Request IR-1:

Please refer to the footnote on page 11 of document N-1, the 2017 ACE Plan, regarding the federal government's recent carbon policy announcement:

(a) Please describe NSPI's plan to address the federal government's stated carbon policy.

(b) What is NSPI's expected retirement date for each coal unit in Nova Scotia?

(c) How does the 2017 ACE Plan reflect NSPI's approach to mitigating federal regulatory uncertainty surrounding carbon policy?

Response IR-1:

(a) Please refer to NSUARB IR-32.

(b) Please refer to NSUARB IR-48.

(c) The 2017 ACE Plan maintains the planning flexibility of the generation fleet. Retention of fleet optionality is advantageous as the details of equivalency agreements and cap and trade systems are defined by both the Federal and Provincial Governments.

Request IR-2:

Please refer to the list of four IT projects on page 15 of document N-1, the 2017 ACE Plan:

(a) What are the CI numbers for these projects?

(b) Has the Board approved these projects? If so, please provide a reference to the Order approving them.

(c) For those projects NSPI has applied for approval, but not yet received it, please provide the filing date.

(d) For any project of the four not listed in response to parts b and c, what is the expected filing date?

(e) Why are these four separate projects instead of one project?

(f) How do these projects interrelate?

Response IR-2:

(a-d) Please refer to the following table. Cyber Security enhancements are being completed under multiple CIs (Rows 2 – 11) as they cover many different initiatives that go into service at different times.

Row	CI #	Project	UARB Reference	Filed/approved	Expected Filing date
1	44671	IT - Enterprise Resource Plan (ERP)	M07746	Submitted November 10, 2016.	
2	47477	IT - Security Enhancements - Next Generation Firewall	M07501	Submitted May 31, 2016. Approved November 25, 2016.	
3	48633	IT - Security Enhancements - Java Security	M07552	Submitted June 30, 2016. Approved November 25, 2016.	
4	48635	IT - Security Enhancements - Endpoint Data Encryption and Malware Protection	M07660	Submitted August 31, 2016. Approved November 25, 2016.	
5	49601	IT - Data Loss Prevention			Q3 2017
6	49603	IT - Patch Management			Q4 2017
7	49094	IT - Identity and Access Management			Q2 2017
8	49480	IT - Disaster Recovery			Q2 2017
9	49600	IT - Network Architecture Redesign			Q4 2017
10	49602	IT - Internal Vulnerability Assessment			Less than $250k
11	49093	IT - SOC-SIEM Infrastructure			Q2 2017
12	46075	IT - T&D Work and Asset Management			Q2 2017
13	TBD	Customer Information System (CIS) replacement			2019

(e) The ERP, T&D Work and Asset Management, and CIS Replacement projects are all separate and distinct assets, providing unique functions to different areas of the business; ERP pertains to the Finance, Supply Chain and Human Resource functions; T&D Work and Asset Management pertains to transmission and distribution planning; and CIS pertains to customer service. This is not unlike generation, transmission, or distribution projects; which may be related by the fact that they serve to maintain the provision of safe and reliable power to customers but can apply to different assets and functions on NS Power's system. These IT projects also have different timelines and in-service dates, further necessitating separate filings (in the case of CIS, multiple years later). Finally, filing these projects separately provides additional clarity and transparency of scope and project costs.

(f) Please refer to part (e). The interrelationship between these projects is primarily focused where business processes cross between business units. The core technology assets that are included in the scope of each project are separate and distinct.

Request IR-3:

Please refer to the projected $70 million in total project spending for new general plant projects for subsequent approval, on page 43 of document N-1, the 2017 ACE Plan. Of these projects, 25 are listed under the Computers/IT sub-criteria, which includes about $60 million of the $70 million.

(a) What is NSPI's plan for filing for approval of these projects?

(b) How can NSPI group the projects so that they can be reviewed efficiently since they are not submitted for approval in the ACE Plan?

(c) Are any of these projects related to the implementation of AMI? If so, how?

Response IR-3:

(a) Please refer to NSUARB IR-17 for a schedule of subsequent submittal filings. As with past practice, each of these projects will be filed when the project is sufficiently scoped. This will occur throughout 2017 as more information is gathered on each of these projects.

(b) NS Power will seek to consolidate or file similar projects as a group where appropriate, while balancing the need for timely submissions to the UARB. An example of where this approach has been employed is noted on page 40 of the 2017 ACE Plan, CI 46075 - T&D Work and Asset Management. This project consolidated multiple related CIs previously listed for separate submission on the 2016 ACE Plan Subsequent Submittal List. Additionally, NS Power will be exploring process improvements regarding the submission of IT capital projects for approval in future ACE Plans, minimizing the number of IT capital projects on future Subsequent Submittal Lists.

(c) No.

Request IR-4:

Please refer to pages 29-30 of document N-1, the 2017 ACE Plan. The following cancelled CIs are listed as no longer being an "economic alternative:" 48025, 48024, 48023.

(a) Please describe conditions when Tuft's Cove runs out of merit dispatch. How frequently do these conditions occur? How have dispatch patterns changed over the past two years?

(b) Why are these cancelled projects no longer considered economic?

(c) Related project CI 48022 is pending before the Board. Is this project still economic and why?

(d) Could NSPI have completed any of these cancelled projects prior to CI 48022 and CI 46587? If so, which ones?

(e) Would any of the cancelled projects be economic without CI 46587? If so, which ones, and why weren't these projects brought forward for approval ahead of CIs 46587 and 48022?

Response IR-4:

(a) Tufts Cove must run 'out of merit' when the Onslow South load flow exceeds 880 MW in the summer or 985 MW in the winter. The difference between the summer and winter limits is based on summer and winter transmission system thermal ratings. If the Onslow South flows exceeds these limits, the Halifax area cannot sustain voltage stability for contingencies unless Tufts Cove generation is on line. The Tufts Cove generation serves to reduce the Onslow South flow and also provide dynamic VARs to help support system voltage.

The Generation Duration Curve provided on page 2 of the Avoided Cost Study (provided as NSUARB IR-14 Attachment 1) submitted with the CI 48022 - Spider Lake Capital Project best describes the frequency these conditions occur. The graph provides the minimum Tuft's Cove Generation requirements based on a percentage of time.

