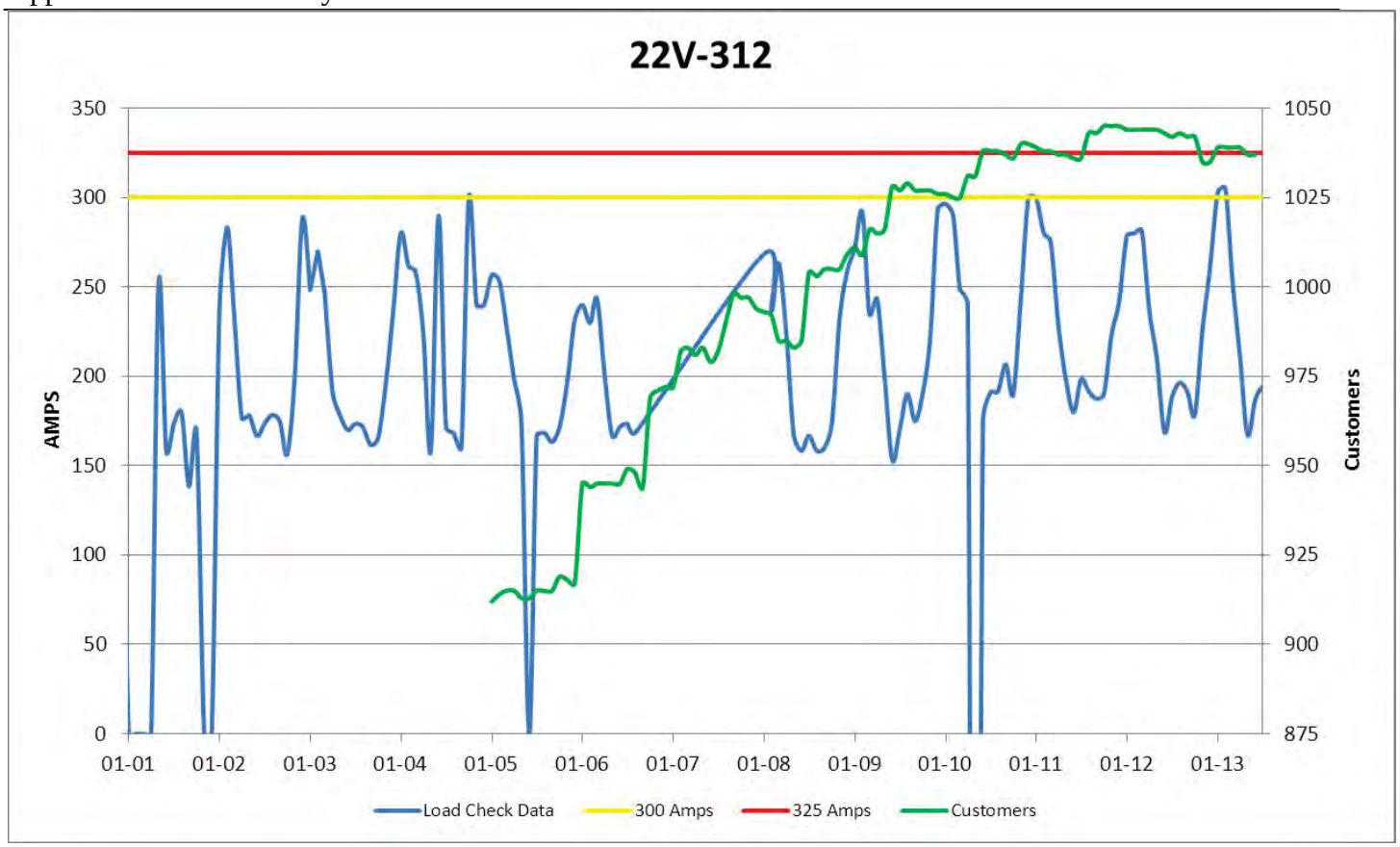


Figure 26 22V-312 Load History

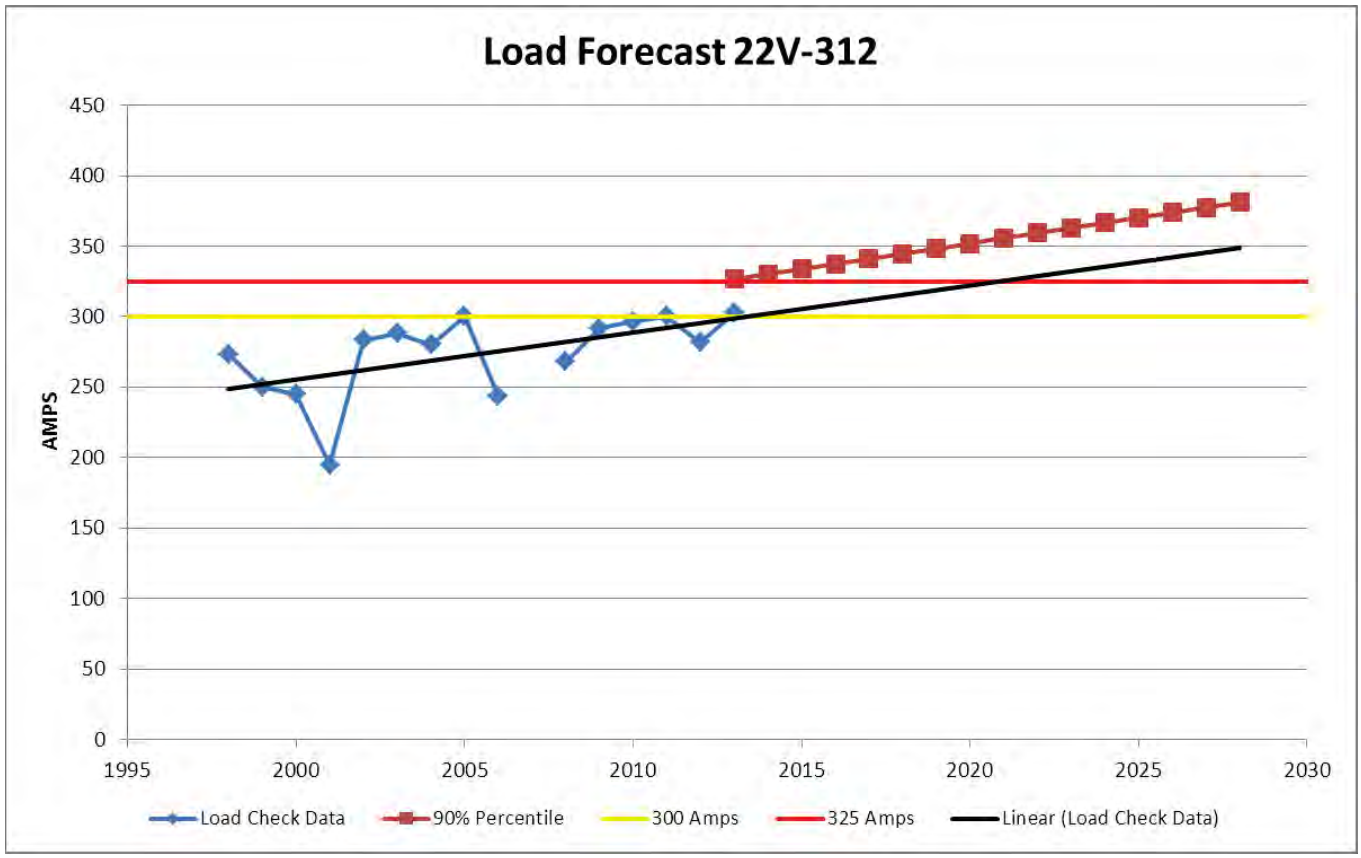


Figure 27 22V-312 Load Forecast

Appendix B: Load History and Forecast

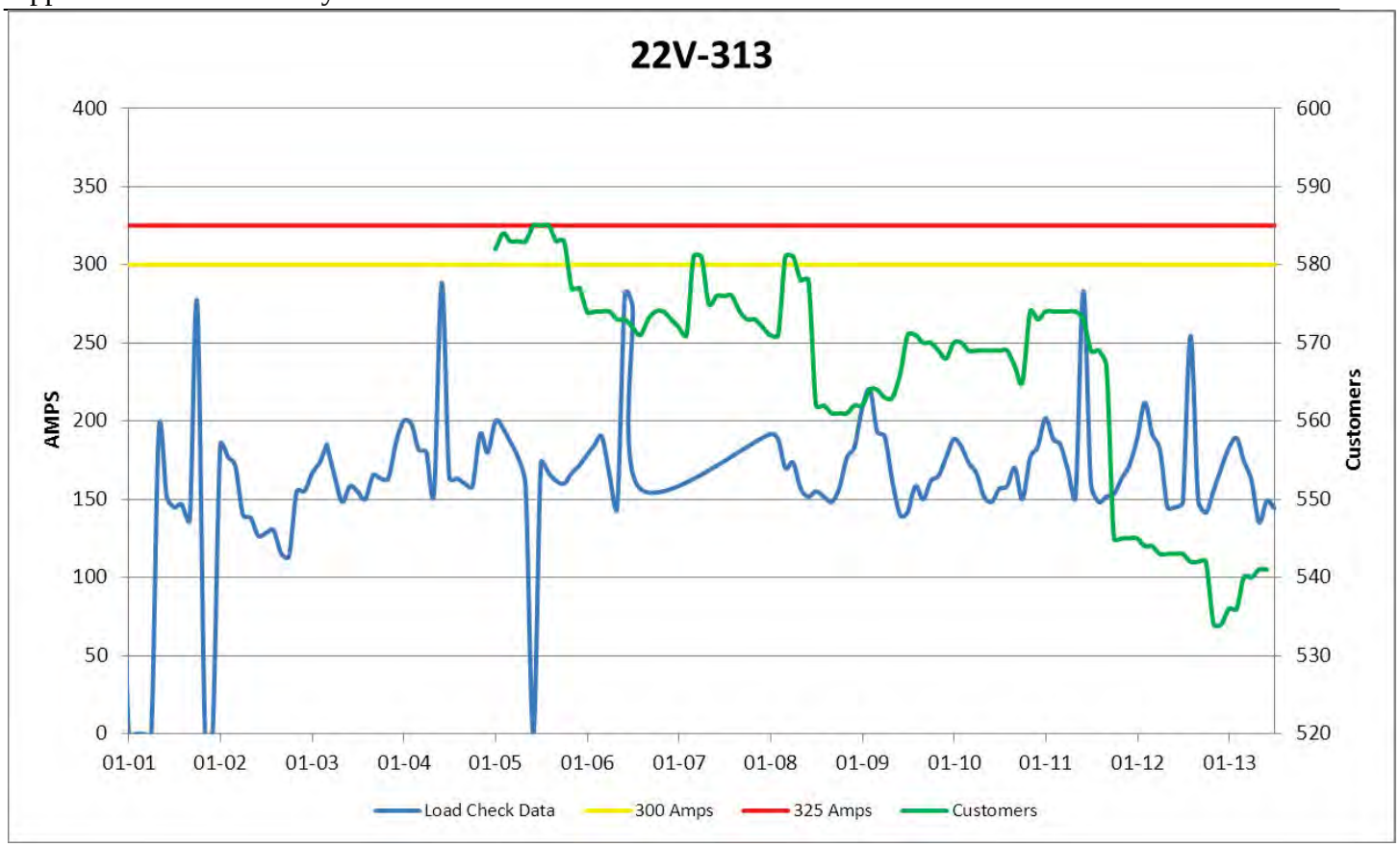


Figure 28 22V-313 Load History

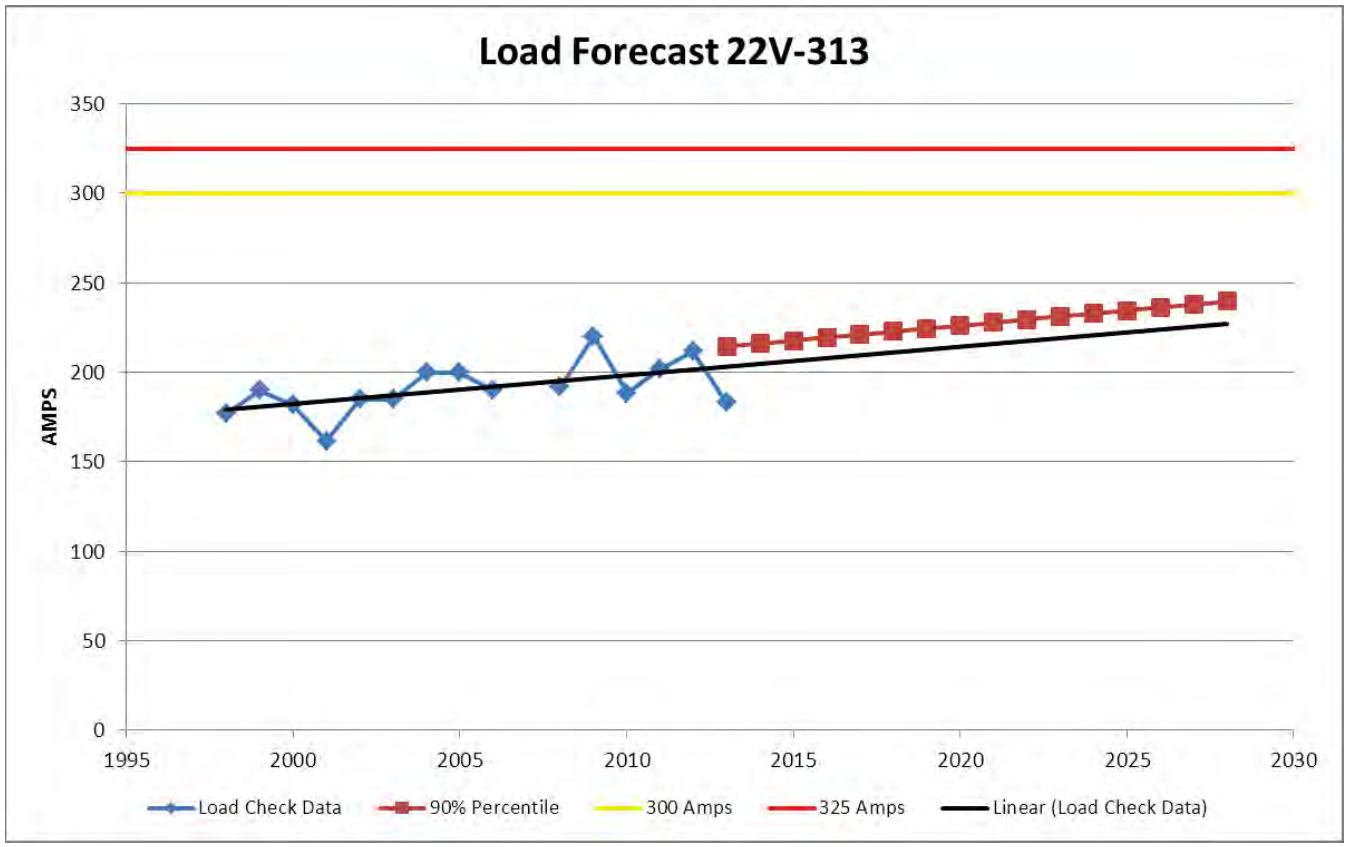


Figure 29 22V-313 Load Forecast

Appendix B: Load History and Forecast

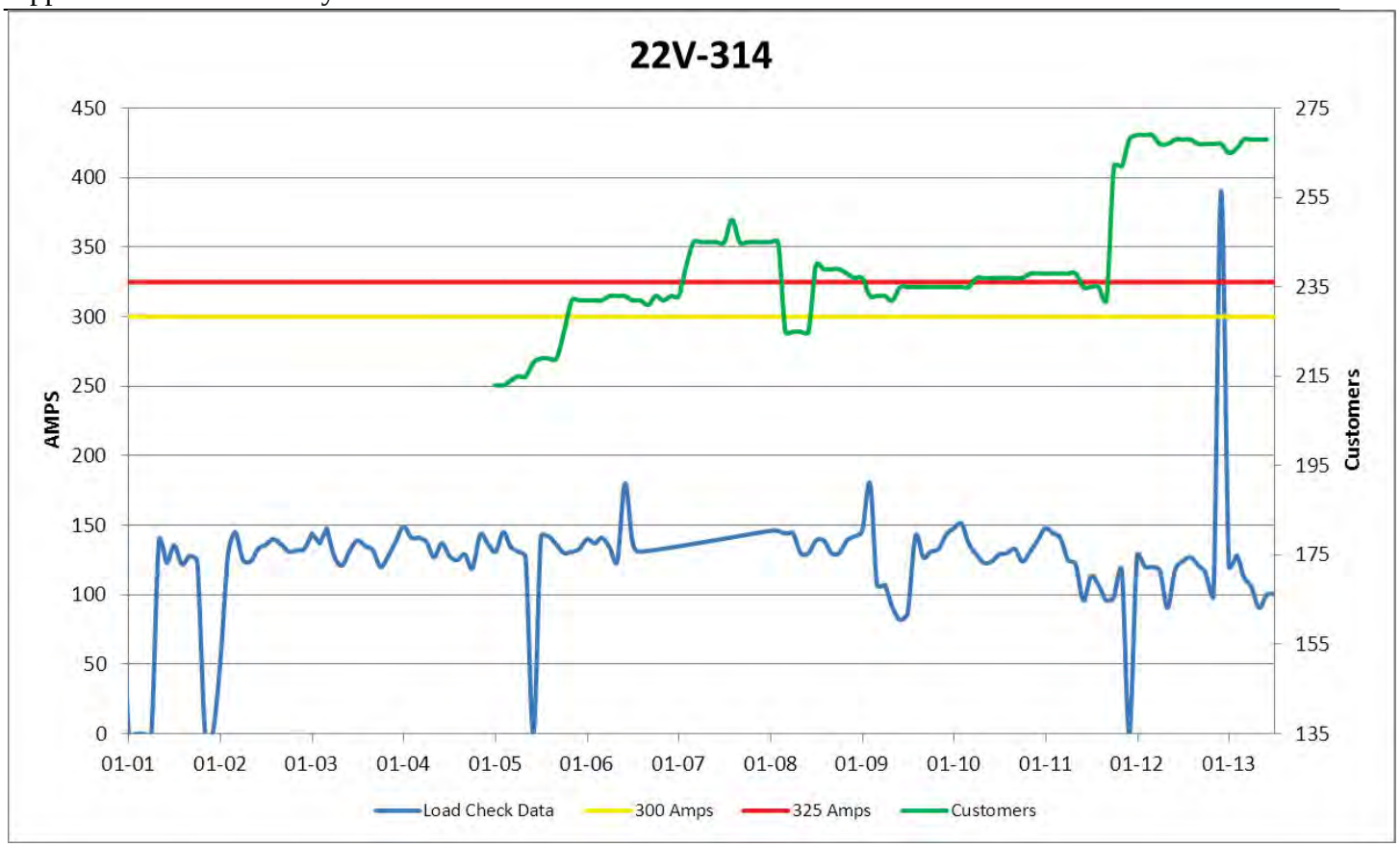


Figure 30 22V-314 Load History

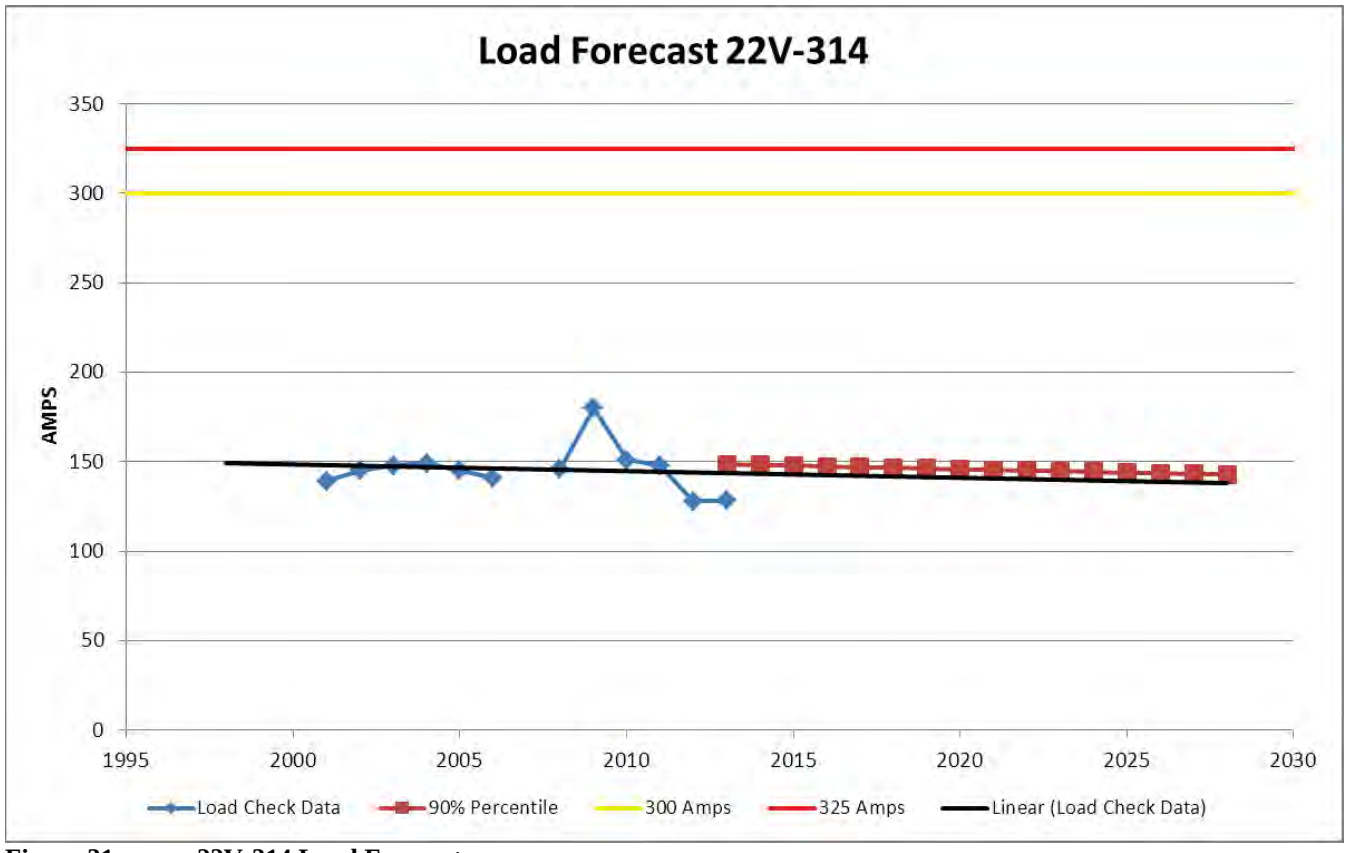


Figure 31 22V-314 Load Forecast

Appendix B: Load History and Forecast

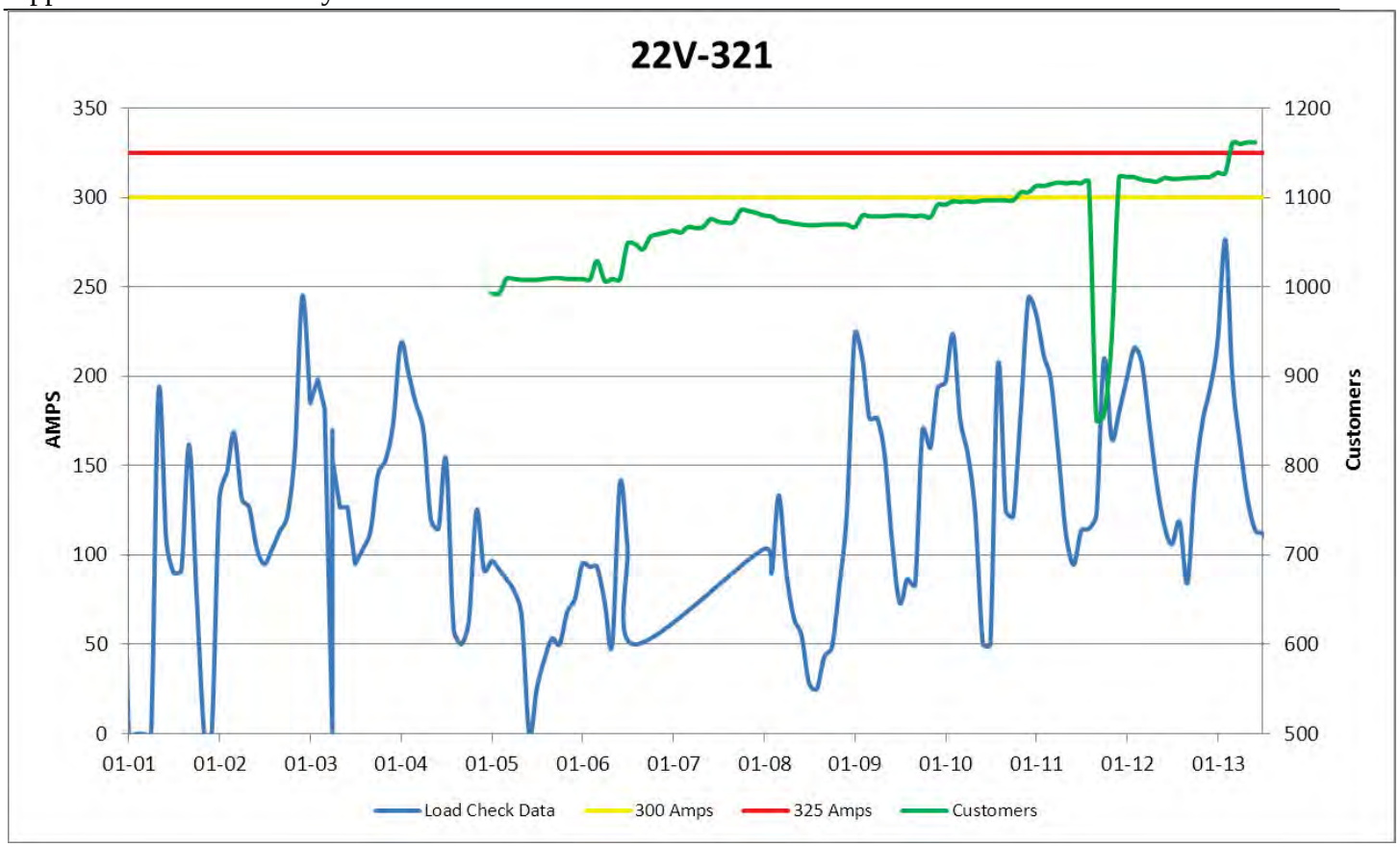


Figure 32 22V-321 Load History

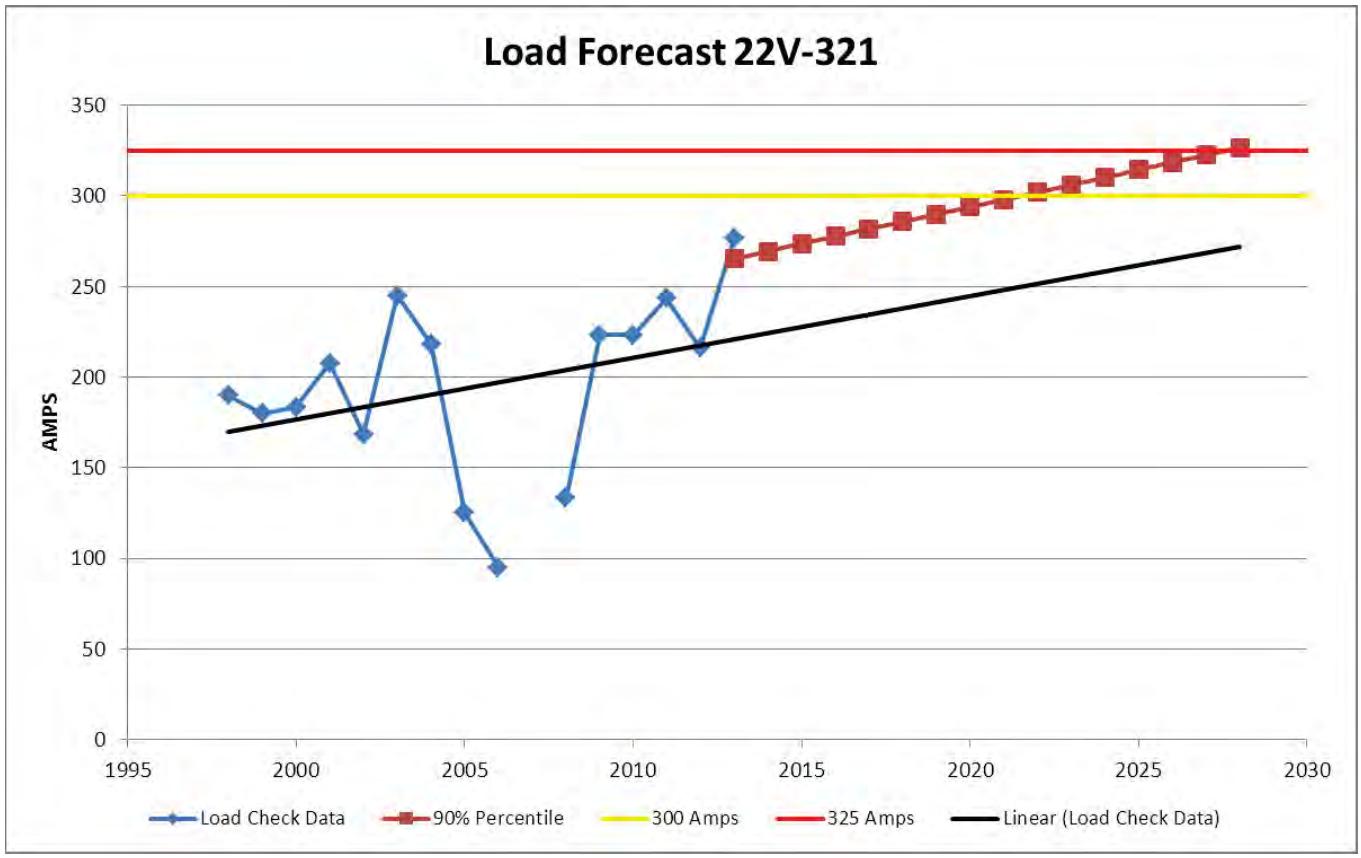


Figure 33 22V-321 Load Forecast

Appendix B: Load History and Forecast

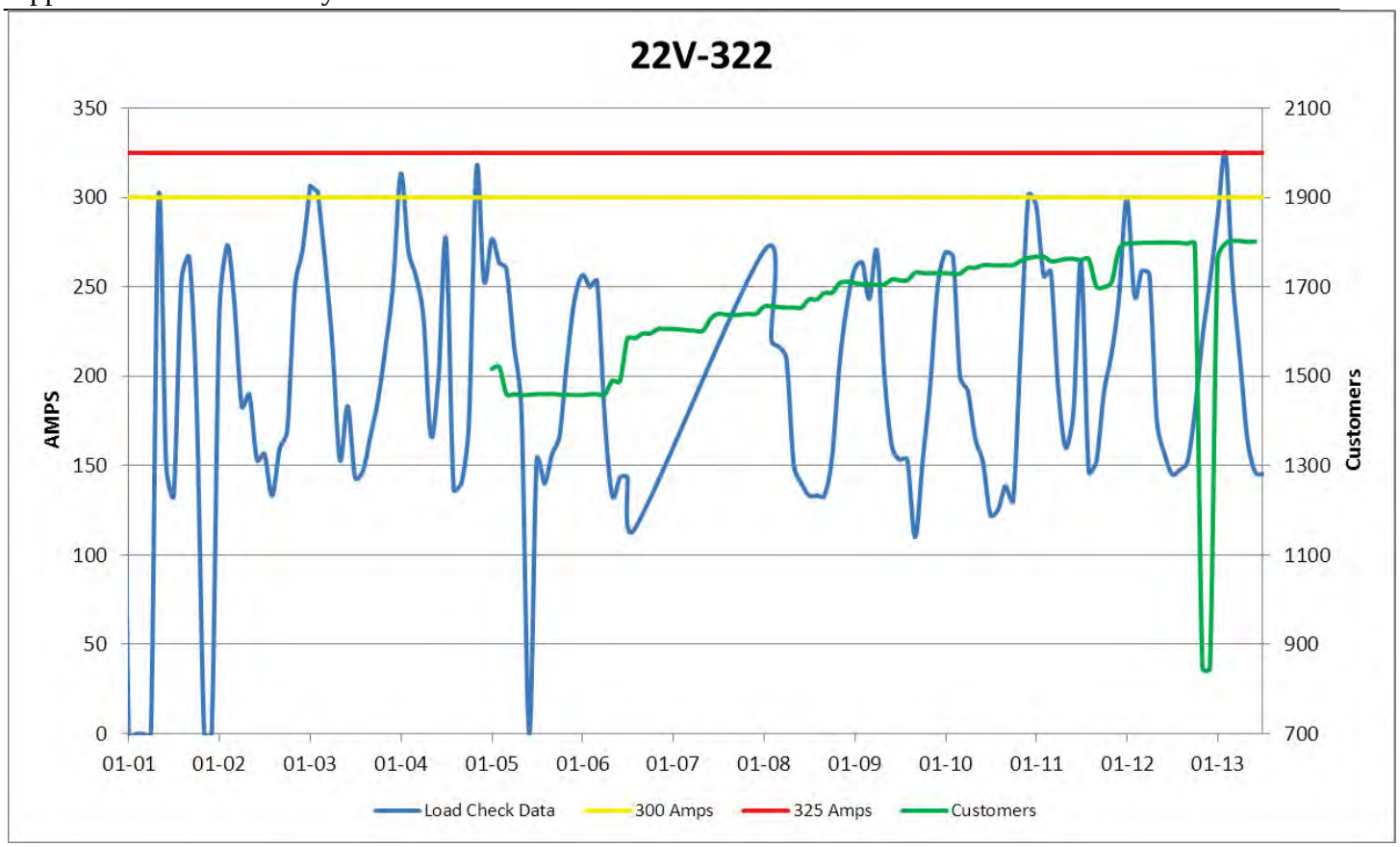


Figure 34 22V-322 Load History

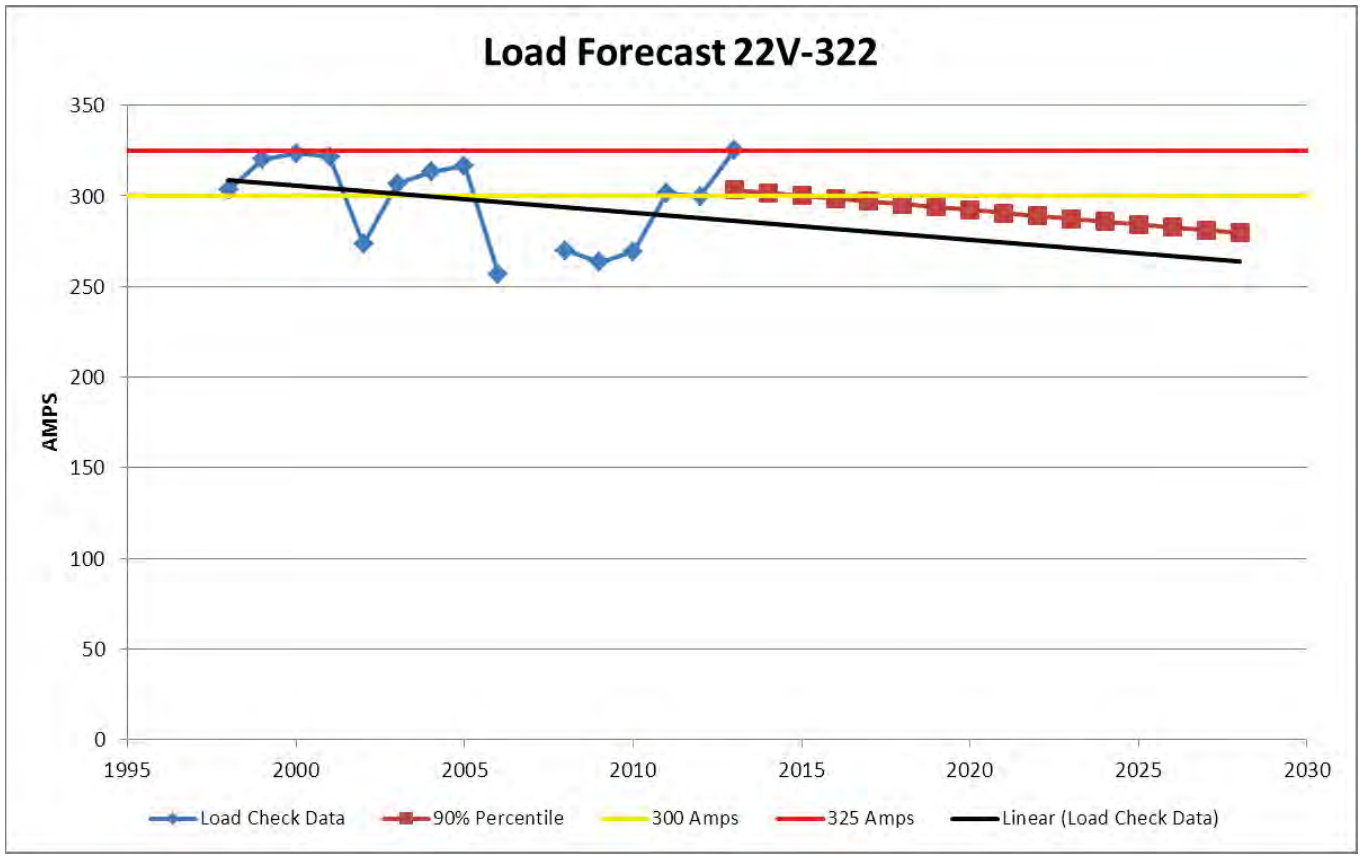


Figure 35 22V-322 Load Forecast

Appendix B: Load History and Forecast

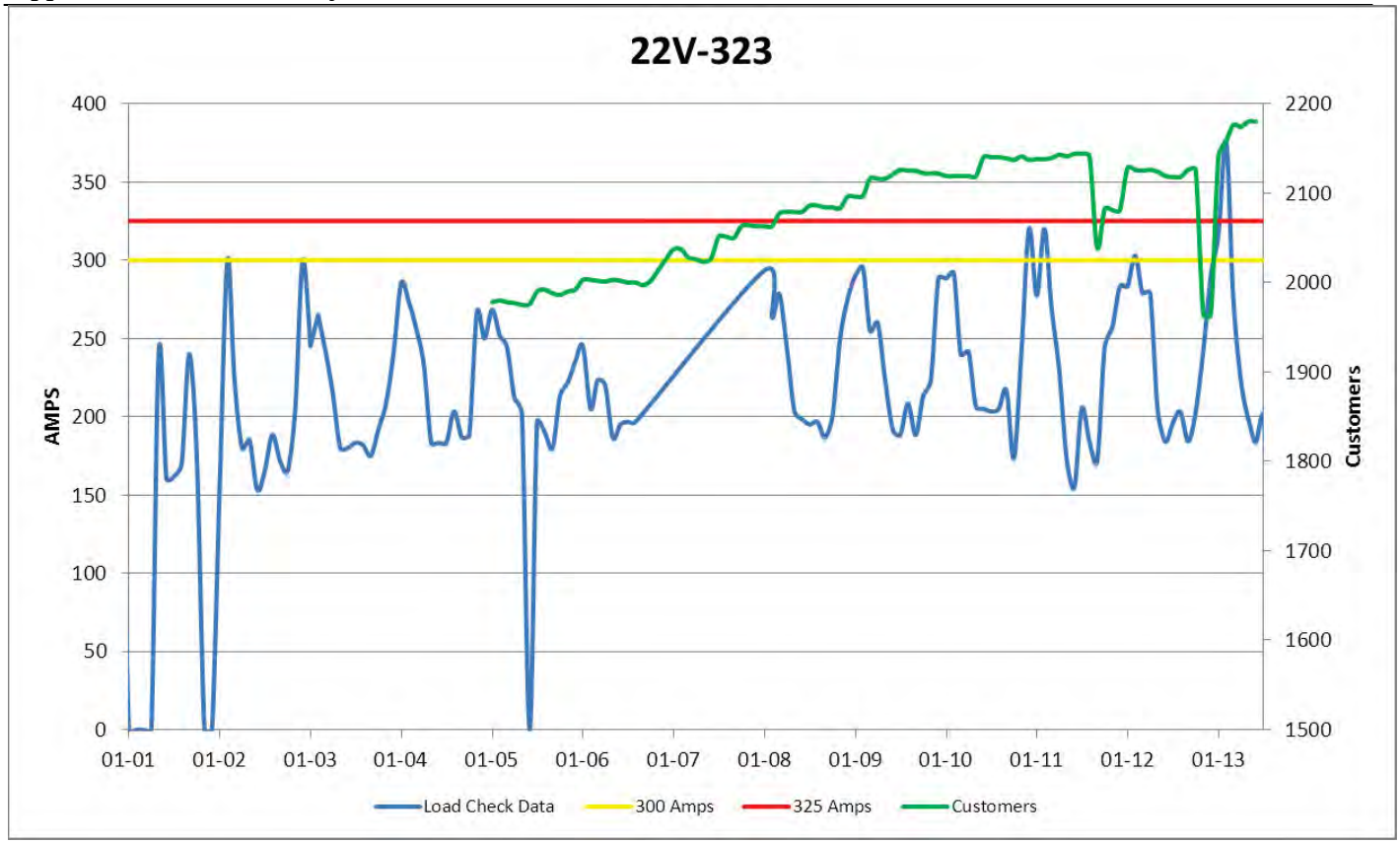


Figure 36 22V-323 Load History

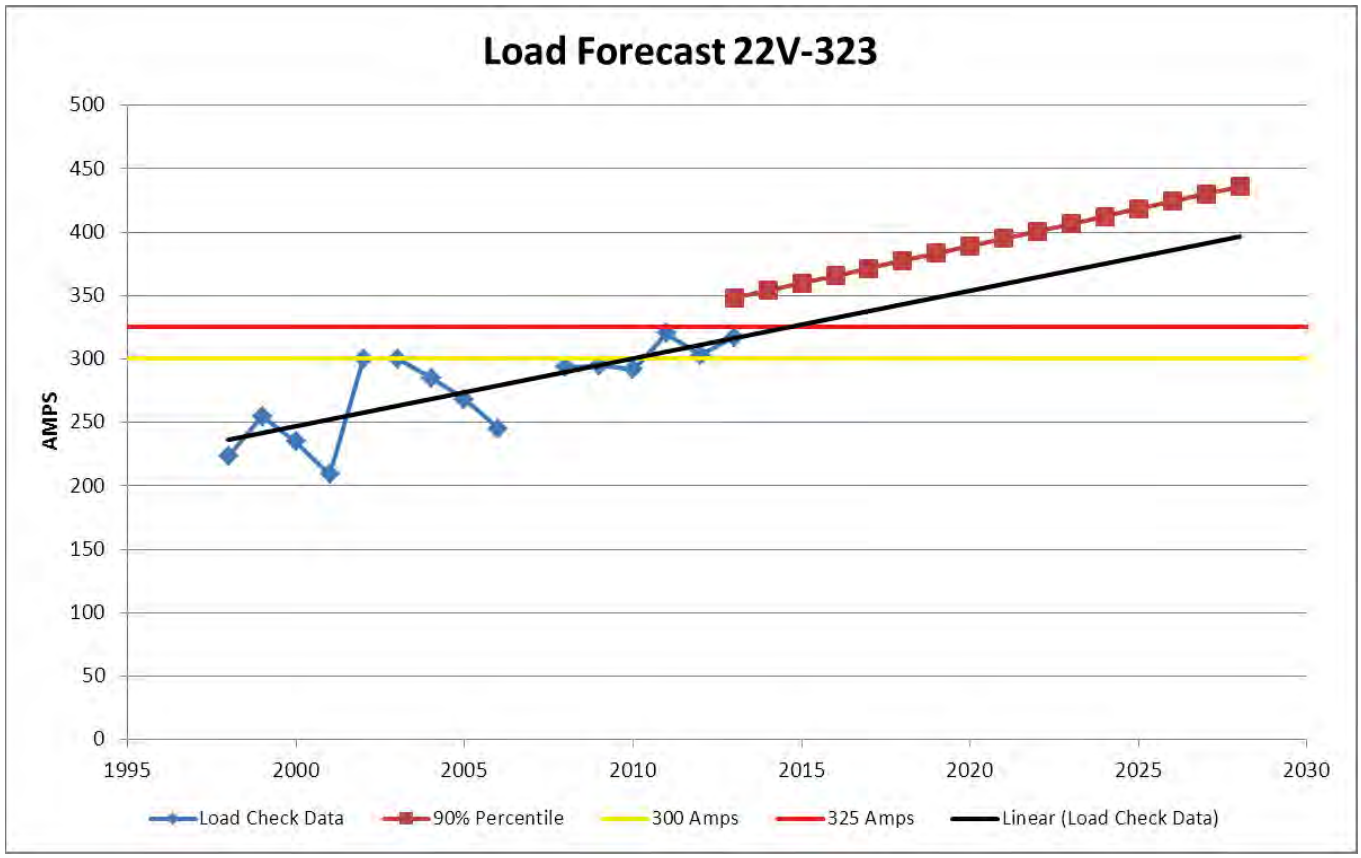


Figure 37 22V-323 Load Forecast

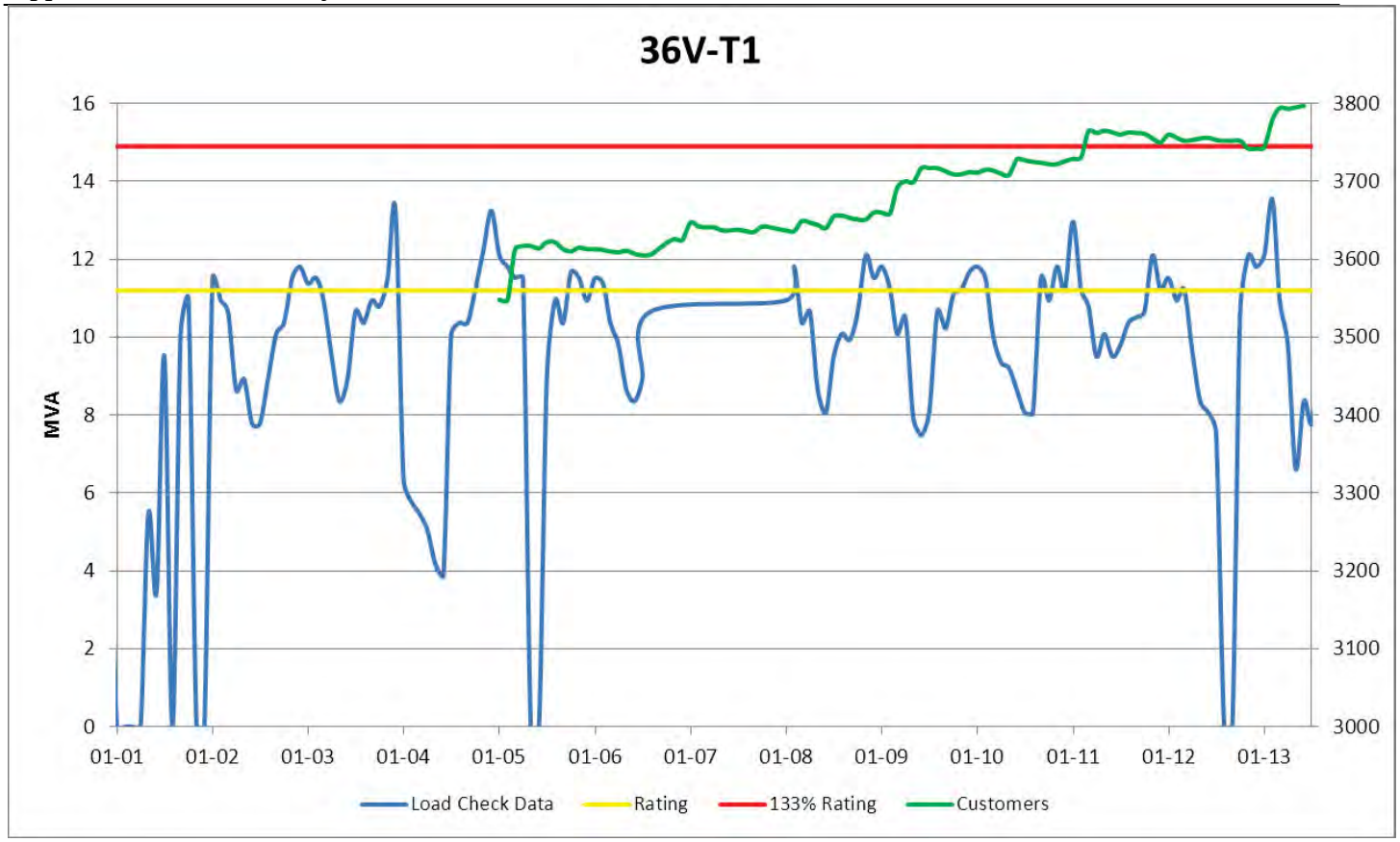


Figure 38 36V-T1 Load History

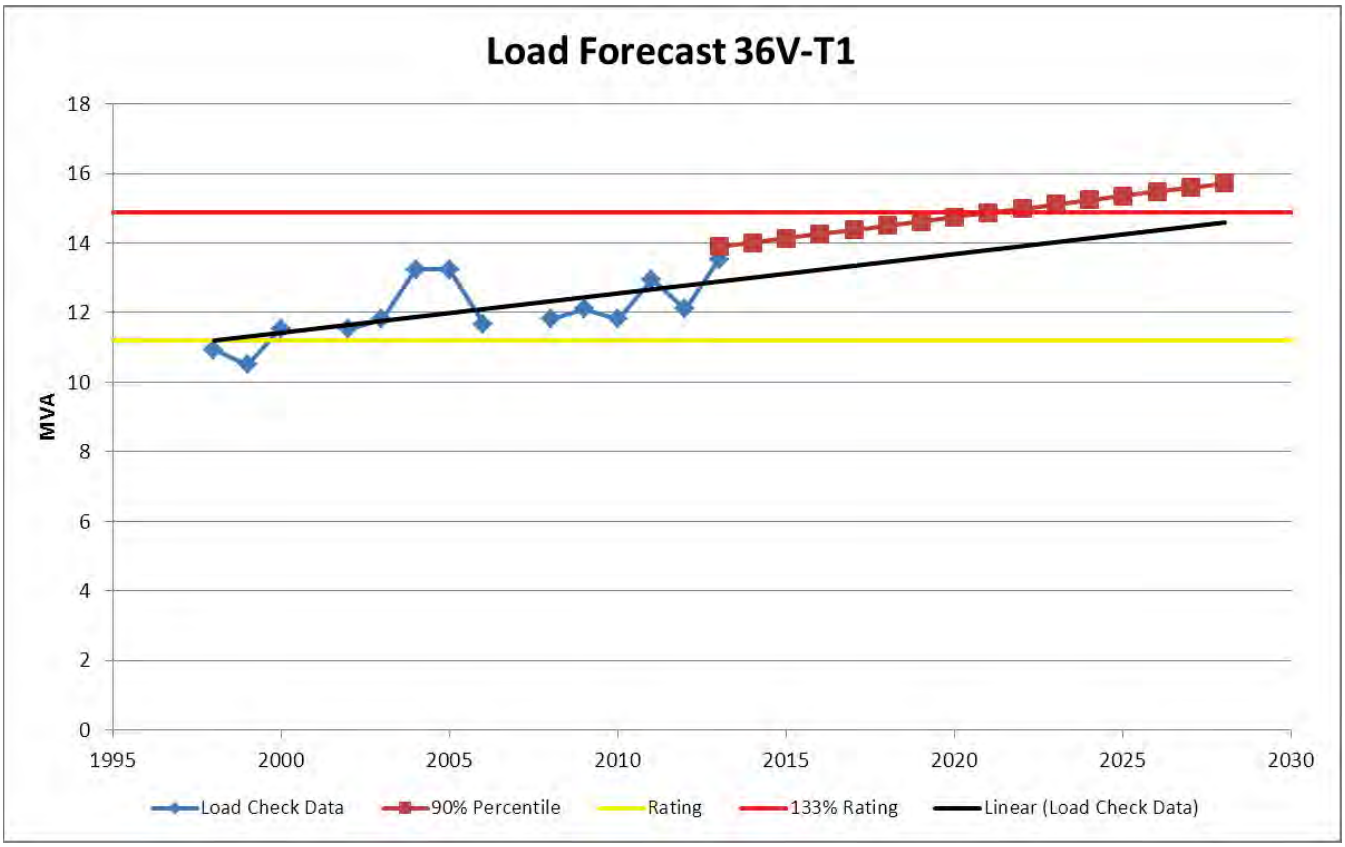


Figure 39 36V-T1 Load Forecast