The Tufts Cove 'Out of Merit' dispatch patterns are dependent on System Load and Onslow South flows as described above. These dispatch patterns have not changed significantly over the past two years.

(b) Please refer to NSUARB IR-14.

(c) Yes. Please refer to NSUARB IR-14.

(d) The Transmission Planning Study (provided as NSUARB IR-14 Attachment 2) submitted with the CI 48022 - Spider Lake Capital Project identified that the network upgrades required to reduce the requirements to run Tufts Cove generation out of merit were sequential, with the new Spider Lake Substation being the first upgrade required. For the study, CI 46587 was assumed to be in-service and economically justified on its own.

e) The cancelled projects would not be economic without either CI 46587 or CI 48022.

Request IR-5:

Please refer to page 152 of document N-1, the 2017 ACE Plan, which mentions the possibility of a "renewable energy deficit forecast:"

(a) Does NSPI anticipate a renewable energy deficit in the next five years? If so when, and how did this impact NSPI's Replacement Energy Cost modeling?

(b) Please provide a projection of total renewable energy output by resource type (wind, hydro, tidal, solar, biomass, and any others) compared to NSPI's projected renewable energy targets for the next five years. Include projected hydro generation imports over Maritime Link.

(c) Please explain why biomass fired generation is the only other renewable resource able to provide additional renewable generation.

Response IR-5:

(a) NS Power does not anticipate a renewable electricity production deficit in the next five years. The referenced statement was made in contemplation of an alternative analysis scenario where, due to unforeseen and unexpected circumstances, a theoretical renewable electricity production deficit could arise.

(b) Please refer to the table below.

	2017	2018	2019	2020 with PHP	2020 no PHP[1]	2021 with PHP	2021 no PHP[1]
Energy Requirements (GWh)							
Sales Forecast	10,493	10,532	10,550	10,584	9,504	10,577	9,497
RES (%) Requirement	25%	25%	25%	40%	40%	40%	40%
RES Requirement (GWh)	**2,623**	**2,633**	**2,638**	**4,234**	**3,802**	**4,231**	**3,799**
Renewable Energy Sources (GWh)							
Wind							
NSPI Wind	260	260	260	260	260	260	260
IPP Wind	748	748	748	748	748	748	748
COMFIT Wind Energy	481	505	505	503	503	503	503
REA Procurement (South Canoe/Sable)	355	355	355	355	355	355	355
Hydro							
Eligible NSPI Legacy Hydro	969	980	978	946	946	969	969
IPP Hydro	3	3	3	3	3	3	3
Maritime Link	0	0	0	906	906	1,153	1,153
Solar & Tidal							
Solar & Tidal Energy	24	38	39	40	40	40	40
Biomass/Biogas							
PH Biomass	17	8	9	240	29	45	35
IPP Biomass/Biogas	76	76	76	76	76	76	76
COMFIT Non-Wind Energy	154	210	210	210	210	210	210
Forecasted Renewable Electricity (GWh)	**3,086**	**3,183**	**3,182**	**4,286**	**4,076**	**4,361**	**4,351**
Forecasted Surplus or Deficit (GWh)	**463**	**550**	**545**	**52**	**274**	**130**	**553**
Forecasted RES Percentage of Sales	**29.4%**	**30.2%**	**30.2%**	**40.5%**	**42.9%**	**41.2%**	**45.8%**

Detailed forecasts for eligible renewable electricity from solar and tidal have not been developed. The combined annual production from these sources is currently expected to range between 24 and 40 GWh annually through the period 2017 to 2021.

Please note that for years prior to 2020, a "no PHP" case would decrease the Net System Requirement by 1080 GWh, and effectively increase the forecasted renewable electricity as a percentage of sales.

(c) Biomass fired generation is the only other renewable resource able to provide additional renewable generation as other sources of renewable electricity have must-take generation forecasted up to the full available annual production level of the installed technology.

Request IR-6:

Please refer to page 154 of document N-1, the 2017 ACE Plan, which compares two methods of calculating hydro replacement energy costs (RECs):

(a) One of the stated advantages of using the Locational Marginal Pricing (LMP) methodology is that it varies for different hydro generators depending on their dispatch patterns. What dispatch pattern was used to calculate the forecasted REC for the LMP method shown on this page?

(b) Please provide a five year forecast of RECs for each hydro generating station in Nova Scotia using the LMP method.

Response IR-6:

(a) The sum of all hydro generation forecasted hourly dispatch patterns was used to calculate the forecasted REC for the LMP method.

(b) The calculation required to provide a five year forecast of RECs for each hydro generating station in Nova Scotia using the LMP method is not a part of NS Power's Replacement Energy Cost calculation method and was therefore not completed as a part of the 2017 ACE Plan submission. In order to accurately produce and review this data, more time is required than is provided for in the ACE IR schedule. As such, NS Power proposes that this information and further discussion on this subject is provided as part of the subsequent capital stakeholder engagement process.

Request IR-7:

Please refer to pages 154-155 of document N-1, the 2017 ACE Plan, which states that "the marginal cost methodology relies on forecasted hourly marginal costs which are sensitive to forecasted system maintenance schedule, the outcome of randomized distribution of generating fleet forced outages, and to the way the simulator decomposes annual emissions caps into daily dispatch targets"

(a) Does "marginal cost methodology" refer to the LMP methodology NSPI analyzed? If not, what does it refer to?

(b) Since NSPI's system must be dispatched to accommodate generator outages and emissions caps, why would it not be reasonable to have RECs be sensitive to these assumptions?

Response IR-7:

(a) Yes.

(b) NS Power's REC calculation methodology does accommodate for generator outages and emissions caps and their sometimes fluid nature.

Fuel and Purchased Power forecasts are based on system dispatch optimizations that use one discrete system maintenance schedule. The system maintenance schedule, while representative of the annual maintenance plan, will likely be modified as the Company responds to changing conditions. NS Power's REC calculation methodology, based on average production cost comparison, is better able to accommodate system maintenance timing outcomes.

Annual system emissions cap compliance is another major factor in fleet dispatch optimization. Fleet dispatch optimization is closely related to fleet availability, which is in turn affected by the system maintenance schedule. This may result in the LMP outputting higher emissions compliance costs during system maintenance periods, than what is reasonably expected or experienced. NS Power's REC calculation methodology, based on weighted average production cost comparisons, is less exposed to sensitive hourly factors that may influence the calculation.

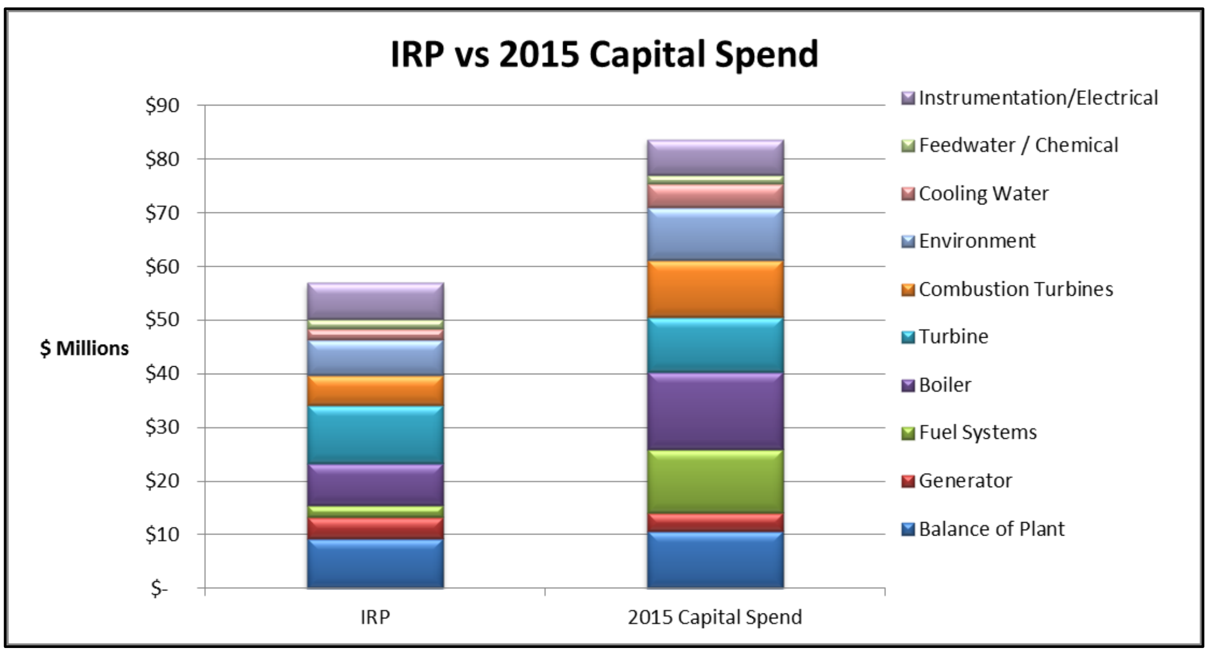
The LMP method of REC calculation relies on one discrete system maintenance schedule, as it considers system generation cost in each discrete hour of the year. Due to the reliance on discrete dispatch parameters which are subject to change in response to evolving system conditions, LMP is a less accurate representation of anticipated REC.

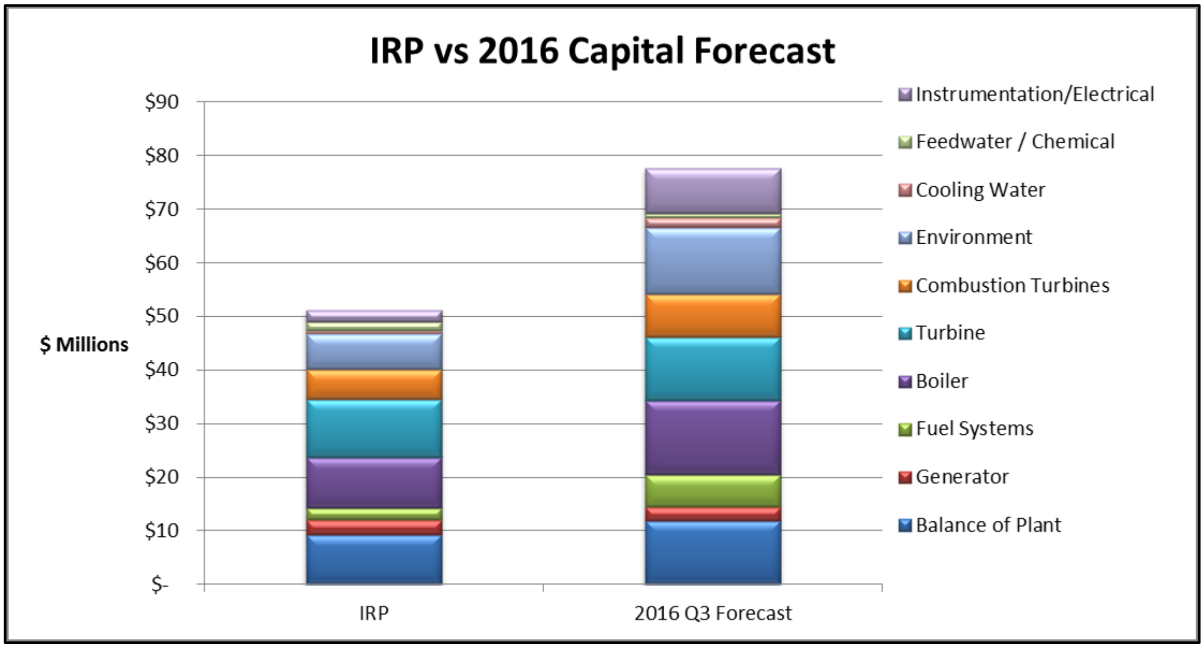
Request IR-8:

Please refer to the chart on page 103 of document N-1, the 2017 ACE Plan. Please provide similar charts showing projected annual investment per the IRP and actual spending for each of years 2015 and 2016.