Appendix B: Load History and Forecast

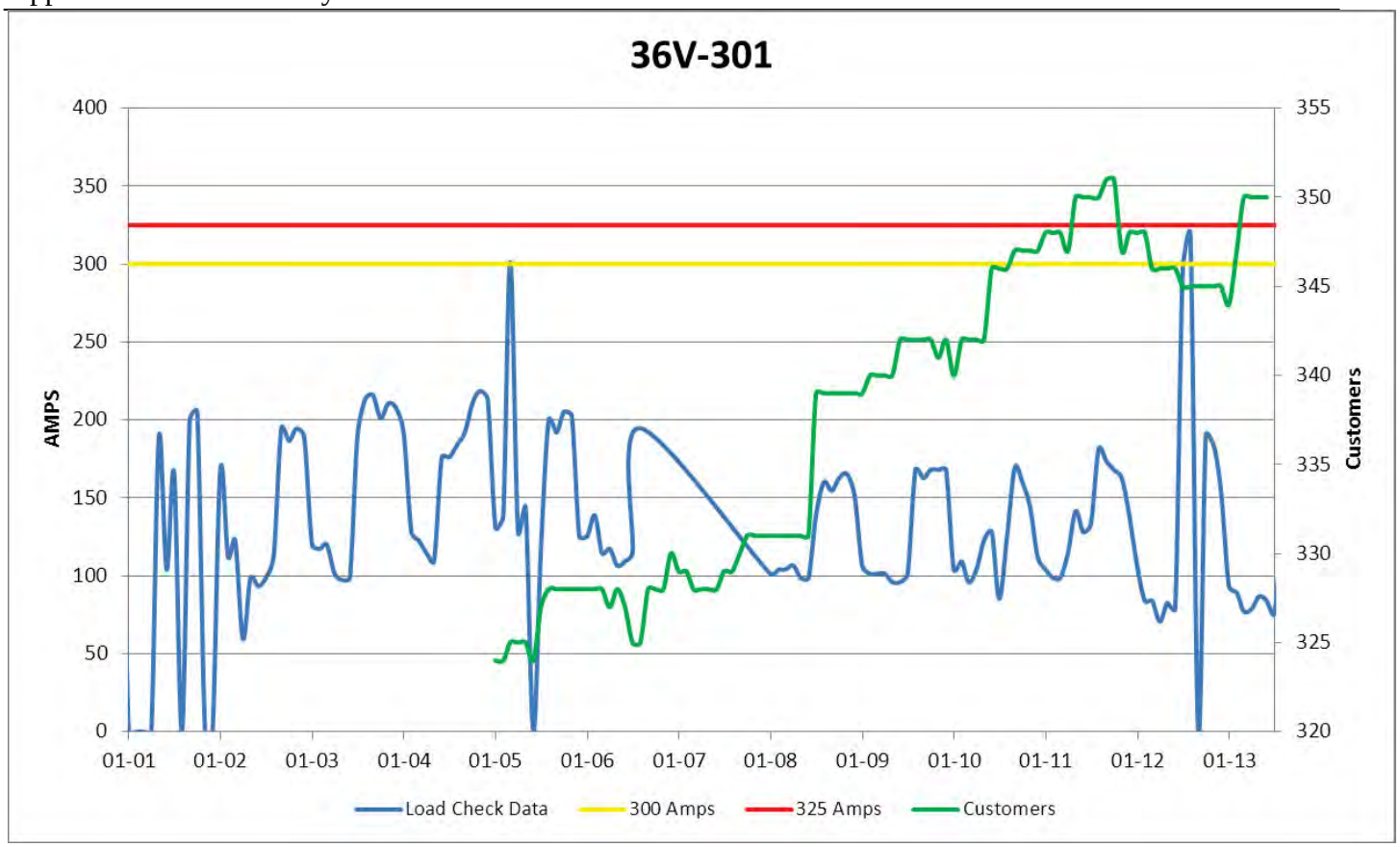


Figure 40 36V-301 Load History

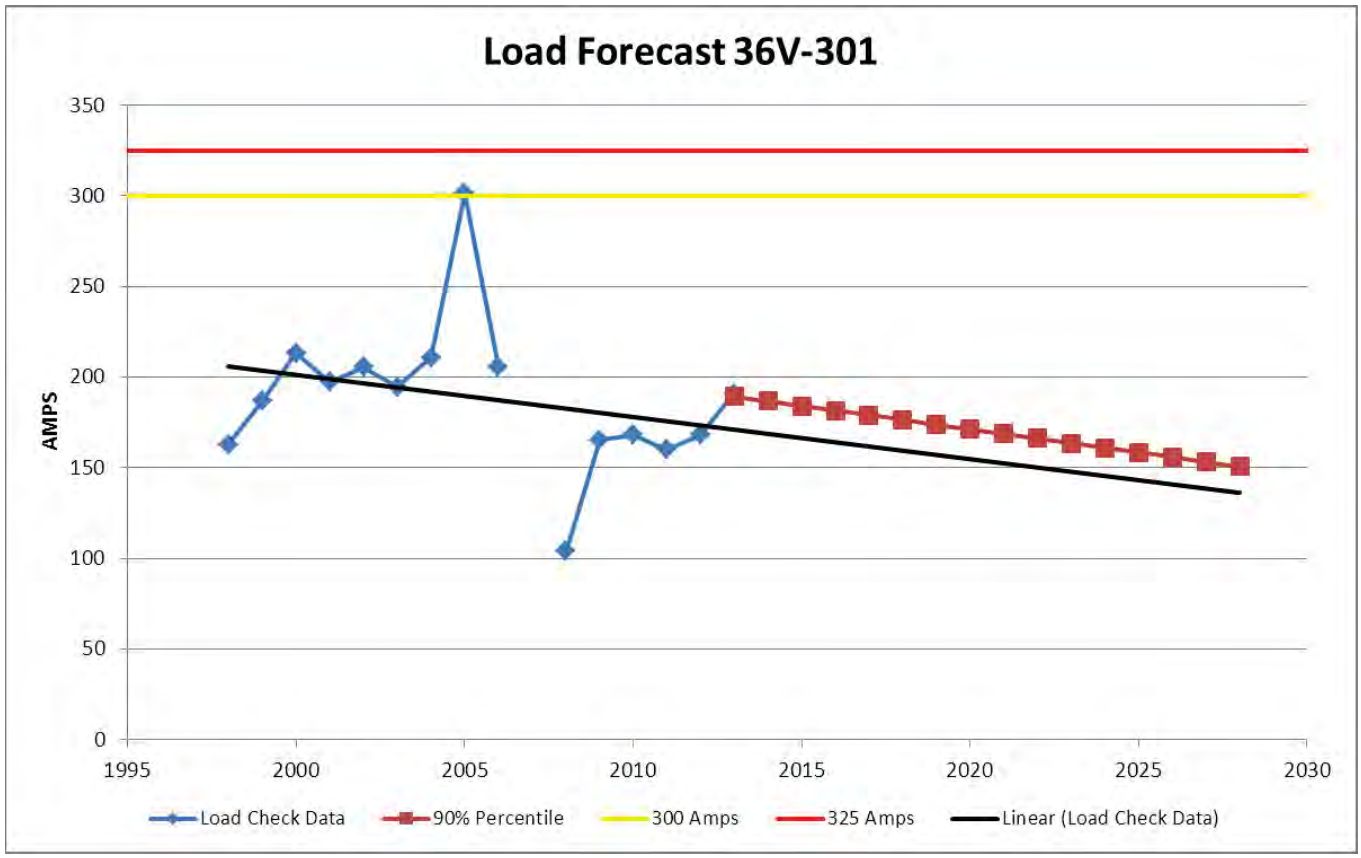


Figure 41 36V-301 Load Forecast

Appendix B: Load History and Forecast

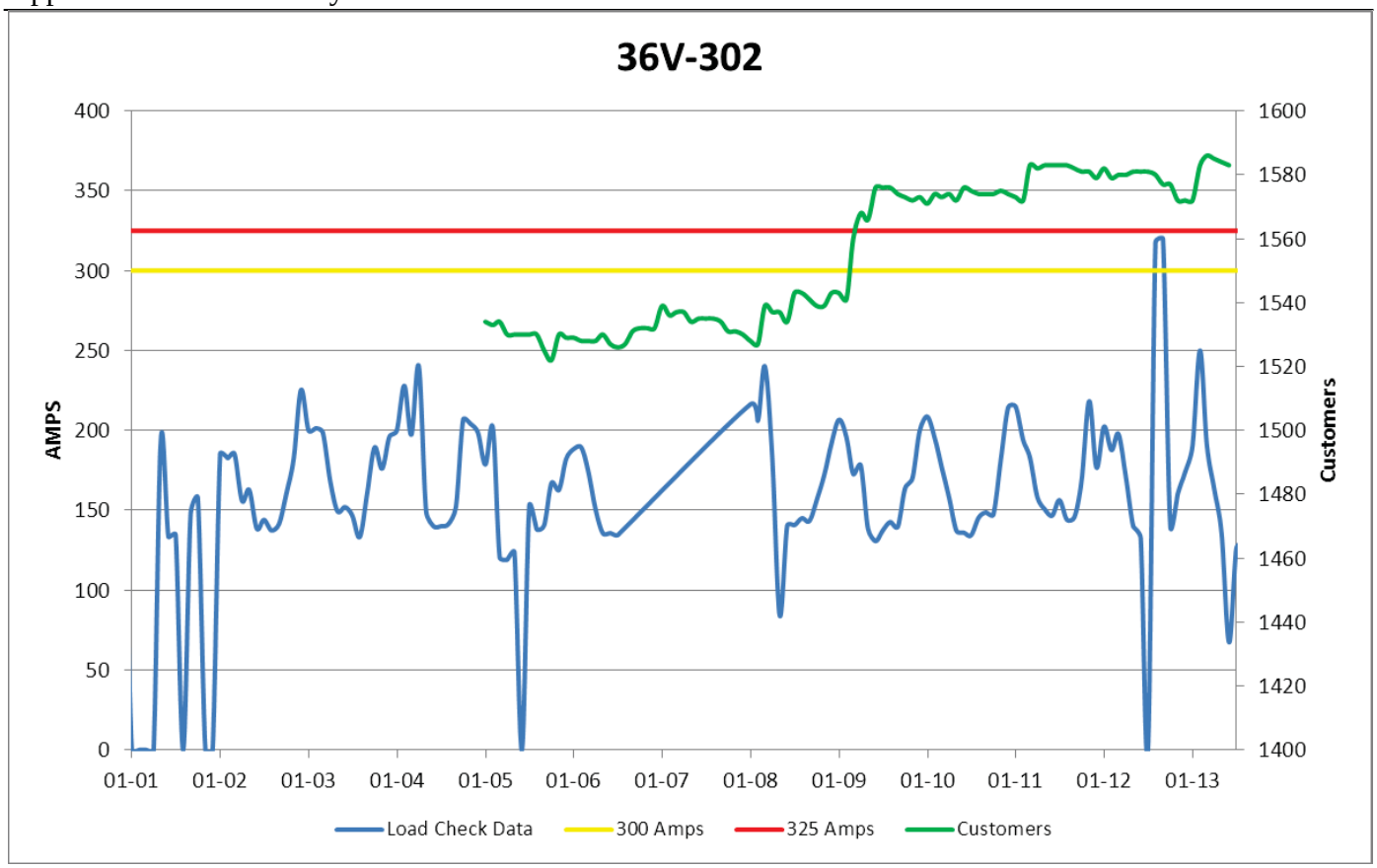


Figure 42 36V-302 Load History

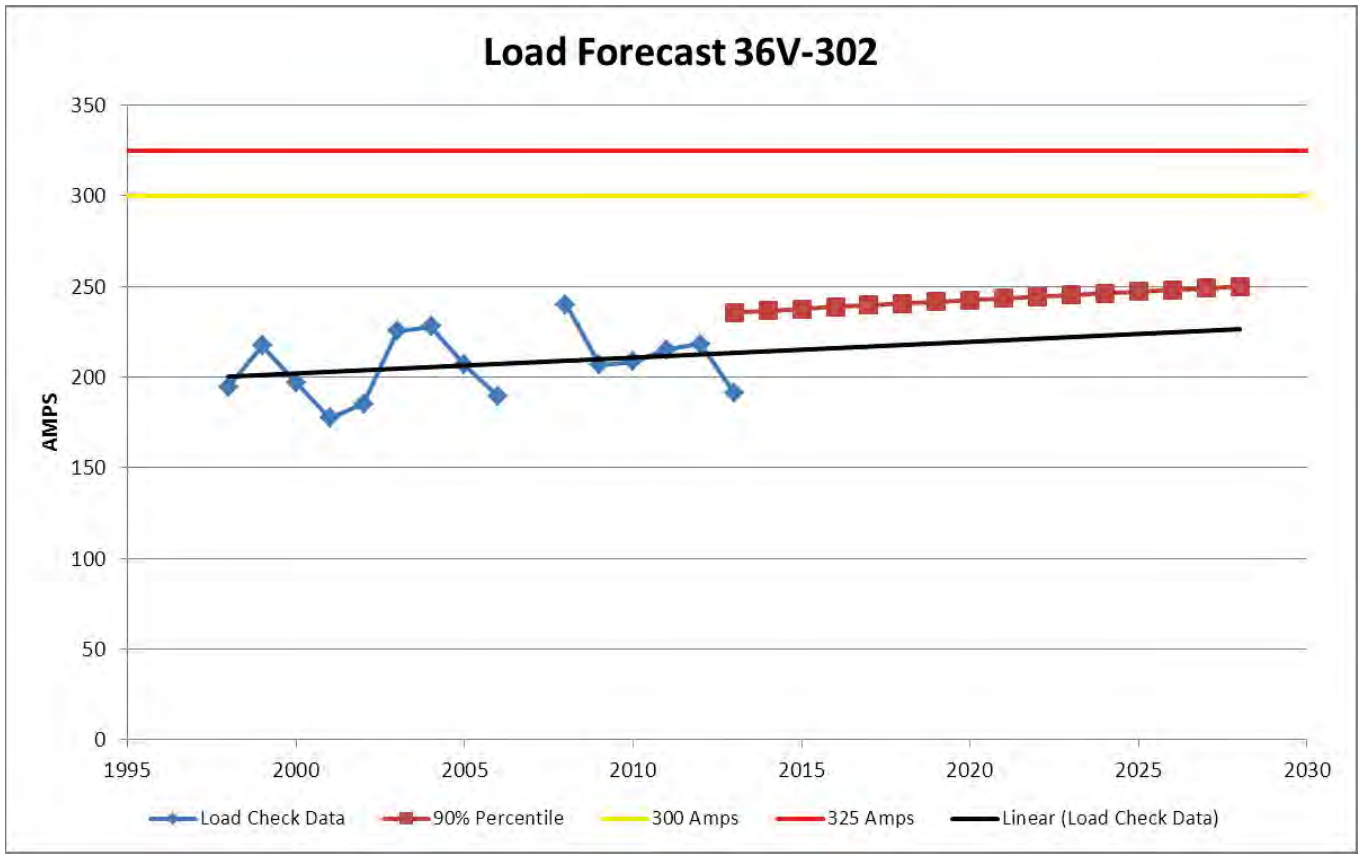


Figure 43 36V-302 Load Forecast

Appendix B: Load History and Forecast

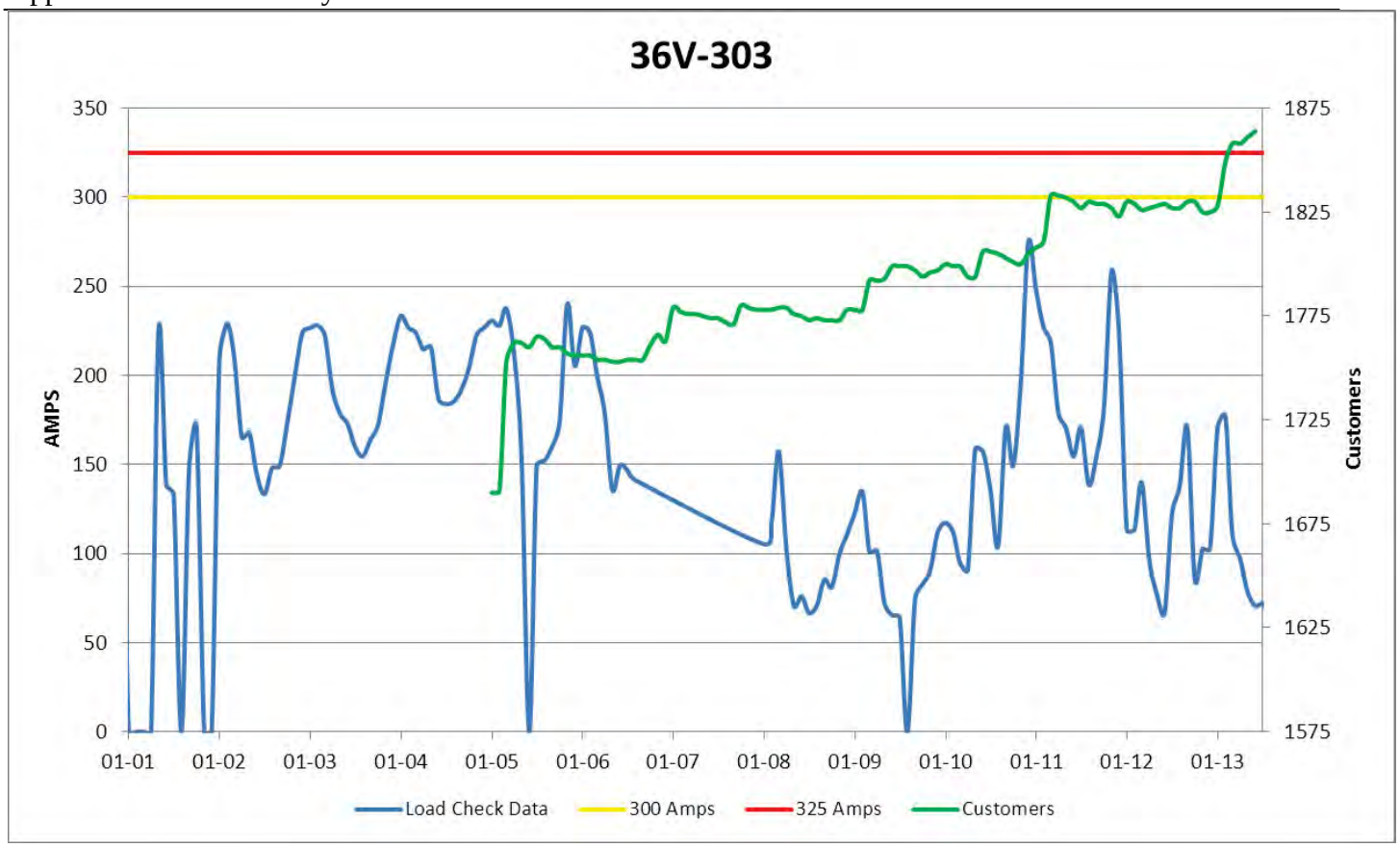


Figure 44 36V-303 Load History

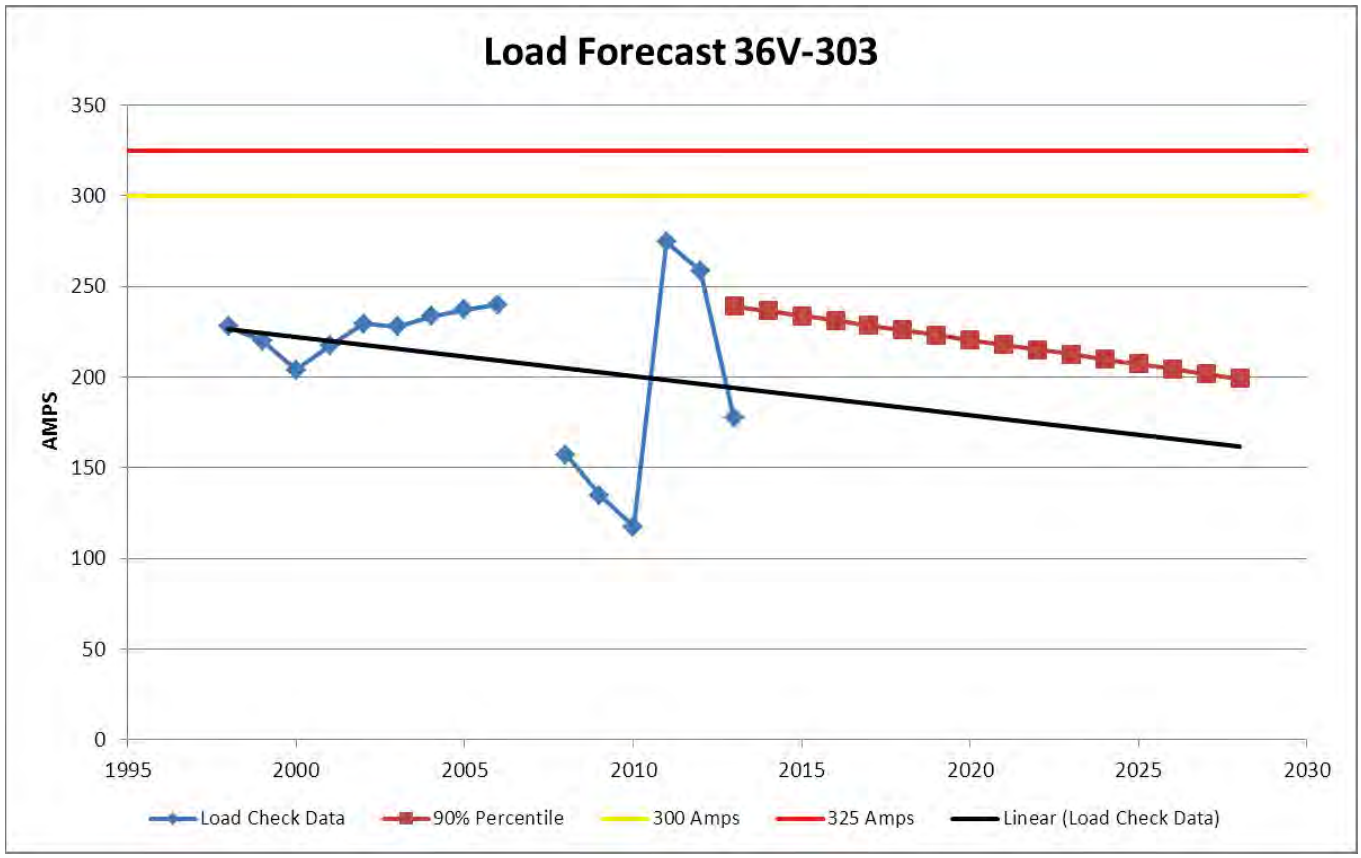


Figure 45 36V-303 Load Forecast

Appendix B: Load History and Forecast

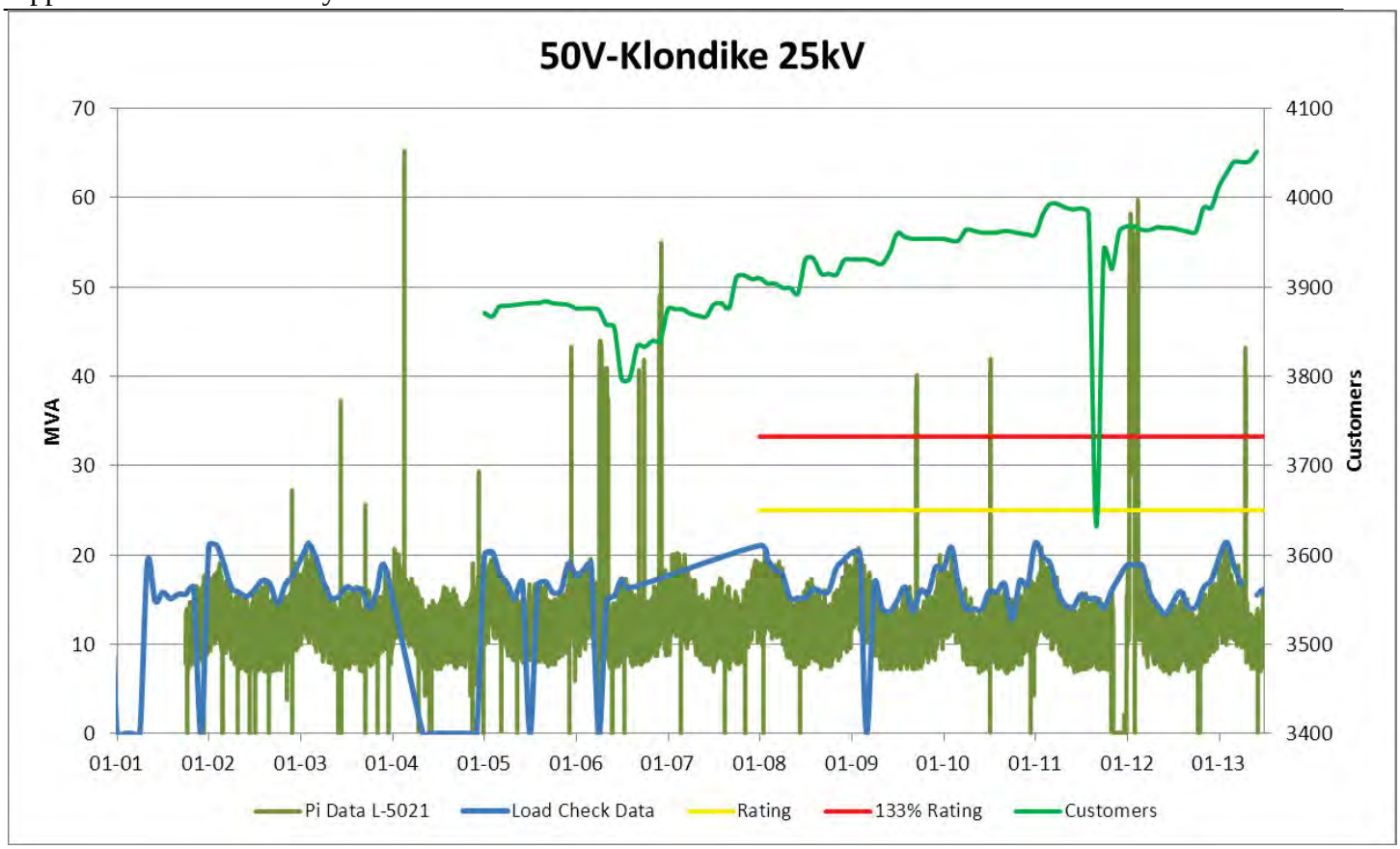


Figure 46 50V-Klondike Load History

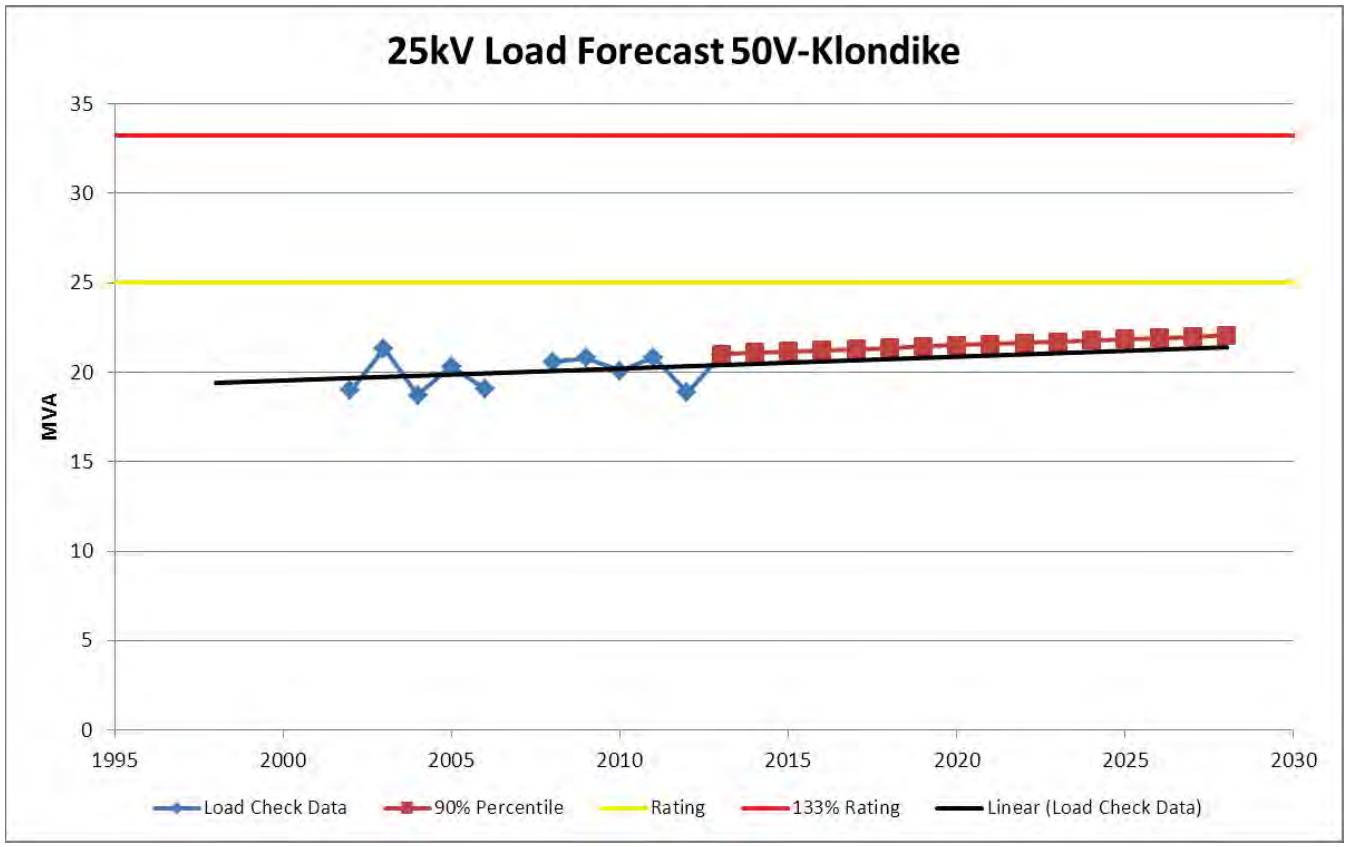


Figure 47 50V-Klondike Load Forecast

Appendix B: Load History and Forecast

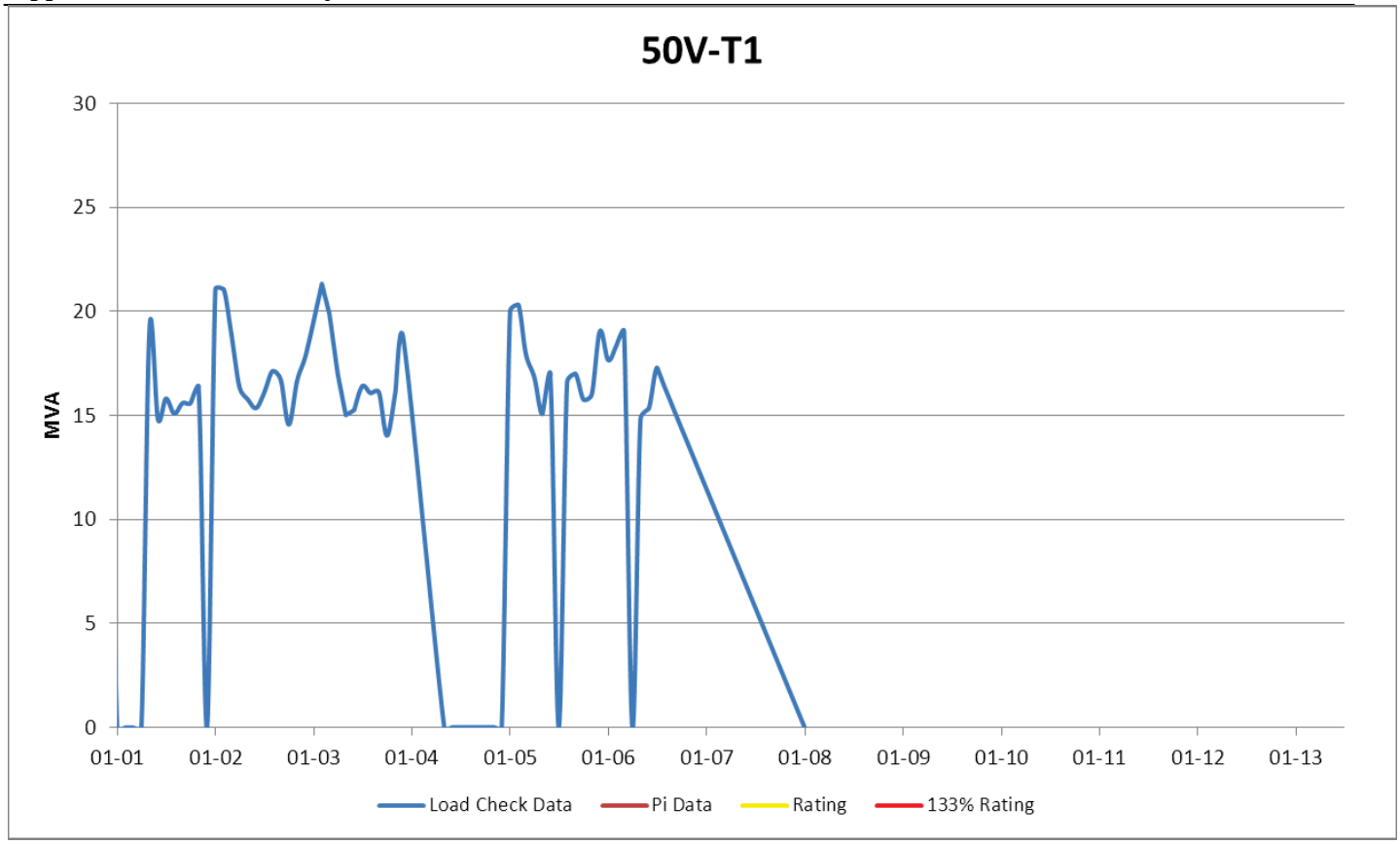


Figure 48 50V-T1 Load History

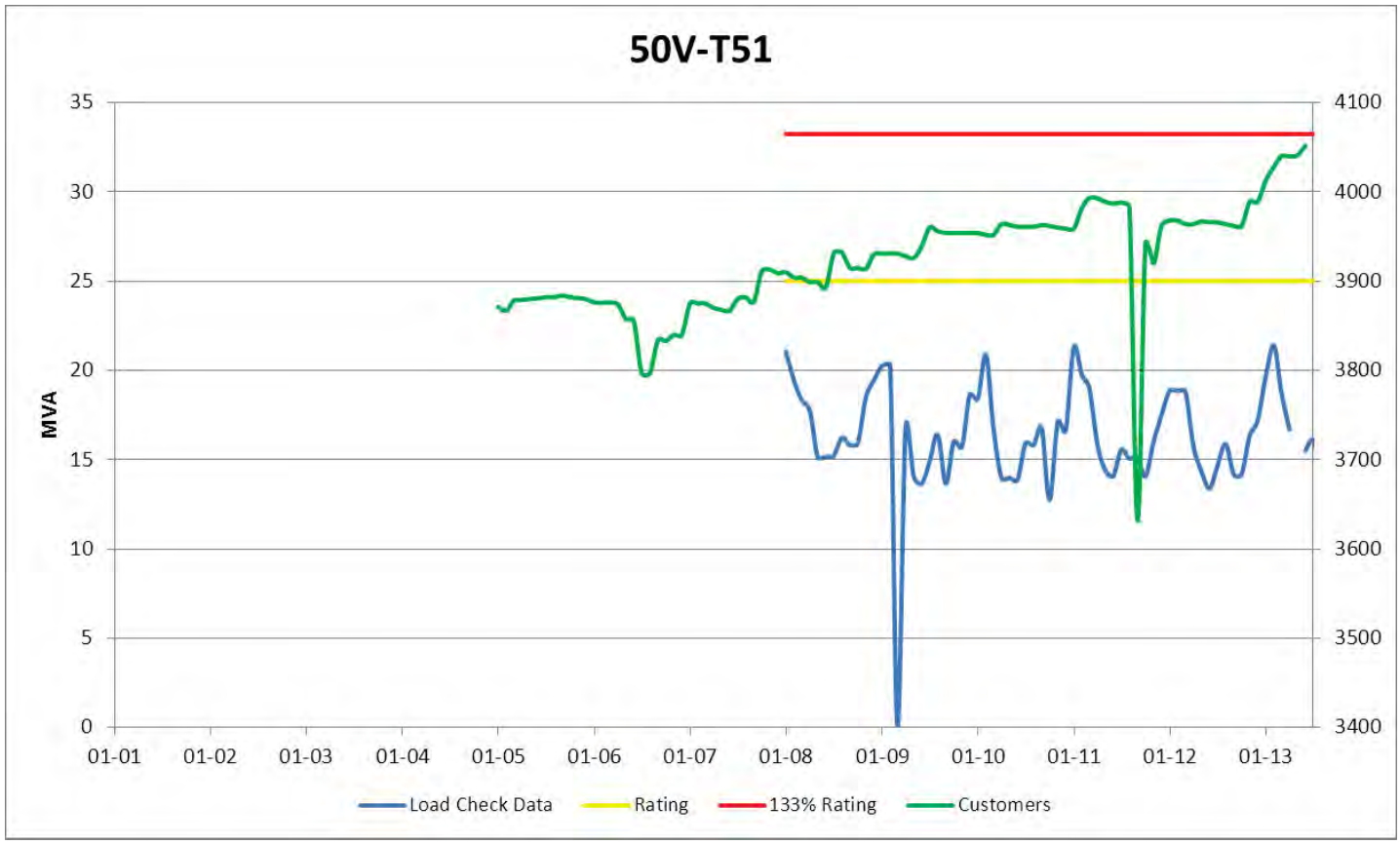


Figure 49 50V-T51 Load History

Appendix B: Load History and Forecast

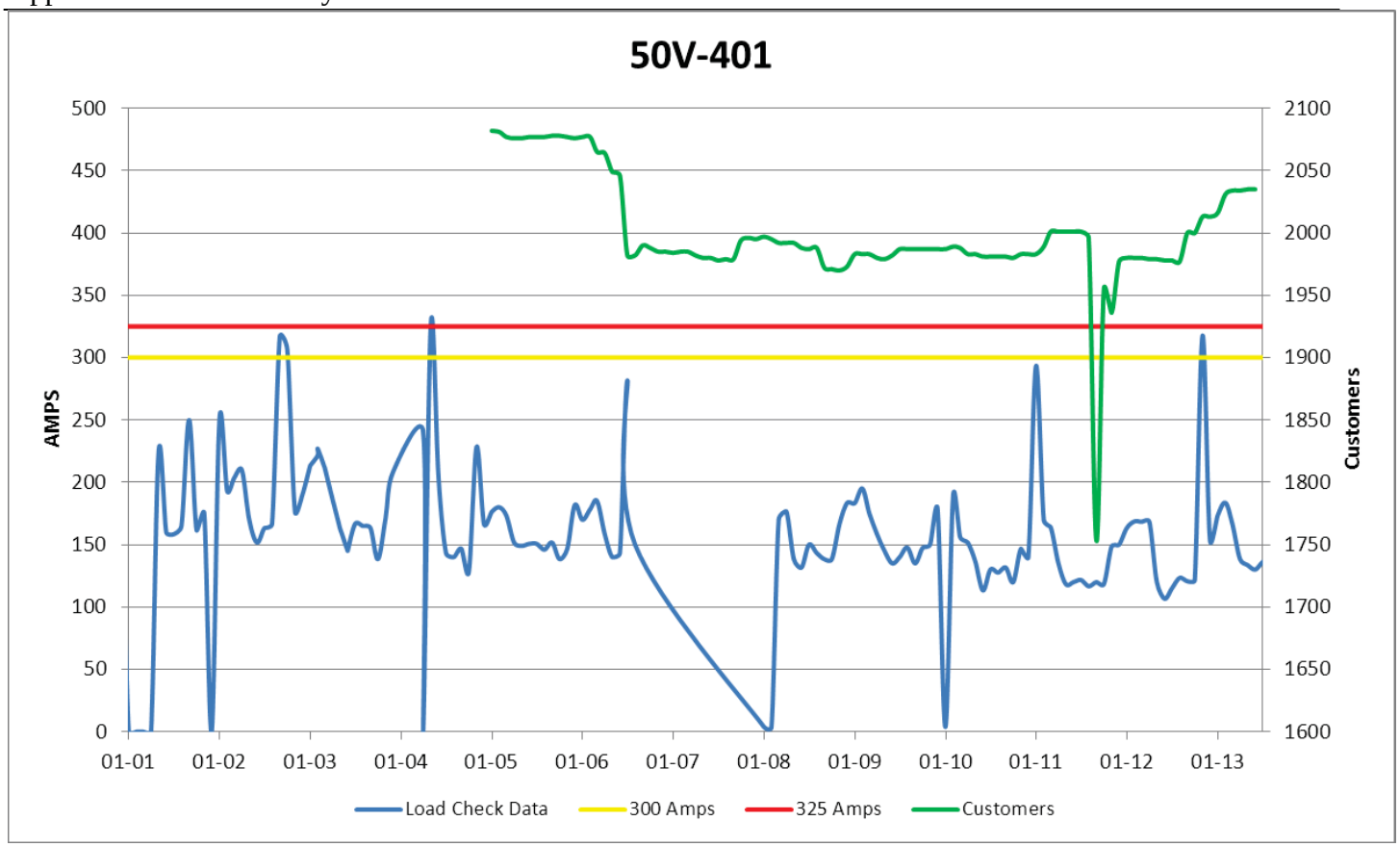


Figure 50 50V-401 Load History

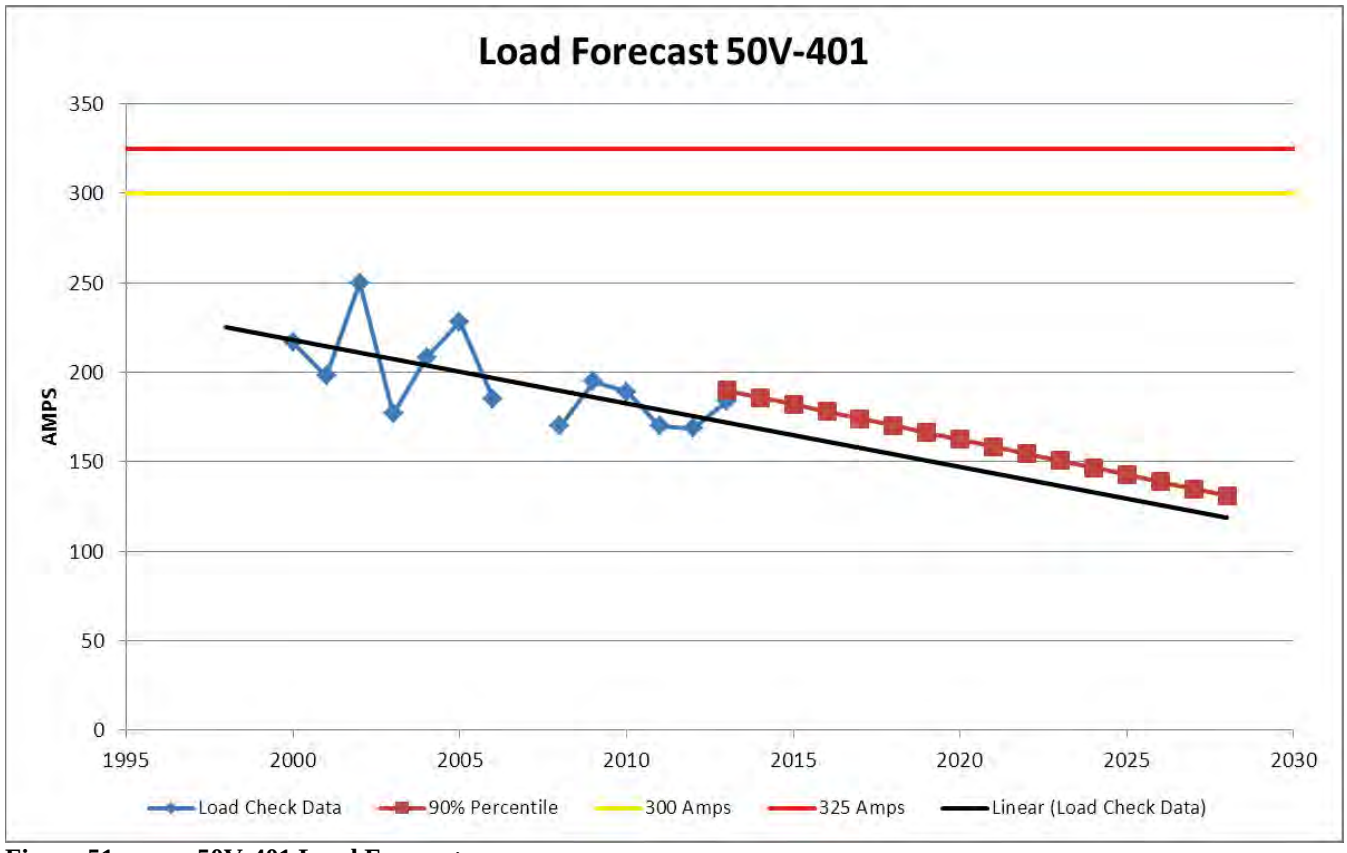


Figure 51 50V-401 Load Forecast

Appendix B: Load History and Forecast

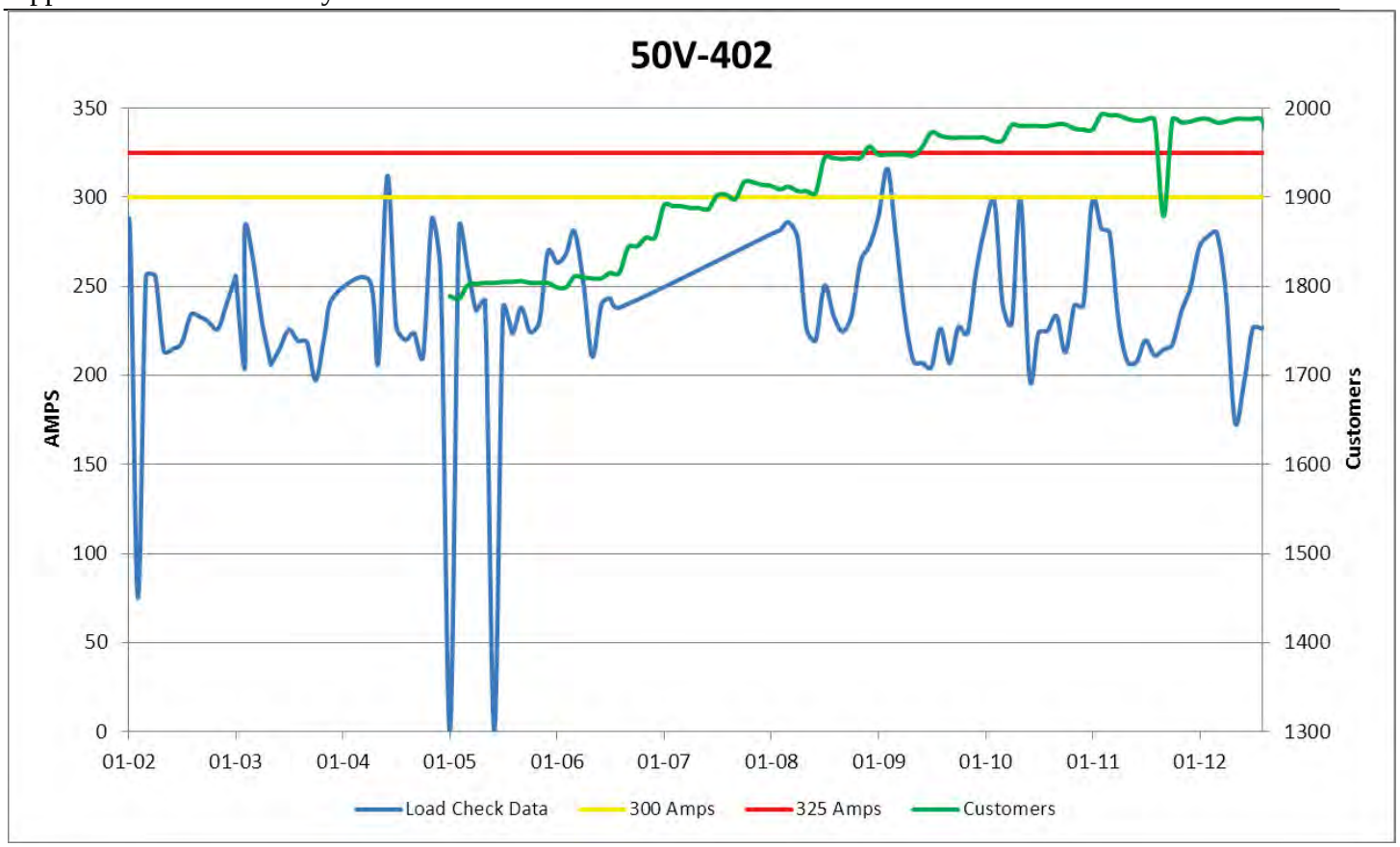


Figure 52 50V-402 Load History