Response IR-8:

Please refer to the charts below for IRP comparisons to 2015 actual capital spend and 2016 forecasted capital spend. As discussed in the 2017 ACE Plan, the 2014 IRP was completed using only 2014 dollars and did not include any form of inflation for future years and was at a time where the Canadian dollar was relatively on par with the US dollar. When applied to the 2014 IRP forecast, a conservative estimate of the increase in that forecast would be $6 million.



1 
IRP vs 2016 Capital Forecast
$ Millions
$90
$80
$70
$60
$50
$40
$30
$20
$10
$-
IRP
2016 Q3 Forecast
Instrumentation/Electrical
Feedwater / Chemical
Cooling Water
Environment
Combustion Turbines
Turbine
Boiler
Fuel Systems
Generator
Balance of Plant

Request IR-9:

Please refer to page 107 of document N-1, the 2017 ACE Plan. Why is CI 47166 included on the list if it has a ranking of 4?

Response IR-9:

Please refer to NSUARB IR-33.

Request IR-10:

Please refer to page 13 of document N-1, the 2017 ACE Plan, which discusses performance standard benchmarks.

(a) How, if at all, does the Board's recent Decision in M07387 impact the 2017 ACE Plan?

(b) Does NSPI intend to increase transmission and distribution (T&D) capital investment in response to the the approved performance standard benchmarks? If so, how?

(c) Please identify all non-T&D projects, if any, in the 2017 ACE Plan that will assist NSPI in meeting performance standard benchmarks.

Response IR-10:

(a-c) Please refer to NSUARB IR-6.

Request IR-11:

Please refer to page 136 of document N-1, the 2017 ACE Plan. Please describe in detail the "innovative testing of conductor over 60 years old."

Response IR-11:

In addition to traditional conductor assessment using visual methods and laboratory testing of line sections of concern, conductor nearing its end of life can be assessed using Infrared and Corona scanning technologies. Infrared scans highlight increased conductor spot temperatures, which typically indicate arcing caused by conductor damage or poor connections. Corona uses an ultra-violet image sensor to detect partial discharges, corona, and arcing. Both techniques allow for identification of anomalies that are normally undetectable by the human eye. A helicopter-mounted system facilitates assessment of the conductor on a line-by-line basis. The increased condition data afforded by such testing programs provides advanced warning of conductor deterioration as well as confidence in conductor performance prior to end of useful life.

Request IR-12:

Regarding the Port Hawkesbury Biomass Generation Station

(a) **Please describe this unit's operating strategy.**

(b) **Please provide a list of all capital expenditure projects and annual O&M costs for Port Hawkesbury Biomass since it came online.**

(c) **Please provide a detailed capital expenditure plan for the Port Hawkesbury Biomass Generation Station for the next five years.**

(d) **How has the capital expenditure plan been impacted by the decision to run Port Hawkesbury on economic dispatch instead of "must run" commitment.**

(e) **What are the types of biomass fuel used to power the Port Hawkesbury Biomass Generation Station?**

(f) **Please provide a copy of NSPI's most recent fuel cost forecast in $/MMBTU for biomass fuel.**

(g) **What is the current replacement energy cost for this station used in the EAM and how was it determined?**

(h) **Could NSPI meet its renewable energy requirement targets without this unit? If not, why not?**

(i) **Please justify the continued operation of this facility and provide a list of reasons this unit is still a necessary component of NSPI's generating fleet.**

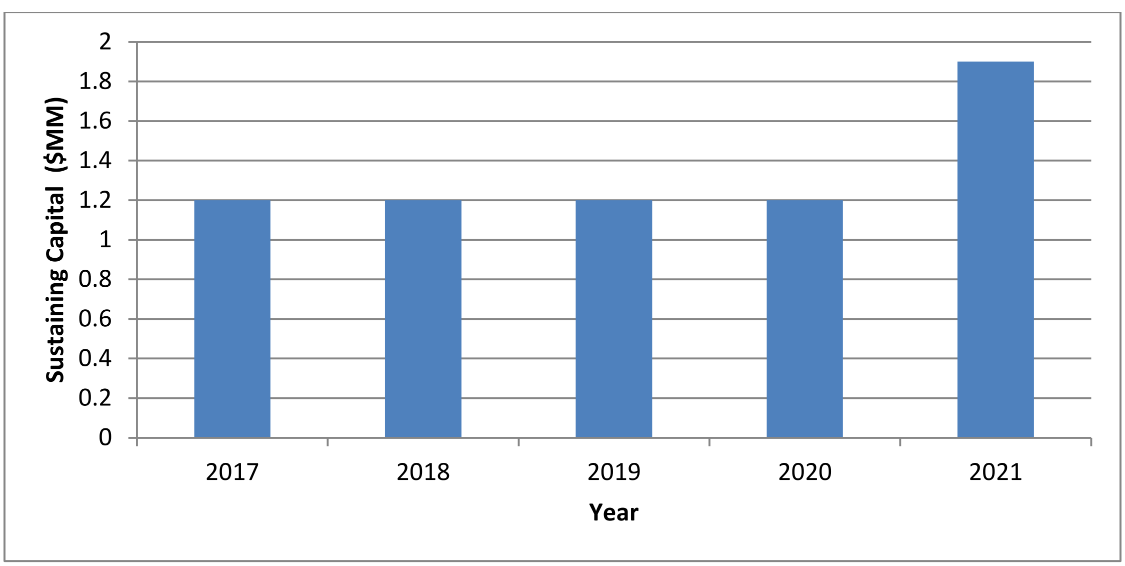
Response IR-12:

(a) The operating strategy of Port Hawkesbury Biomass (PHB) Generation Station is to generate electricity in a safe, reliable and cost-effective manner to meet NS Power or Port Hawkesbury Paper requirements.

(b) Please refer to Attachment 1 for the annual capital costs by project since 2013. The table below shows the OM&G costs since 2013.

	2013 ($)	2014 ($)	2015 ($)	2016 Q3F ($)
OM&G	6,385,159	7,288,973	6,985,716	6,784,088

(c) The capital expenditure plan is driven by unit condition assessments and forecast future utilization. The detailed capital plan is drafted 18 months prior to project execution as per NS Power's outage standardization process. The figure below shows the forecast capital plan for the PHB Generation Station for the next five years. Depending on actual utilization, it is anticipated that a Turbine Major will occur in the mid-2020's (estimated 2025) with some minor work, reflected in the graph below, expected in 2021.



(d) The impact of changing Port Hawkesbury Biomass Unit operating mode will adjust the major outage frequency. Reducing the annual operating hours on the turbine will result in a longer periods between planned major outages.

(e) The type of fuel burned in PHB Generation Station is in compliance with the operating permit issued by Nova Scotia Environment, which is in effect until 2022. Typically, bark and wood chips are used as the fuel source.

(f) The forecast for the 2017 calendar year is [redacted]/MMBTU.

(g) There is no replacement energy cost used in the economic justification of PHB projects. Investments are determined to meet capacity, contractual and renewable energy requirements.

(h) According to present system demand, hydro, and wind generation forecasts, NS Power expects to be able to meet renewable energy requirements without significant use of the PHB Generation Station until the year 2020, as shown in the RES Compliance Forecast filed in the 2016 10 Year System Outlook Report (Figure 16) on June 30, 2016. During this period, if system demand increases or hydro and/or wind generation resources experience a low production year, the PHB Generation Station will be needed to make up the resulting renewable energy shortfall. Once the Renewable Energy Standards (RES) target increases to 40 percent in 2020, significant utilization of the PHB Generation Station may be required to comply with the RES regulations, dependant on the load composition of the system.

(i) The PHB Generation Station is capable of providing essential reliability services to the NS Power system:

- Provision of dispatchable renewable energy

- Provision of synchronous generation at relatively low minimum stable level

- An advantage of synchronous generation over other sources of renewable energy such as wind, solar, tidal and imports is that it provides inertia to the system which contributes to stability and frequency control in the event of major faults. Synchronous generators also contribute to short circuit capacity, a measure of system strength.

- The unit is equipped with a voltage regulator which contributes to the support of the Port Hastings transmission node, particularly when the Point Tupper Unit 2 generator is off-line.

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Project #	Project	2013 Spend	2014 Spend	2015 Spend	2016 Spend
43646-S001-251	PHB - Routine Equipment Replacement	422,955	375,009	81,146	173,369
43648-P016-251	PHB - Tools and Equipment Routine	103,302	9,437	-	-
44888-SC72	PHB - Boiler Refurbishment 2014	-	783,355	-	-
45045-SC44	PHB - Evacuation alarm	-	64,679	26	(600)
45110-SC87	PHB - Ash Handling Modifications	-	109,475	-	-
45114-SC52	PHB - Analytical Panel	-	97,633	10,758	-
46451-SD98	PHB Boiler Refurbishment 2015	-	-	754,883	-
46452-SD99	PHB Fuel System Refurbishment 2015	-	-	239,072	42,480
47613-SF29	PHB - Boiler Refurbishment 2016	-	-	-	567,523
47614-SF17	PHB- Fuel System Refurbishment 2016	-	-	-	351,779
47936-SE77	PHB - Biomass Fuel Tarps	-	-	66,680	-
49355-SG54	PHB - U&U Critical Piping Refurbishment	-	-	-	26,076
	Totals	**526,257**	**1,439,588**	**1,152,566**	**1,160,626**

Request IR-13:

Please provide a list of all of NSPI's hydro and thermal generating units with each unit's:

(a) Summer and Winter capacity

(b) Fuel type

(c) Annual capacity factor for the past 3 calendar years

Response IR-13:

(a-c) Please refer to Attachment 1.

	A)		B)	C)		
Unit / System	**Summer Capacity (MW)**	**Winter Capacity (MW)**	**Fuel Type**	**2014 Capacity Factor**	**2015 Capacity Factor**	**2016 Capacity Factor [1)]**
LIN-1	153	153	Coal	52%	52%	55%
LIN-2	153	153	Coal	50%	29%	18%
LIN-3	153	153	Coal	34%	41%	49%
LIN-4	153	153	Coal	60%	58%	33%
POA	171	171	Pet coke / Coal	72%	76%	73%
POT-2	152	152	Coal	77%	74%	74%
TRE-5	135	150	Coal	59%	59%	54%
TRE-6	157	157	Coal	82%	78%	75%
TUC-1	81	81	Nat gas / HFO	37%	23%	6%
TUC-2	93	93	Nat gas / HFO	51%	39%	22%
TUC-3	147	147	Nat gas / HFO	26%	41%	47%
TUC-4	47	49.5	Nat gas	51%	49%	57%
TUC-5	47	49.5	Nat gas	55%	50%	55%
TUC-6	46	48	Combined Cycle	32%	24%	31%
PH Biomass	45	45	Wood Product / Nat gas	65%	52%	54%
Burnside-1 2)	25	30	LFO	1%	1%	0%
Burnside-2	25	30	LFO	1%	1%	0%
Burnside-3	25	30	LFO	0%	1%	0%
Burnside-4	25	30	LFO	0%	0%	0%
Tusket-4	21	24	LFO	0%	0%	0%
VJ-1	25	30	LFO	0%	0%	0%
VJ-2	25	30	LFO	0%	0%	0%
Wreck Cove	212	212	Hydro	18%	15%	14%
Annapolis	19	19	Hydro	9%	8%	11%
Avon	6.75	6.75	Hydro	52%	37%	40%
Black River	22.5	22.5	Hydro	55%	54%	40%
Nictaux	8.3	8.3	Hydro	45%	46%	50%
Lequille	11.2	11.2	Hydro	36%	27%	21%
Paradise	4.7	4.7	Hydro	45%	61%	51%
Mersey	42.5	42.5	Hydro	75%	73%	63%
Sissiboo	24	24	Hydro	49%	39%	26%
Bear River	13.4	13.4	Hydro	41%	37%	24%
Tusket	2.4	2.4	Hydro	52%	50%	40%
Roseway / Harmony	1.8	1.8	Hydro	-1%	-1%	-1%
St Margarets	10.8	10.8	Hydro	26%	34%	23%
Sheet Harbour	10.8	10.8	Hydro	44%	56%	35%
Dickie Brook	3.8	3.8	Hydro	28%	32%	26%
Fall River	0.5	0.5	Hydro	59%	54%	35%

1) 2016 Capacity Factors are to Dec.1, 2016. Also note, 2016 is a leap year.