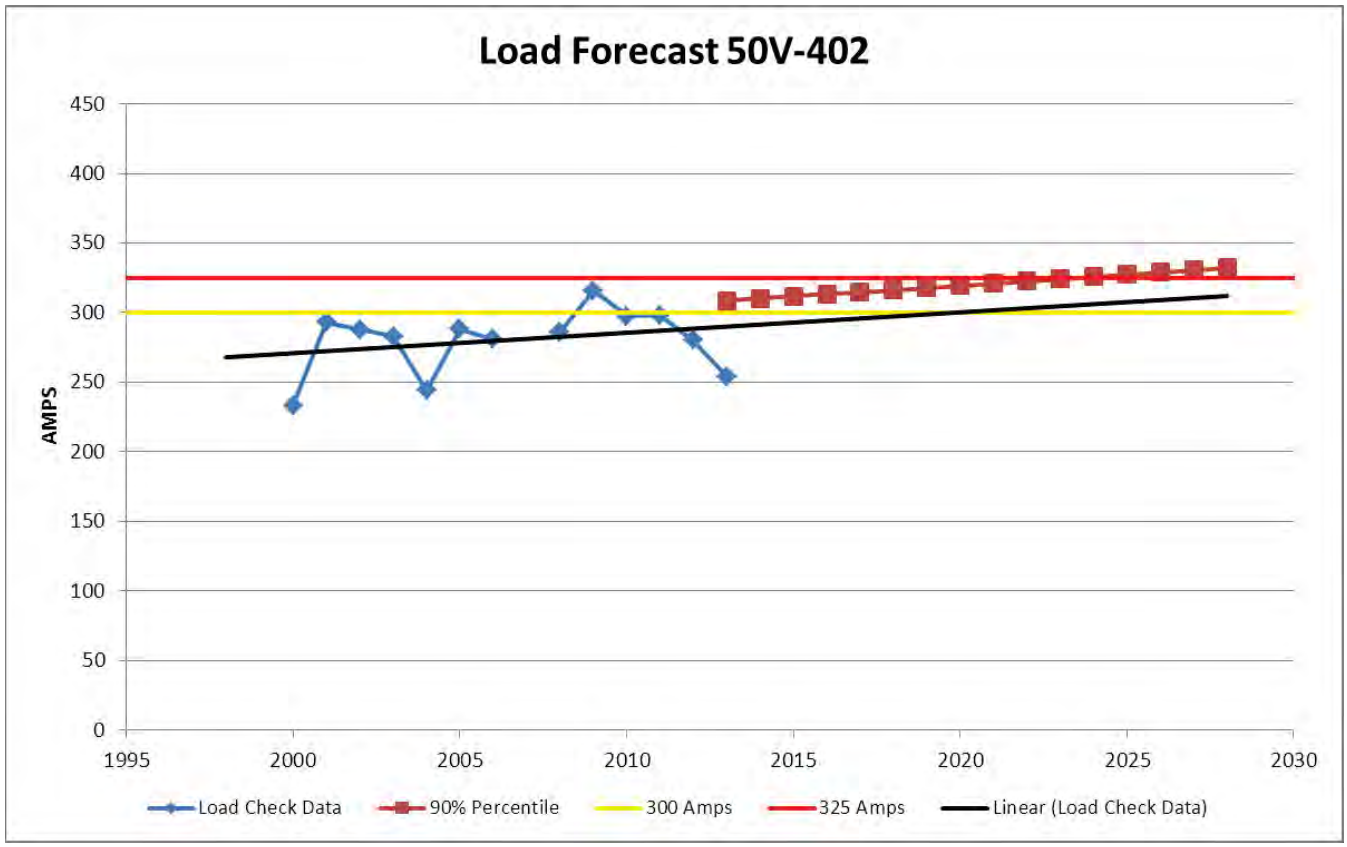


Figure 53 50V-402 Load Forecast

APPENDIX C

Economic Analysis

Summary of Alternatives

99V-Highbury Road
Summary of Alternatives

Division :	Distribution Planning	**Date :**	17-May-13
Department :	Planning and Performance	**CI Number:**	
Originator :	James MacQueen	**Project No. :**	

	Alternative	After Tax WACC	PV of EVA / NPV	Rank	IRR	Disc Pay
A	Replacement of 36V-Hilaton	6.48%	-1,282,883	3	-7.62%	0.0 years
B	Reconfiguration of 36V-Hilaton and 22V-New Minas Feeders	6.48%	-481,726	1	-7.52%	0.0 years
C	Reconfiguration of 36V-Hilaton with Load transfer to 50V-Klon	6.48%	-1,282,395	2	-7.83%	0.0 years
	0	NA	NA	NA	#NUM!	0.0 years

Recommendation :

This Economic Assessment Model recommends the reconfiguration of 22V-New Minas and 36V-Hilaton feeders.

Notes/Comments :

Replacement of 36V-Hilaton

This alternative will see the replcament of 36V-Hilaton. This will include:
- Replacement of 36V-T1 with a 10/12/15MVA transformer
- Creation of 4th feeder, at 36V-Hilaton
- Reconfiguration of 36V-Hilaton feeders

Reconfiguration of 36V-Hilaton and 22V-New Minas Feeders

This alternative will include:
- Creation of new express feeder from 99V-Highbury Road to Blecher Street