Request IR-14:

Please provide the natural gas price and delivered coal price assumptions relied upon to generate replacement energy cost estimates for the EAM used to support the 2017 ACE Plan.

Response IR-14:

Replacement Energy Cost calculations are based on fuel and purchased power prices used in the development of the 2017-2019 Fuel Stability Plan Refresh Application filed on May 27th, 2016. The delivered coal and natural gas prices are described in Section 5.2 (page 41-42) and Section 5.3 (page 47-48) of the Application[1], respectively.

[1] M07348 - Nova Scotia Power Inc. - 2017-2019 Fuel Stability Plan and Base Cost of Fuel Reset Application, pages 41-48.

Request IR-15:

Please provide a detailed explanation of NSPI's long-term operating strategy for each of the Lingan generating units, including the age of each unit, the estimated remaining operating life of each unit, and projected major capital spending projects over the next 5 years. Please also specify how the operating strategy has been updated or changed since the previous ACE Plan was filed.

Response IR-15:

The Lingan Generation Station is comprised of four 150 MW pulverized-coal fired generating units commissioned between 1979 and 1984. As with all steam units in the generation fleet, these units are expected to experience a decline in energy production as NS Power's renewable resource requirements increase and energy sales remain flat. However, energy production is not the only value these units bring to the NS Power system. Collectively these units provide approximately 25 percent of NS Power's required installed firm capacity. The Company continues to refine its operating strategy and the associated maintenance strategies for these units as the associated Federal and Provincial policies with respect to carbon are developed. In the interim all units continue to provide important and cost-effective energy, capacity and planning flexibility for our customers.

1. Lingan 1 – Commissioned 1979; Forecasted operating life is beyond 15 years from today:

- Lingan 1 is a flexible unit with two-shifting capability and no significant operating limitations.
- Asset planning is based on gradual reduction in capacity factor and service hours offset by increased two-shift utilization to the end of the decade.
- Post 2020, it is anticipated that this unit will see very low utilization for more than a decade while providing essential capacity requirements.

- Based on the anticipated reduction in future utilization, major investments are not planned at this time. Tactical investments will be made based on year over year assessments. Other mitigating measures will be considered before selecting investment.
- There has been no change in operating strategy since the 2016 ACE Plan.

2. Lingan 2 – Commissioned 1980; Forecasted to operate until 2020:

- Lingan 2's operating life is being managed with anticipated retirement in 2020.
- Major outages and investments are being avoided in this unit.
- Risks are being mitigated with operating limitations:
  - Restricted stop/start cycles
  - Long duration layups to preserve remaining life for winter operation
- The only change in operating strategy since the last ACE Plan submission is that it is now intended to sustain LIN2 as operational until 2020. This is anticipated to translate into 6 to 8 months more operating hours.

3. Lingan 3 – Commissioned 1983; Forecasted operating life is beyond 20 years:

- Lingan 3 underwent a major refit in 2015 and has been positioned for full service and flexible operation.
- Lingan 3 is anticipated to be operational for several more major maintenance intervals (typically 8 year intervals).
- This unit will continue to have investments in all asset classes similar to historical. The next major maintenance interval is planned for 2023.
- There has been no change in operating strategy since the 2016 ACE Plan.

4. Lingan 4 – Commissioned 1984; Forecasted operating life is beyond 20 years:

- Lingan 4 underwent a major refit in 2016 and has been positioned for full service and flexible operation.
- Lingan 4 is anticipated to be operational for several more major maintenance intervals.
- This unit will continue to have investments in all asset classes similar to historical practice. The next major maintenance interval is planned for 2024.
- There has been no change in operating strategy since the 2016 ACE Plan.

Request IR-16:

Please refer to page 169 of document N-1, the 2017 ACE Plan. Please describe NS Power's "dam safety risk prioritization." Include methodology, factors taken into consideration, and list of safety projects by prioritization and associated cost estimates.

Response IR-16:

NS Power's dam safety prioritization worksheet is utilized as a planning tool for assessing and prioritizing deficiencies associated with the water-retaining structures (dams, spillways, etc.). The information utilized in the prioritization worksheet is taken from the Dam Safety Reviews (DSR), which are completed for each of the 17 hydro systems. DSRs are completed on a seven year cycle for a hydro system and a full set of DSRs, for all 17 hydro systems, are also completed within a seven year cycle.

The prioritization worksheet assesses the structures based on four main categories:

1. Design Adequacy Assessment for a Sunny Day Condition;
2. Design Adequacy Assessment for an Earthquake Condition;
3. Design Adequacy Assessment for a Flood Condition; and
4. General Physical Condition Assessment.

For each category, concern ratings are assigned to each of the items assessed. The maximum of the concern ratings are then assigned as the overall concern rating for the specific structures. The overall concern rating is then multiplied by a scaling factor to determine the Vulnerability Index for each structure.

For a Sunny Day Condition, the reservoir level would be at the Full Supply Level (FSL) or Normal Operating Level. The following items are reviewed as part of this assessment:

overtopping of the crest, overtopping of the core, stability of the concrete or timber structures for No Ice and Ice loading conditions, the downstream slope stability of the embankment structures, and the upstream slope stability based on a rapid drawdown scenario.

For the Flood Condition, the reservoir level would be at the Inflow Design Flood (IDF) level, which is the design flood level based on the dam classification of the structure. The following items are reviewed as part of this assessment: overtopping of the crest, overtopping of the core, and the stability of the concrete or timber structures under flood loading conditions.

For the Earthquake Condition, the reservoir level would remain at the FSL and seismic coefficients would be applied to the analyses. The following items are reviewed as part of this assessment: the stability of the concrete or timber structures under seismic loads, and the upstream and downstream slope stability of the embankment structures under seismic loads.