- Reconfiguration of existing feeders north of Cornwallis River

Reconfiguration of 36V-Hilaton with Load transfer to 50V-Klondoke

This alternative will see include:
- The addition of 25-12kV stepdowns
- Conversion of existing 4kV stepdowns

0

2013 EAM Rev-2.xls 5/17/2013

NPV Comparison

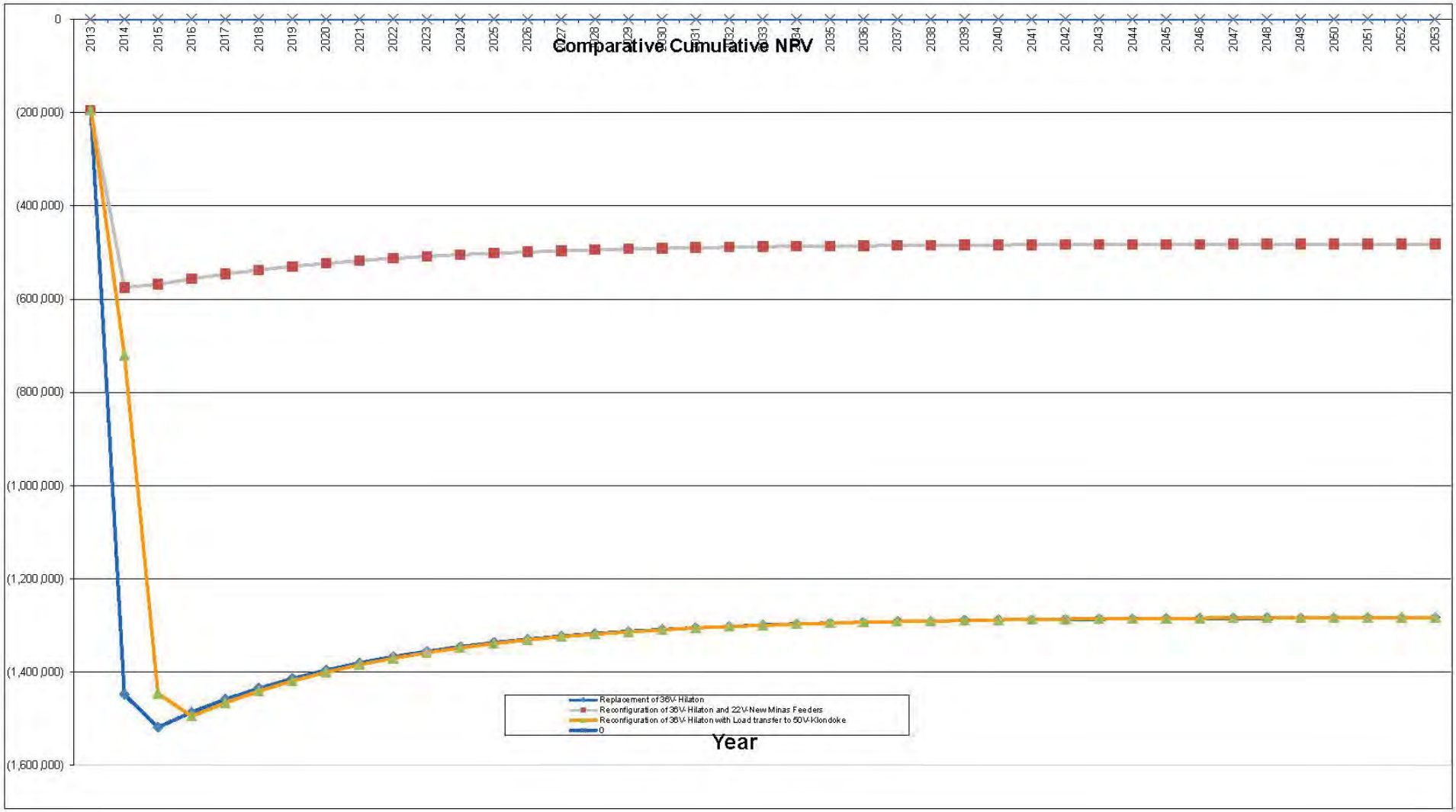


Figure 54 Economic Assessment Model NPV

Alternative 1- Replace 36V-T1

Table 7 Alternative 1- Replace 36V-T1

99V-Highbury Road
Replacement of 36V-Hilaton

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	(195,000.0)	-	-	(195,000.0)	-	(195,000.0)	(195,000.000)	1.0	(195,000.0)
2014	-	-	#########	-	-	##########	-	(1,334,000.0)	(1,252,817.431)	0.9	(1,447,817.4)
2015	-	-	(100,000.0)	65,160.0	1,563,840.0	(100,000.0)	20,199.6	(79,800.4)	(70,383.196)	0.9	(1,518,200.6)
2016	-	-	-	125,107.2	1,438,732.8	-	38,783.2	38,783.2	32,124.758	0.8	(1,486,075.9)
2017	-	-	-	115,098.6	1,323,634.2	-	35,680.6	35,680.6	27,756.177	0.8	(1,458,319.7)
2018	-	-	-	105,890.7	1,217,743.4	-	32,826.1	32,826.1	23,981.671	0.7	(1,434,338.0)
2019	-	-	-	97,419.5	1,120,324.0	-	30,200.0	30,200.0	20,720.452	0.7	(1,413,617.6)
2020	-	-	-	89,625.9	1,030,698.0	-	27,784.0	27,784.0	17,902.720	0.6	(1,395,714.8)
2021	-	-	-	82,455.8	948,242.2	-	25,561.3	25,561.3	15,468.165	0.6	(1,380,246.7)