For the Physical Condition Assessment, the physical conditions of the structures are assessed for the embankment, concrete, and timber structures. The items assessed as part of the embankment structures include: the crest, upstream slope, downstream slope, instrumentation / monitoring, and conduits. The items assessed as part of the concrete structures include: crest / upstream face / downstream face, piers / abutments, gates / stoplogs, apron / foundation, and channel. The items assessed as part of the timber structures include: crest / decking, upstream and downstream faces, abutments, foundation, and outlet channel.

As part of the requirements of the flood studies, risk values associated with downstream flood events are determined based on the design flood scenarios. These values are assessed for both the sunny day failure and flood failure scenarios.

The Vulnerability Index and risk value parameters are used to determine the Risk and Rank scores for each of the four assessment categories. The risk value parameters are used to determine the Life Safety score. The Risk scores are then determined by multiplying the Vulnerability Index by the Life Score for three risk categories: Life Safety Risk, Environmental and Cultural Risk, and Infrastructure and Economic Risk. The sum of the Risk scores, for the four assessment categories, is used to determine the overall rank of the structure. The overall risk ranking numbers are then sorted in descending order to prioritize the structures. The higher the overall risk number, the higher the rank number.

The prioritization worksheet is a working document and will be updated following the completion of DSRs. The overall prioritization of the structures will change over time based on structures being refurbished, changes to the hydro systems, changes to the CDA Guidelines, etc. The structures are listed, by priority, in the prioritization worksheet and projects are selected based on that information. However, there are no costs associated with each structure/potential project at this time. Potential Preliminary Engineering (PE) projects are identified using the prioritization worksheet and the costs estimates would be completed as part of the PE projects.

For a list of safety projects by prioritization and associated cost estimates, please refer to Attachment 1.

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

IR-16 - Supporting Documentation
Capital Dam Safety Projects - Prioritization List (2017 to 2019)
December-16

Structures	CI Number	Prioritization Rank[1]	Deficiencies	Estimated Construction Costs	Potential Rehabilitation Activities
2017 Construction Projects					
Tusket Main Dam/Canal Embankment/Powerhoue Dam Refurbishment	29807	45/49/24	Freeboard and stability requirements not met. Operational deficiencies with the tainter gates in winter conditions.	$10M	Construct a new concrete dam structure, construct a new bridge downstream of the dam, and refurbish the embankment dams.
Scragg Lake Dam Refurbishment	48535	29	Embankment stability requirements not met. Spillway structure in poor physical condition, stability requirements not met.	$1.8M	Reconstruct the spillway/sluiceway structure and upgrade the embankment sections.
Gaspereau Lake - Lane's Mills Spillway/Muskrat Cove Dyke Refurbishment	16374	147/18	Freeboard and stability requirements not met for all loading conditions.	$6.4M	The existing spillway/fish ladder will be refurbished and a new concrete dam section will be constructed with a spillway section to replace the existing embankment dyke.
Lequille Headpond Dams & Spillways Refurbishment	48533	23/46/50	Freeboard requirements not met for all water-retaining structures.	$3.5M	Increase the discharge capacity of the spillway structure, raise the embankment dams, and refurbish or replace the canal intake structure.
2018 Construction Projects					
Sissiboo Falls Main Dam		13	Rubber dam requires replacement, possible concrete work required.	$2.5M	Replacement of the rubber dam and possible concrete works.
Gulch Spillway	48631	42	Stability requirements not met.	$0.6M	Refurbishment of the concrete spillway.
WRC Dams D-5, D-6-1, D-6-2, D-10, D-11-1 and D-11-2		81/83/117	Freeboard and downstream slope stability requirements not met. Major seepage issues and high pore pressures at Dam D-6-1.	$4M (combined)	Raising of the dam crests and addressing the slope stability concerns. Also, addressing the high seepage flows in Dam D-6-1.
Ruth Falls Dam Refurbishment		9	Freeboard and stability requirements not met. Operational deficiencies exist with the stoplog structure.	$4M	Refurbish the concrete dam and embankment structures.
WRC Dam D-9 Refurbishment	48536	22	Freeboard and downstream slope stability requirement not met.	$0.5M	Raise the crest and address slope stability concerns.
Nictaux Canal Embankment		8	Slope stability requirements not met at highest section of the embankment.	$0.3M	Construct downstream toe berm.
Lower Great Brook Water-Retaining Structures		30/39/62	Stability requirements not met for all loading conditions on the embankment and concrete structures. Freeboard requirements not met.	$5M	Rehabilitate the embankment and concrete structures.
2019 Construction Projects					
Marshall Falls Dam Refurbishment	49756	2	Embankment stability requirements not met. Spillway structure in poor physical condition, stability requirements not met.	$3.5M	Refurbish the embankment dams and construct a new spillway/ sluiceway structure.
Weymouth Falls Intake Structure		61	Stability requirements not met. Concrete in poor physical condition.	$1M	Replacement of the existing structure with a new concrete structure.
Miller Lake Dam		64	Stability requirements not met. Concrete in poor physical condition.	$1.5M	Replacement of the existing structure with a new concrete structure.
Nictaux Main Dam		18	Upstream riprap in poor condition.	$1.5M	Refurbishment of the riprap on the upstream slope.
White Rock Canal Embankment		59	Stability requirements not met.	$1M	Refurbishment of the embankment slopes.
Lower Lake Falls Water-Retaining Structures		12/15/20/35	Freeboard and stability requirements not met.	$6.6M	Rehabilitate the embankment and concrete structures.

Notes:
1 - The Proritization Rank is the ranking of the dams within NSPI's Dam Safety Prioritization Worksheet.

Request IR-17:

Please provide a schedule of planned maintenance outages for each of NSPI's generating units for the next three years. Please highlight major outages.

Response IR-17:

The table below shows the duration of the scheduled planned maintenance outages for each of NS Power's generating units for the next three years. Major outages are noted. Please refer to UARB IR-49 for a detailed schedule for 2017.