2022	-	-	-	75,859.4	872,382.8	-	23,516.4	23,516.4	13,364.680	0.6	(1,366,882.0)
2023	-	-	-	69,790.6	802,592.2	-	21,635.1	21,635.1	11,547.245	0.5	(1,355,334.8)
2024	-	-	-	64,207.4	738,384.8	-	19,904.3	19,904.3	9,976.958	0.5	(1,345,357.8)
2025	-	-	-	59,070.8	679,314.0	-	18,311.9	18,311.9	8,620.212	0.5	(1,336,737.6)
2026	-	-	-	54,345.1	624,968.9	-	16,847.0	16,847.0	7,447.967	0.4	(1,329,289.6)
2027	-	-	-	49,997.5	574,971.4	-	15,499.2	15,499.2	6,435.133	0.4	(1,322,854.5)
2028	-	-	-	45,997.7	528,973.7	-	14,259.3	14,259.3	5,560.032	0.4	(1,317,294.5)
2029	-	-	-	42,317.9	486,655.8	-	13,118.5	13,118.5	4,803.934	0.4	(1,312,490.5)
2030	-	-	-	38,932.5	447,723.3	-	12,069.1	12,069.1	4,150.657	0.3	(1,308,339.9)
2031	-	-	-	35,817.9	411,905.5	-	11,103.5	11,103.5	3,586.218	0.3	(1,304,753.6)
2032	-	-	-	32,952.4	378,953.0	-	10,215.3	10,215.3	3,098.535	0.3	(1,301,655.1)
2033	-	-	-	30,316.2	348,636.8	-	9,398.0	9,398.0	2,677.172	0.3	(1,298,977.9)
2034	-	-	-	27,890.9	320,745.8	-	8,646.2	8,646.2	2,313.108	0.3	(1,296,664.8)
2035	-	-	-	25,659.7	295,086.2	-	7,954.5	7,954.5	1,998.554	0.3	(1,294,666.3)
2036	-	-	-	23,606.9	271,479.3	-	7,318.1	7,318.1	1,726.774	0.2	(1,292,939.5)
2037	-	-	-	21,718.3	249,760.9	-	6,732.7	6,732.7	1,491.954	0.2	(1,291,447.6)
2038	-	-	-	19,980.9	229,780.1	-	6,194.1	6,194.1	1,289.066	0.2	(1,290,158.5)
2039	-	-	-	18,382.4	211,397.7	-	5,698.5	5,698.5	1,113.768	0.2	(1,289,044.7)
2040	-	-	-	16,911.8	194,485.8	-	5,242.7	5,242.7	962.309	0.2	(1,288,082.4)
2041	-	-	-	15,558.9	178,927.0	-	4,823.2	4,823.2	831.447	0.2	(1,287,251.0)
2042	-	-	-	14,314.2	164,612.8	-	4,437.4	4,437.4	718.380	0.2	(1,286,532.6)
2043	-	-	-	13,169.0	151,443.8	-	4,082.4	4,082.4	620.689	0.2	(1,285,911.9)
2044	-	-	-	12,115.5	139,328.3	-	3,755.8	3,755.8	536.283	0.1	(1,285,375.6)
2045	-	-	-	11,146.3	128,182.0	-	3,455.3	3,455.3	463.355	0.1	(1,284,912.3)
2046	-	-	-	10,254.6	117,927.5	-	3,178.9	3,178.9	400.344	0.1	(1,284,511.9)
2047	-	-	-	9,434.2	108,493.3	-	2,924.6	2,924.6	345.902	0.1	(1,284,166.0)
2048	-	-	-	8,679.5	99,813.8	-	2,690.6	2,690.6	298.864	0.1	(1,283,867.1)
2049	-	-	-	7,985.1	91,828.7	-	2,475.4	2,475.4	258.222	0.1	(1,283,608.9)
2050	-	-	-	7,346.3	84,482.4	-	2,277.4	2,277.4	223.107	0.1	(1,283,385.8)
2051	-	-	-	6,758.6	77,723.8	-	2,095.2	2,095.2	192.767	0.1	(1,283,193.0)
2052	-	-	-	6,217.9	71,505.9	-	1,927.6	1,927.6	166.553	0.1	(1,283,026.5)
2053	-	-	-	5,720.5	65,785.4	-	1,773.3	1,773.3	143.904	0.1	(1,282,882.6)
Total	-	-	#########	1,563,214.6		##########	484,596.5	(1,144,403.5)	(1,282,882.6)		

Alternative 2- 99V-Highbury, 22V-New Minas, and 36V-Hillaton Load Transfers

Table 8 Alternative 2- 12kV Load Transfers

99V-Highbury Road
Reconfiguration of 36V-Hilaton and 22V-New Minas Feeders

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	(195,000.0)	-	-	(195,000.0)	-	(195,000.0)	(195,000.000)	1.0	(195,000.0)
2014	-	-	(404,500.0)	-	-	(404,500.0)	-	(404,500.0)	(379,883.546)	0.9	(574,883.5)
2015	-	-	-	23,980.0	599,500.0	-	7,433.8	7,433.8	6,556.541	0.9	(568,327.0)
2016	-	-	-	46,041.6	529,478.4	-	14,272.9	14,272.9	11,822.463	0.8	(556,504.5)
2017	-	-	-	42,358.3	487,120.1	-	13,131.1	13,131.1	10,214.750	0.8	(546,289.8)
2018	-	-	-	38,969.6	448,150.5	-	12,080.6	12,080.6	8,825.667	0.7	(537,464.1)
2019	-	-	-	35,852.0	412,298.5	-	11,114.1	11,114.1	7,625.482	0.7	(529,838.6)
2020	-	-	-	32,983.9	379,314.6	-	10,225.0	10,225.0	6,588.509	0.6	(523,250.1)
2021	-	-	-	30,345.2	348,969.4	-	9,407.0	9,407.0	5,692.551	0.6	(517,557.6)
2022	-	-	-	27,917.6	321,051.9	-	8,654.4	8,654.4	4,918.432	0.6	(512,639.2)
2023	-	-	-	25,684.2	295,367.7	-	7,962.1	7,962.1	4,249.584	0.5	(508,389.6)
2024	-	-	-	23,629.4	271,738.3	-	7,325.1	7,325.1	3,671.692	0.5	(504,717.9)
2025	-	-	-	21,739.1	249,999.2	-	6,739.1	6,739.1	3,172.386	0.5	(501,545.5)
2026	-	-	-	19,999.9	229,999.3	-	6,200.0	6,200.0	2,740.980	0.4	(498,804.5)
2027	-	-	-	18,399.9	211,599.4	-	5,704.0	5,704.0	2,368.239	0.4	(496,436.3)
2028	-	-	-	16,927.9	194,671.4	-	5,247.7	5,247.7	2,046.187	0.4	(494,390.1)
2029	-	-	-	15,573.7	179,097.7	-	4,827.9	4,827.9	1,767.930	0.4	(492,622.2)
2030	-	-	-	14,327.8	164,769.9	-	4,441.6	4,441.6	1,527.513	0.3	(491,094.6)
2031	-	-	-	13,181.6	151,588.3	-	4,086.3	4,086.3	1,319.790	0.3	(489,774.8)
2032	-	-	-	12,127.1	139,461.2	-	3,759.4	3,759.4	1,140.314	0.3	(488,634.5)
2033	-	-	-	11,156.9	128,304.3	-	3,458.6	3,458.6	985.245	0.3	(487,649.3)
2034	-	-	-	10,264.3	118,040.0	-	3,181.9	3,181.9	851.264	0.3	(486,798.0)
2035	-	-	-	9,443.2	108,596.8	-	2,927.4	2,927.4	735.502	0.3	(486,062.5)
2036	-	-	-	8,687.7	99,909.0	-	2,693.2	2,693.2	635.483	0.2	(485,427.0)
2037	-	-	-	7,992.7	91,916.3	-	2,477.7	2,477.7	549.065	0.2	(484,878.0)
2038	-	-	-	7,353.3	84,563.0	-	2,279.5	2,279.5	474.398	0.2	(484,403.6)
2039	-	-	-	6,765.0	77,798.0	-	2,097.2	2,097.2	409.886	0.2	(483,993.7)
2040	-	-	-	6,223.8	71,574.1	-	1,929.4	1,929.4	354.146	0.2	(483,639.5)
2041	-	-	-	5,725.9	65,848.2	-	1,775.0	1,775.0	305.987	0.2	(483,333.6)
2042	-	-	-	5,267.9	60,580.3	-	1,633.0	1,633.0	264.376	0.2	(483,069.2)
2043	-	-	-	4,846.4	55,733.9	-	1,502.4	1,502.4	228.424	0.2	(482,840.8)
2044	-	-	-	4,458.7	51,275.2	-	1,382.2	1,382.2	197.361	0.1	(482,643.4)
2045	-	-	-	4,102.0	47,173.2	-	1,271.6	1,271.6	170.523	0.1	(482,472.9)
2046	-	-	-	3,773.9	43,399.3	-	1,169.9	1,169.9	147.334	0.1	(482,325.5)
2047	-	-	-	3,471.9	39,927.4	-	1,076.3	1,076.3	127.298	0.1	(482,198.2)
2048	-	-	-	3,194.2	36,733.2	-	990.2	990.2	109.987	0.1	(482,088.3)
2049	-	-	-	2,938.7	33,794.5	-	911.0	911.0	95.030	0.1	(481,993.2)
2050	-	-	-	2,703.6	31,091.0	-	838.1	838.1	82.107	0.1	(481,911.1)
2051	-	-	-	2,487.3	28,603.7	-	771.1	771.1	70.942	0.1	(481,840.2)
2052	-	-	-	2,288.3	26,315.4	-	709.4	709.4	61.294	0.1	(481,778.9)
2053	-	-	-	2,105.2	24,210.2	-	652.6	652.6	52.959	0.1	(481,725.9)
Total	-	-	(599,500.0)	575,289.8		(599,500.0)	178,339.8	(421,160.2)	(481,725.9)		

Alternative 3- 50V-Klondike 4kV Conversions, 36V-Hillaton Load Transfers

Table 9 Alternative 3- 50V-Klondike 4kV Conversions, 36V-Hillaton Load Transfers

99V-Highbury Road
Reconfiguration of 36V-Hilaton with Load transfer to 50V-Klondoke

Year	Total Revenue	Operating Costs	Capital	CCA	UCC	CFBT	Applicable Taxes	CFAT	PV of CF	Discount Factor	CNPV
2013	-	-	(195,000.0)	-	-	(195,000.0)	-	(195,000.0)	(195,000.000)	1.0	(195,000.0)
2014	-	-	(559,000.0)	-	-	(559,000.0)	-	(559,000.0)	(524,981.217)	0.9	(719,981.2)
2015	-	-	(842,000.0)	63,840.0	1,596,000.0	(842,000.0)	19,790.4	(822,209.6)	(725,181.069)	0.9	(1,445,162.3)
2016	-	-	(100,000.0)	130,572.8	1,501,587.2	(100,000.0)	40,477.6	(59,522.4)	(49,303.363)	0.8	(1,494,465.6)
2017	-	-	-	120,127.0	1,381,460.2	-	37,239.4	37,239.4	28,968.771	0.8	(1,465,496.9)
2018	-	-	-	110,516.8	1,270,943.4	-	34,260.2	34,260.2	25,029.366	0.7	(1,440,467.5)
2019	-	-	-	101,675.5	1,169,267.9	-	31,519.4	31,519.4	21,625.673	0.7	(1,418,841.8)
2020	-	-	-	93,541.4	1,075,726.5	-	28,997.8	28,997.8	18,684.842	0.6	(1,400,157.0)
2021	-	-	-	86,058.1	989,668.4	-	26,678.0	26,678.0	16,143.928	0.6	(1,384,013.1)
2022	-	-	-	79,173.5	910,494.9	-	24,543.8	24,543.8	13,948.548	0.6	(1,370,064.5)
2023	-	-	-	72,839.6	837,655.3	-	22,580.3	22,580.3	12,051.713	0.5	(1,358,012.8)
2024	-	-	-	67,012.4	770,642.9	-	20,773.9	20,773.9	10,412.825	0.5	(1,347,600.0)
2025	-	-	-	61,651.4	708,991.5	-	19,111.9	19,111.9	8,996.806	0.5	(1,338,603.2)
2026	-	-	-	56,719.3	652,272.1	-	17,583.0	17,583.0	7,773.348	0.4	(1,330,829.8)
2027	-	-	-	52,181.8	600,090.4	-	16,176.3	16,176.3	6,716.266	0.4	(1,324,113.6)
2028	-	-	-	48,007.2	552,083.1	-	14,882.2	14,882.2	5,802.935	0.4	(1,318,310.6)
2029	-	-	-	44,166.7	507,916.5	-	13,691.7	13,691.7	5,013.806	0.4	(1,313,296.8)
2030	-	-	-	40,633.3	467,283.2	-	12,596.3	12,596.3	4,331.988	0.3	(1,308,964.8)
2031	-	-	-	37,382.7	429,900.5	-	11,588.6	11,588.6	3,742.890	0.3	(1,305,221.9)
2032	-	-	-	34,392.0	395,508.5	-	10,661.5	10,661.5	3,233.902	0.3	(1,301,988.0)
2033	-	-	-	31,640.7	363,867.8	-	9,808.6	9,808.6	2,794.130	0.3	(1,299,193.9)
2034	-	-	-	29,109.4	334,758.4	-	9,023.9	9,023.9	2,414.162	0.3	(1,296,779.7)
2035	-	-	-	26,780.7	307,977.7	-	8,302.0	8,302.0	2,085.865	0.3	(1,294,693.9)
2036	-	-	-	24,638.2	283,339.5	-	7,637.8	7,637.8	1,802.212	0.2	(1,292,891.7)
2037	-	-	-	22,667.2	260,672.3	-	7,026.8	7,026.8	1,557.133	0.2	(1,291,334.5)
2038	-	-	-	20,853.8	239,818.5	-	6,464.7	6,464.7	1,345.382	0.2	(1,289,989.2)
2039	-	-	-	19,185.5	220,633.1	-	5,947.5	5,947.5	1,162.426	0.2	(1,288,826.7)
2040	-	-	-	17,650.6	202,982.4	-	5,471.7	5,471.7	1,004.350	0.2	(1,287,822.4)
2041	-	-	-	16,238.6	186,743.8	-	5,034.0	5,034.0	867.771	0.2	(1,286,954.6)
2042	-	-	-	14,939.5	171,804.3	-	4,631.2	4,631.2	749.764	0.2	(1,286,204.8)
2043	-	-	-	13,744.3	158,060.0	-	4,260.7	4,260.7	647.805	0.2	(1,285,557.0)
2044	-	-	-	12,644.8	145,415.2	-	3,919.9	3,919.9	559.712	0.1	(1,284,997.3)
2045	-	-	-	11,633.2	133,782.0	-	3,606.3	3,606.3	483.597	0.1	(1,284,513.7)
2046	-	-	-	10,702.6	123,079.4	-	3,317.8	3,317.8	417.834	0.1	(1,284,095.9)
2047	-	-	-	9,846.4	113,233.0	-	3,052.4	3,052.4	361.014	0.1	(1,283,734.9)
2048	-	-	-	9,058.6	104,174.4	-	2,808.2	2,808.2	311.920	0.1	(1,283,423.0)
2049	-	-	-	8,334.0	95,840.5	-	2,583.5	2,583.5	269.503	0.1	(1,283,153.5)
2050	-	-	-	7,667.2	88,173.2	-	2,376.8	2,376.8	232.854	0.1	(1,282,920.6)
2051	-	-	-	7,053.9	81,119.4	-	2,186.7	2,186.7	201.188	0.1	(1,282,719.4)
2052	-	-	-	6,489.5	74,629.8	-	2,011.8	2,011.8	173.829	0.1	(1,282,545.6)
2053	-	-	-	5,970.4	68,659.4	-	1,850.8	1,850.8	150.190	0.1	(1,282,395.4)
Total	-	-	##########	1,627,340.6		###########	504,475.6	(1,191,524.4)	(1,282,395.4)		

General Plant

CI Number: 43227

Title: 2014 RTU Replacements

Start Date: 2014/03
Final Cost Date: 2015/06
Function: General Plant
Forecast Amount: $687,839

DESCRIPTION:

Remote Terminal Units (RTUs) are deployed in substations and generating stations to allow for communications of data and control signals to enable the operation of Nova Scotia Power's SCADA system. The 2014 RTU capital replacement program will replace select RTUs, enabling NS Power to redeploy spare parts for other existing RTUs. In 2014, this project provides for the replacement of the following RTUs: 22W Barrington, 10W Tusket, 2S Victoria Junction and 22N Church Street.

Summary of Related CIs +/- 2 years:
CI 41428 2012 RTU Capital Replacement $314,026
CI TBD 2015 RTU Replacements $TBD

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Sub Criteria: Equipment Replacement

Why do this project?

Due to evolving industry standards, technology and product lifespan, approximately 90 RTUs that are currently in service have been deemed obsolete by the original equipment manufacturers. The commercial availability of spare parts is becoming increasingly difficult to manage effectively.

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.

This work will be completed by internal resources.

CI Number : 43227 - 2014 RTU Replacements **Project Number**

Parent CI Number : -

Cost Centre : 620 - 620-Control Centre Operations **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D Reg. Labour AO		53,514	0	53,514
095		095 - T&CS Regular Labour AO		12,324	0	12,324
095		095-COPS Regular Labour AO		75,986	0	75,986
001	064	001 - T&D Regular Labour	064 - GP - Sup. Control and DA	93,671	0	93,671
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	26,250	0	26,250
001	085	001 - Regular Labour (No AO)	085 Design	1,914	0	1,914
002	085	002 - Overtime Labour (No AO)	085 Design	0	0	0
002	085	002 - T&CS Overtime Labour	085 Design	0	0	0
			Total Cost:	687,839	0	687,839
			Original Cost:	301,696		

Capital Project Detailed Estimate

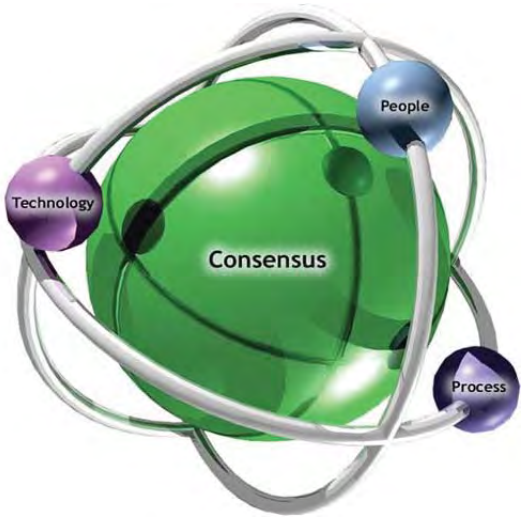
Location: General Plant
CI# / FP#: 43227
Title: 2014 RTU Replacement
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician / Technician	PD	270.0	$ 347	$ 93,671.10		
1.2	Engineering	PD	71.9	$ 365	$ 26,250.80		
1.3	Procurement	Lot	1	$ 1,914.00	$ 1,914.00		
1.4					$ -		
1.5					$ -		
				Sub-Total	$ 121,835.90		
2	**012 Materials**						
2.1	Purchase of RTUs				$ 382,724.00		
2.2					$ -		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 382,724.00		
3	**041 Meals & Entertainment**						
3.1					$ 8,491.00		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 8,491.00		
4	**011 Travel Expense**						
4.1					$ 22,031.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 22,031.00		
5	**066 Other Goods & Services**						
5.1	Project Contingency				$ 10,933.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 10,933.00		
6	**095 Administrative Overhead**						
6.1	095 - T&CS Regular Labour AO				$ 12,324.35		
6.2	092-Vehicle T&D Reg. Labour AO				$ 53,514.27		
6.3	095-COPS Contracts AO				$ -		
6.4	095-COPS Overtime Labour AO				$ -		
6.5	095-COPS Regular Labour AO				$ 75,986.03		
				Sub-Total	$ 141,824.65		
				SUB-TOTAL (no AO, AFUDC)	$ 546,014.90		
				TOTAL (AO, AFUDC included)	$ 687,839.55		
7	**Original Cost**						
7.1					$ 301,696.00		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

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: 44967

Title: 2014 Multiplexer Network Upgrade

Start Date: 2014/02
Final Cost Date: 2015/03
Function: General Plant
Forecast Amount: $435,618

DESCRIPTION:

This project will be deploying a new network technology as a replacement for NS Power's 3600 Newbridge Mainstreet multiplexer network that was Manufacturer Discontinued (MD) over four (4) years ago. This deployment will target 10 multiplexers of the 130 multiplexers the Company has in its network. This will allow NS Power to start moving some traffic off the old network including: voice, mobile radio, SCADA/RTU and IT network to this new platform. This will be part of an ongoing project to replace this MD multiplexer equipment to ensure that the NS Power telecommunication network can reliably support critical infrastructure communications during routine operations and periods of increased demand, such as during storm events.

Summary of Related CIs +/- 2 years:
2012 – CI 41420 Upgrade Multiplexer Network Manager $294,671
2015 – CI TBD 2015 Multiplexer Upgrade $TBD
2016 – CI TBD 2016 Multiplexer Upgrade $TBD

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Sub Criteria: Telecontrol and Telecommunications

Why do this project?

Replacement of the multiplexer equipment at these sites is required to ensure reliability and provide the required system capacity of the telecom network infrastructure. This network carries data which is essential to the safe control of the power system and the effective operation of the business activities.

Why do this project now?

The existing 3600 Newbridge Mainstreet multiplexer network carries most of NS Power's telecommunications traffic including critical teleprotection communication, SCADA/RTU, voice traffic such as System Operations Phones and internal PBX network trunks and corporate IT network traffic. This equipment was MD over 4 years ago. By starting to move to a newer platform we will be able to transition the 3600/3630 Newbridge network over time without jeopardizing the network reliability that is necessary to support the operation of NS Power's critical infrastructure.

Why do this project this way?

Replacing the obsolete 3600 Newbridge Mainstreet multiplexer equipment with more modern technology will ensure the continuing reliability of the NS Power telecommunications network supporting NS Power critical infrastructure. This project will allow for the installation of new multiplexer equipment complete with the required redundancy. This new equipment will allow the NS Power telecom network to transition to a full IP network platform. This will ensure that these sites share the same spares, common maintenance practices, training and expertise. This new multiplexer equipment will interface with our new network manager 5620 Service Access Multiplexer (SAM) that is now in service.

CI Number : 44967 - 2014 Multiplexer Network Upgrades

Parent CI Number : -

Cost Centre : 620 - 620-Control Centre Operations **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		2,379	0	2,379
092		092-Vehicle T&D Reg. Labour AO		20,891	0	20,891
094		094 - Interest Capitalized		12,242	0	12,242
095		095-COPS Overtime Labour AO		3,377	0	3,377
095		095-COPS Regular Labour AO		29,664	0	29,664
001	059	001 - T&D Regular Labour	059 - GP - Multiplex	20,818	0	20,818
002	059	002 - T&D Overtime Labour	059 - GP - Multiplex	8,327	0	8,327
011	059	011 - Travel Expense	059 - GP - Multiplex	1,620	0	1,620
012	059	012 - Materials	059 - GP - Multiplex	255,000	0	255,000
028	059	028 - Consulting	059 - GP - Multiplex	62,400	0	62,400
041	059	041 - Meals & Entertainment	059 - GP - Multiplex	1,875	0	1,875
001	085	001 - T&D Regular Labour	085 Design	15,750	0	15,750
001	085	001 - Regular Labour (No AO)	085 Design	1,275	0	1,275
			Total Cost:	435,618	0	435,618
			Original Cost:	93,533		

Capital Project Detailed Estimate

Location: General Plant
CI# / FP#: 44967
Title: 2014 Multiplexer Network Upgrades
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electricians	PD	60.00	$ 346.93	$ 20,817.60		
1.2	Engineering	PD	43.15	$ 365.00	$ 15,750.00		
1.3	Project Support	lot	1.00	$ 1,275.00	$ 1,275.00		
1.4					$ -		
1.5					$ -		
				Sub-Total	$ 37,842.60		
2	**012 Materials**						
2.1	MPLS Routers	lot	10.00	$ 24,000.00	$ 240,000.00		
2.2	VPN Router / Firewall	lot	2.00	$ 5,000.00	$ 10,000.00		
2.3	Satellite GPS Clock	lot	1.00	$ 5,000.00	$ 5,000.00		
				Sub-Total	$ 255,000.00		
3	**011 Travel Expense**						
3.1					$ 1,620.00		
3.2					$ -		
3.3					$ -		
				Sub-Total	$ 1,620.00		
4	**041 Meals & Entertainment**						
4.1					$ 1,875.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 1,875.00		
5	**002 OT Labour**						
5.1	Technicians	hr	12.00	693.92	$ 8,327.04		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 8,327.04		
6	**028 Consulting**						
6.1	Consulting - Design	hr	168.00	$ 300.00	$ 50,400.00		
6.2	Consulting - IT	hr	40.00	$ 300.00	$ 12,000.00		
6.3					$ -		
				Sub-Total	$ 62,400.00		
7	**094 Interest Capitalized**						
7.1					$ 12,242.11		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 12,242.11		
8	**095 Administrative Overhead**						
8.1	092-Vehicle T&D OT Labour AO				$ 2,378.64		
8.2	092-Vehicle T&D Reg. Labour AO				$ 20,891.09		
8.3	095-COPS Contracts AO				$ -		
8.4	095-COPS Overtime Labour AO				$ 3,377.44		
8.5	095-COPS Regular Labour AO				$ 29,663.64		
				Sub-Total	$ 56,310.81		
				SUB-TOTAL (no AO, AFUDC)	$ 367,064.64		
				TOTAL (AO, AFUDC included)	$ 435,617.56		
9	**Original Cost**						
9.1					$ 93,532.70		

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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

CI Number: 44966

Title: 2014 Microwave System Capacity Upgrade

Start Date: 2014/02
Final Cost Date: 2015/03
Function: General Plant
Forecast Amount: $397,729

DESCRIPTION:

NS Power's microwave system carries NS Power's telecommunication traffic including teleprotection, Remote Terminal Unit (RTU), all voice traffic including internal Private Branch Exchange (PBX) network and corporate IT traffic. This project is for the capacity upgrade for five hops on the Western/Valley Microwave Links. These links are approaching their traffic capacity limit, and will reach their limits in the near future due to traffic growth.

Summary of Related CIs +/- 2 years:
2012 – CI 41419 Replace Microwave Radio System 2012 $619,782
2013 – CI 43190 Replace Microwave Radio System 2013 $351,087

JUSTIFICATION:

Justification Criteria: Work Support Facilities

Sub Criteria: Telecontrol and Telecommunication

Why do this project?

This project is for capacity upgrades for portions of the Valley and South Shore Microwave Radio systems. The capacity upgrades are for the 419H Brushy Hill to 425V Newtonville to 411V Stronach Mountain microwave radio links of the Valley Microwave System and the 415H Ragged Lake to 420W Aspotogan to 421W Bridgewater microwave radio links of the South Shore Microwave System. It will also upgrade the 430W New Tusket to 415W Tusket microwave radio link of the Valley Microwave System from a non-protected radio system to a fully protected Frequency Diversity radio system, thereby making all of NS Power's Valley and South Shore Microwave Radio Systems fully protected. This means there will be redundant transmitters and receivers with different frequencies to protect against outages from equipment failures or radio path fading. This will result in higher overall availability and reliability for the critical traffic carried on these radio systems.

Why do this project now?

These links are approaching their traffic capacity limits. They carry the entire NS Power telecommunication traffic including teleprotection, RTU, all voice traffic including internal PBX network and corporate IT traffic. This makes these telecommunications links critical to safe and effective system and business operations. Increasing the capacity will give NS Power room to add additional services and slowly migrate from Time Division Multiplexing (TDM) network to Internal Protocal (IP) network.

Why do this project this way?

The capacity upgrade kit is the most efficient and cost effective way of achieving the necessary performance improvements for these portions of the Valley and South Shore Microwave Radio Systems. Purchasing new radios for the new capacity would cost approximately $72,000 per radio link versus the cost of approximately $52,000 per radio link for the capacity upgrade kit. This is a savings of approximately $20,000 per radio link. The upgrade kit includes new power amplifiers, new oscillator boards, new filters, new crystals and new capacity keys. The upgrade kit can be easily implemented in the field without an outage or interruption to the radio system network. For the 403W New Tusket to 415W Tusket microwave radio link, the existing non-protected equipment will be replaced with a new Frequency Diversity protected radio link and the existing equipment used as maintenance spares for the overall NS Power Microwave Radio System network.

CI Number : 44966 - 2014 Microwave System Capacity Upgrade **Project Number**

Parent CI Number : -

Cost Centre : 620 - 620-Control Centre Operations **Budget Version** 2014 ACE Plan

Capital Item Accounts

Acct	Actv	Account	Activity	Forecast Amount	Amount	Variance
092		092-Vehicle T&D OT Labour AO		1,824	0	1,824
092		092-Vehicle T&D Reg. Labour AO		12,117	0	12,117
094		094 - Interest Capitalized		11,356	0	11,356
095		095-COPS Regular Labour AO		17,206	0	17,206
095		095-COPS Contracts AO		3,907	0	3,907
095		095-COPS Overtime Labour AO		2,589	0	2,589
001	060	001 - T&D Regular Labour	060 - GP - Broadband Radio	15,960	0	15,960
002	060	002 - T&D Overtime Labour	060 - GP - Broadband Radio	6,384	0	6,384
011	060	011 - Travel Expense	060 - GP - Broadband Radio	2,160	0	2,160
012	060	012 - Materials	060 - GP - Broadband Radio	295,000	0	295,000
013	060	013 - COPS Contracts	060 - GP - Broadband Radio	14,000	0	14,000
028	060	028 - Consulting	060 - GP - Broadband Radio	4,000	0	4,000
041	060	041 - Meals & Entertainment	060 - GP - Broadband Radio	4,500	0	4,500
001	085	001 - T&D Regular Labour	085 Design	5,250	0	5,250
001	085	001 - Regular Labour (No AO)	085 Design	1,475	0	1,475
			Total Cost:	397,729	0	397,729
			Original Cost:			

Capital Project Detailed Estimate

Location: General Plant
CI# / FP#: 44966
Title: 2014 Microwave System Capacity Upgrade
Execution Year: 2014

Item	Description	Unit	Quantity	Unit Estimate	Total Estimate	Cost Support Reference	Completed Similar Projects (FP#'s)
1	**001 Regular Labour**						
1.1	Electrician	PD	46.00	$ 346.93	$ 15,960.16		
1.2	Engineering	PD	14.38	$ 365.00	$ 5,250.00		
1.3	Project Support	lot	1.00	$ 1,475.00	$ 1,475.00		
1.4					$ -		
1.5					$ -		
				Sub-Total	$ 22,685.16		
2	**013 Contracts**						
2.1	Rigging Services	lot	1	14,000	$ 14,000.00		
2.2					$ -		
2.3					$ -		
2.4					$ -		
				Sub-Total	$ 14,000.00		
3	**012 Materials**						
3.1	7 GHz Microwave Radio Hop (Capacity Upgrade Kits)	lot	[redacted]			Cost Support Item #1	
3.2	New Tusket - Tusket upgrade to Frequency Diversity	lot				Cost Support Item #2	
3.3	Contingency	lot					
				Sub-Total	$ 295,000.00		
4	**011 Travel Expense**						
4.1					$ 2,160.00		
4.2					$ -		
4.3					$ -		
				Sub-Total	$ 2,160.00		
5	**041 Meals & Entertainment**						
5.1					$ 4,500.00		
5.2					$ -		
5.3					$ -		
				Sub-Total	$ 4,500.00		
6	**002 OT Labour**						
6.1	Technicians	hr	73.60	86.74	$ 6,384.06		
6.2					$ -		
6.3					$ -		
				Sub-Total	$ 6,384.06		
7	**028 Consulting**						
7.1	Misc. Consulting				$ 4,000.00		
7.2					$ -		
7.3					$ -		
				Sub-Total	$ 4,000.00		
8	**094 Interest Capitalized**						
8.1					$ 11,356.00		
8.2					$ -		
8.3					$ -		
				Sub-Total	$ 11,356.00		
9	**095 Administrative Overhead**						
9.1	092-Vehicle T&D OT Labour AO				$ 1,823.59		
9.2	092-Vehicle T&D Reg. Labour AO				$ 12,117.33		
9.3	095-COPS Contracts AO				$ 3,907.41		
9.4	095-COPS Overtime Labour AO				$ 2,589.38		
9.5	095-COPS Regular Labour AO				$ 17,205.65		
				Sub-Total	$ 37,643.36		
				SUB-TOTAL (no AO, AFUDC)	$ 348,729.22		
				TOTAL (AO, AFUDC included)	$ 397,728.58		
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.
Note 2: The labour figures noted above are an average of salaries across a variety of jobs within similar classifications including fringe, and are used solely for budgeting purposes.
Note 3: Small differences in totals are attributable to rounding.

Customer Nova Scotia Power Inc.
Project: Nova Scotia Power (NSPI) Upgrade (from24 Mbps to 50 Mbps, 128TCM, 32dBm, 16DS1
Product MDR-8708E FD (w/Discrete Filters)
Issue Date:June 25, 2013

This BOM lists the parts required to upgrade an existing MDR-8508E-24 16DS1 as follows
1.) Capacity to 50Mbps
2.) SSPA Power Amplifiers to +32dBm (Fansare required for +32 dBm)
3.) Frequency shift (RF Channel TBD) OPTIONAL

				Link 1	
				Site A	Site B
				16DS1 +32 dBm	16DS1 +32 dBm
		TOTAL	$[redacted]	$[redacted]	$[redacted]
Item	Description	Part Number	Unit Price	Qty	Qty
			$CAN		
			Tx1 freq		
			Rx1 freq		
			Tx2 freq		
			Rx2 freq		
	Capacity Keys				
1.	Capacity Key for 50 Mbps	3EM04177AA	[redacted]	4	4
	Option Key				
2.	OptionKey (supports DS1 capacity up to 32DS1's)	695-5647-023			
	PA Power Option				
3.	7 GHz SSPA, Power Amplifier +32dBm (7125-7750 MHz)	3EM04070AE		2	2
4.	Fan Assembly below PDU Mount	3EM19148AC		1	1
	Discrete Filters				
5.	Tx Filter Assembly (Filter, Circulator, Screws) price includes Tuning of Filter assembly	3DH04158FF		2	2
6.	RxA Filter Assembly / Price includes Tuning of Filter Assembly	3DH04158FG		1	1
7.	RxB Filter Assembly / Price includes Tuning of Filter Assembly	3DH04158FH		1	1
	Oscillators & Crystals				
8.	Oscillator Board (118.0000 - 125.0000 MHz)	3DH04123XX		2	2
9.	Oscillator Board (125.0000 - 130.0000 MHz)	3DH04123XX		2	2
10.	Crystal (ch XXXX.XX MHz - xtal XXX.XXXX MHz)	XXX-XXXX-XXX		1	1
11.	Crystal (ch XXXX.XX MHz - xtal XXX.XXXX MHz)	XXX-XXXX-XXX		1	1
12.	Crystal (ch XXXX.XX MHz - xtal XXX.XXXX MHz)	XXX-XXXX-XXX		1	1
13.	Crystal (ch XXXX.XX MHz - xtal XXX.XXXX MHz)	XXX-XXXX-XXX		1	1
	Crystal Frequencies listed are for EXAMPLE only.**				
			Total	[redacted]	

NOTES:
1.) Upgrading capacity from 24 Mbps to 50 Mbps will reduce System Gain by 4.5 dB (10E-6: 8508E-24 = -78 dB; 8708E-50 = 73.5 dB).
2.) BOM assumes the radio uses Discrete filters as opposed to Stacking filters. Please indicate if Stacking filters are preferred and ALU will revise the quote accordingly.
Frequency RETUNE option:
3.) If a frequency retune is required the RF Channel freq's & type of filters (Diplexers or Discrete; Narrow Band or Wideband) will need to be provided by Customer.
4.) ALU will revise the quote accordingly with proper Filters and OSC/XTAL P/N's upon request.
5.) Labor to perform the reconfiguration is not included in this Quotation.

Terms and Conditions

1 This quotation is preliminary pending final network requirements Nova Communications will issue a revised quotation if requirements differ from above quoted items
2 All prices are in Canadian Dollars
3 Duties and taxes are to be added to prices shown
4 All quotation and orders are subject to Nova Communications standard terms and conditions applicable to the products and/or services included in the quotation unless otherwise agreed in writing
5 Payment terms Thirty days from date of invoice
6 Shipping Terms FCA Longview Texas For radio - Prepaid, Ship and Charge
7 Delivery times As agreed in writing, and in the absence of agreement will be subject to Alcatel-Lucent's standard current lead times
8 Errors and omissions can be corrected and will be accepted by the Customer
9. This quotation is valid for 30 days from date of issue.

Nova Communications
167 Trider Crescent
Dartmouth, Nova Scotia
B3B 1V6

Customer: Nova Scotia Power Inc.
Project Nova Scotia Power (NSPI) Replace N/S DS1 with HS+F/D ETHERNET (5 Links)
Product: MDR-8508E-50 Mbps Ethernet (up to 32 DS1)
Issue Date October 29, 2012

				Link 1 Complete		Link 2 New radio		Link 3 Complete		Link 4 New radio		Link 5 New radio	
				STRONACH to DND Bridgetown MDR-8708E-50 Mbps FD 50 Mbps ETHERNET (up to 32 DS1) 28 dBm		DND Bridgetown to Lansdowne MDR-8708E-50 Mbps FD 50 Mbps ETHERNET (up to 32 DS1) 32 dBm		Lansdowne to N. Range Corner MDR-8708E-50 Mbps FD 50 Mbps ETHERNET (up to 32 DS1) No PA		N. Range Corner to New Tusket MDR-8708E-50 Mbps FD 50 Mbps ETHERNET (up to 32 DS1) 28 dBm		New Tusket to Tusket MDR-8708E-50 Mbps FD 50 Mbps ETHERNET (up to 32 DS1) 32 dBm	
		Link TOTAL	$[redacted]	$0	$0	$[redacted]	$[redacted]	$0	$0	$[redacted]	$[redacted]	$[redacted]	$[redacted]
Item	Description	Part Number	Unit Price $CAN	Qty	Qty	Qty	Qty	Qty	Qty	Qty	Qty	Qty.	Qty.
			Tx1 freq			tbd	tbd			tbd	tbd	tbd	tbd
			Rx1 freq			tbd	tbd			tbd	tbd	tbd	tbd
			Tx2 freq			tbd	tbd			tbd	tbd	tbd	tbd
			Rx2 freq			tbd	tbd			tbd	tbd	tbd	tbd
	ETHERNET Radio												
	7 GHz Frequency Band (7125 - 7725 MHz)												
	Radio - ETHERNET Interface												
1.	MDR-8708E-50Mbps +15 dBm, Hot-Standby, (up to 32 DS1)	MDR-8708E-50-15-HS	[redacted]			1	1			1	1	1	1
	Configuration Options												
2.	Frequency Diversity, MDR-8X08 DS1 radio	MDR-8X08-FD-HS				1	1			1	1	1	1
	Power Options												
3.	MDR-8x08, Xmtr Output: 28 dBm (protected)	MDR-8x08-28								1	1		
4.	MDR-8x08, Xmtr Output: 30 dBm (protected) Fan is included with 30dB	MDR-8x08-30											
5.	MDR-8x08, Xmtr Output: 32 dBm (protected) Fan is included with 32dB	MDR-8x08-32				1	1					1	1
6.	Fan Assembly below PDU Mount	3EM19148AC					1					1	1
7.	Fan Assembly below PDU Mount	3EM19148AA				1							
	Waveguide - SMA Transition Option												
8.	W/G Transition Kit (1 port, 1 Antenna) 7125-8500	3DH04122GK				1	1			1	1	1	1
	MDR-8XXX Options:												
9.	Relay Interface (Provides MCS-11 ALM Inputs or Alarm Outputs)	3DH03219AA				1	1			1	1	1	1
10.	Controller Key for up to 16x DS1	695-5647-022				1	1			1	1	1	1
11.	Controller Key for up to 32x DS1	695-5647-023											
12.	TMN Module	3EM13462AB											
13.	TMN Software	3EM14629AKAA											
14.	M B Software	3DB04799AFAA											
	Miscel aneous Radio Options:												
15.	Standard Alum Rack 7' 19"	694-9000-006											
16.	Power Distribution Panel	3EM13317AA											
17.	DC Power Cables Radio to PDU	695-7845-005											
18.	Wire-wrap Adapter, External Alarms, 50 Pin	695-4171-002											
19.	Repeater Interrack Data Cable (OC3/Ethernet), 8 Ft.	695-4125-011				1				1		1	
20.	Alarm and Control Interface Cable, 50 Ft.	695-4121-002											
21.	Handset PTT	3EM11996AA											
22.	16 DS1 Cable 50 foot	695-7806-003											
23.	Manufacturing Test RTU	3EM24226AA				1	1			1	1	1	1
24.	Fan Assembly between Radios	3EM19148AA								1	1		
25.	Fan Assembly below PDU Mount	3EM19148AC											
26.	User Interface Cable, 15 ft.	695-7848-003											
			Total	$0	$0	[redacted]		$0	$0	[redacted]			
					$0				$0				

	MDR-8000 Spares -- Common		
1.	I/O Interface (1.544 Mbps) DS1	3DH03131AA	[redacted]
2.	Ethernet I/O Interface	3EM16169AA	
3.	Controller	3DH03155AB	
4.	Power Supply	3DH03164AB	
5.	Relay Interface	3DH03219AA	
6.	TMN Interface	3EM13462AB	
7.	Fan**	3EM19148AC	
	7 GHz Spare Components		
8.	Transmitter (7125 - 7750 MHz)	3DH04170AC	
9.	Receiver (7125 - 7750 MHz)	3DH04175AJ	
10.	7 GHz PA - +28 dBm	3EM04070AA	
11.	7 GHz PA - +30 dBm	3EM04070AC	
12.	7 GHz PA - +32 dBm	3EM04070AE	
13.	Oscillator Board (118.0000 - 125.0000 MHz)	3DH04123AJ	
14.	Oscillator Board (125.0000 - 130.0000 MHz)	3DH04123AK	
15.	Crystal (ch 7246.25 MHz - xtal 120.7708 MHz)	289-4424-042	
16.	Crystal (ch 7571.25 MHz - xtal 126.1875 MHz)	155-0821-709	
	Crystal Frequencies listed are for EXAMPLE only.		
			Total Spares

NOTES

1.) This is a Budgetary QUOTE.
2.) Oscillator and Crystal frequencies listed are for example only and will need to be defined prior to submitting a PO.
3.) Nova Communications will revise the quote accordingly with proper OSC and XTAL P/N's upon request.
4.) The lowest capacity supported on the ETHERNET radio is 5 DS1 existing 4-DS1 radio will require a CAPACITY KEY Upgrade to 5-DS1 (8 Mbps).
5.) Quote assumes existing racks and PDU's will be re-used.
6.) Quote assumes the existing Waveguide and Flange adapters will be reused.
7.) 8 Mbps Etherent radio's can supportup to 5 DS1's 12 Mbps up to 8 DS1's 24 Mbps up to 16 DS1's existing DS1 cables can be re-used to interface DS1 traffic as required.
8.) As requested by customer - fans have been added to all radio's (where not included with the PA option).
9.) The Relay Interface and TMN cardscan be re-used from the existing radio if desired.

7

Terms and Conditions

1. This quotation is preliminary pending final network requirements. Nova Communications will issue a revised quotation if requirements differ from above quoted items.
2. All prices are in Canadian Dollars.
3. Duties and taxes are to be added to prices shown.
4. All quotation and orders are subject to Nova Communications standard terms and conditions applicable to the products and/or services included in the quotation unless otherwise agreed in writing.
5. Payment terms: Thirty days from date of invoice.
6. Shipping Terms: FCA Longview Texas. For radio - Prepaid, Ship and Charge.
7. Delivery times: As agreed in writing, and in the absence of agreement will be subject to Alcatel-Lucent's standard current lead times.
8. Errors and omissions can be corrected and will be accepted by the Customer.
9. This quotation is valid for 30 days from date of issue.