Unit	Weeks (2017)	Weeks (2018)	Weeks (2019)
LIN1	3	3	3
LIN2	0	0	0
LIN3	0	3	3
LIN4	0	3	3
POA	4 + 2	4	4
POT	4	3	12 (Major)
TRE5	4	4	4
TRE6	9 (Major)	3	3
TUC1	2	3	3
TUC2	7 (Major)	5	4
TUC3	15 (Major)	5	3
TUC4	4	5	2
TUC5	5	2	2
TUC6	4	4	2
PHB	3	3	3
BDS1	2	2	2
BDS1	2	2	2
BDS3	2	2	2
BDS4	0	0	0
VJ1	2	2	2
VJ2	2	2	2
Tusket	2	2	2
WC1	6	3	16
WC2	6	3	3

Request IR-18:

For CI# 48535—Scragg Lake Dam and Spillway Refurbishment:

(a) Please provide the 2012 Dam Safety Review that concluded the Scragg Lake Dam did not meet the stability requirements for the Sunny Day condition.

(b) Please describe the overall "general dam safety improvement program" (p. 170 of N-1) and the timeline of any projects that will be implemented in this program.

(c) What about the "initial assessment" (p. 170 of N-1) led to the conclusion that replacement was the best long-term option? What other options were considered?

Response IR-18:

(a) Please refer to Confidential Attachment 1.

(b) NS Power's Dam Safety Management Program follows the Dam Safety Guidelines issued by the Canadian Dam Association (CDA). The main components of the program include the following:

- Dam Safety Reviews and Flood Studies
- Emergency Preparedness Plans
- Operation, Maintenance and Surveillance Manuals
- Semi-Annual Dam Inspections

Dam Safety Reviews (DSR) and Flood Studies are undertaken for each of the 17 hydro systems on a seven year cycle. Typically, two to three DSRs are completed each year and a full set of DSRs, for all 17 hydro systems, are also completed within a seven year cycle.

Emergency Preparedness Plans are updated each year for each of the hydro systems. The updates typically include; changes/refurbishments to the hydro system, contact personnel changes, etc.

NS Power operations personnel conduct semi-annual dam safety inspection in the spring and fall of each year. The goal of these inspections is to identify and note any changes to the water-retaining structure and deficiencies that will require repairs or preventative maintenance. Photographs are taken during each inspection for documentation purposes.

NS Power also has an established inventory database, which describes all of the water-retaining structures and is used as part of the dam safety prioritization worksheet that categorizes the condition of the structures based on the Dam Safety Reviews. The prioritization worksheet is used as a planning tool to prioritize the structure in terms of their overall condition (stability, freeboard, general condition, etc.) and the results are used to develop the rehabilitation schedule for the structures.

Dam safety related refurbishment projects are prioritized and selected based on the results of the dam safety management program. Each year, the dam safety prioritization worksheet and supporting documentation is assessed to determine which refurbishment project will be advanced to preliminary engineering assessment and design. Once a project is selected, the preliminary engineering is typically completed over a one or two year period depending on the size and complexity of the project. Large, more complex projects may take longer to complete the preliminary engineering.

(c) Since the existing Scragg Lake spillway/sluiceway structure was constructed in 1955 and based on the deteriorating condition of the concrete, replacement of the structure was deemed to be the best long-term option.

The 2012 Dam Safety Review noted that the concrete structure was in fair condition with concrete deterioration, the concrete aggregates becoming exposed, large horizontal and vertical crack running along the length of the structure, and weathering of the concrete had formed along the construction joints. Efflorescence, which is the migration of salt to the surface of the concrete from seepage through the structure, was also noted in some of the cracks. It was also noted that the abutments exhibited cracking and efflorescence, and that the abutments had become separated at the lower corners with the rebar being exposed.

Two additional refurbishment alternatives were considered as part of the initial assessment: (a) rehabilitation of the existing structure, and (b) addressing the inadequate stability with rock anchors. For alternative (a), rehabilitating the existing structure typically has similar cost compared to a full replacement of the structure given the time required to complete the rehabilitation works. The wing walls would have had to have been replaced in both alternatives and there was also uncertainty associated with the sections of the existing structure that are submerged and the foundation conditions. For alternative (b), the use of rock anchors would also be cost comparable to re-constructing the concrete gravity dam. This option would also require the reconstruction of the dam similarly to alternative (a). The simple concrete gravity dam re-construction option would be less complicated to construct, have a safer installation process, and would be less likely to experience installation issues. The use of rock anchors would inherently include design life and long-term performance concerns and monitoring requirements. The gravity dam option without rock anchors eliminates the design life and performance concerns.

SBA IR-18 Attachment 1
has been removed due to confidentiality.

Request IR-19:

For CI# 48631—Gulch Spillway Refurbishment:

(a) Please provide the 2014 dam safety review that concluded the Gulch Spillway does not meet current CDA design guidelines for stability.

(b) Please explain and provide any supporting documentation that justifies the Gulch dam being classified as "HIGH" (p.173 of N-1) in the 2014 flood study. Please define what the classification "HIGH" means in this context.

(c) Please provide any analysis of alternative options, such as the addition of rock anchors. Please provide any supporting documentation showing that the alternatives considered are less desirable.

(d) Why is there no EAM for this project to compare the costs of the alternatives identified?

Response IR-19:

(a) Please refer to Sub-section 7.4.4 of Confidential Attachment 1.

(b) The Canadian Dam Association bases its classification on the consequences of dam failure with respect to the following:

- Human Life
- Environmental and Cultural Values
- Infrastructure and Economics

Please refer to Sub-section 7.2 in Confidential Attachment 1 for supporting documentation on the Gulch spillway classification.

(c) Please refer to Partially Confidential Attachment 2 for a cost estimate of the rock anchor option which shows it is a more costly option by $57,000, in addition to the technical issues mentioned in the project description in the 2017 ACE Plan. Rock anchors may lose their effectiveness over time, and the deteriorated concrete would still have to be replaced.

(d) No EAM was used to compare these two options as the rock anchor option is the more costly of the two options, and all future costs are the same.

SBA IR-19 Attachment 1
has been removed due to confidentiality.

Gulch Spillway Contract Cost Estimate (Rock Anchors)

Cost Estimate

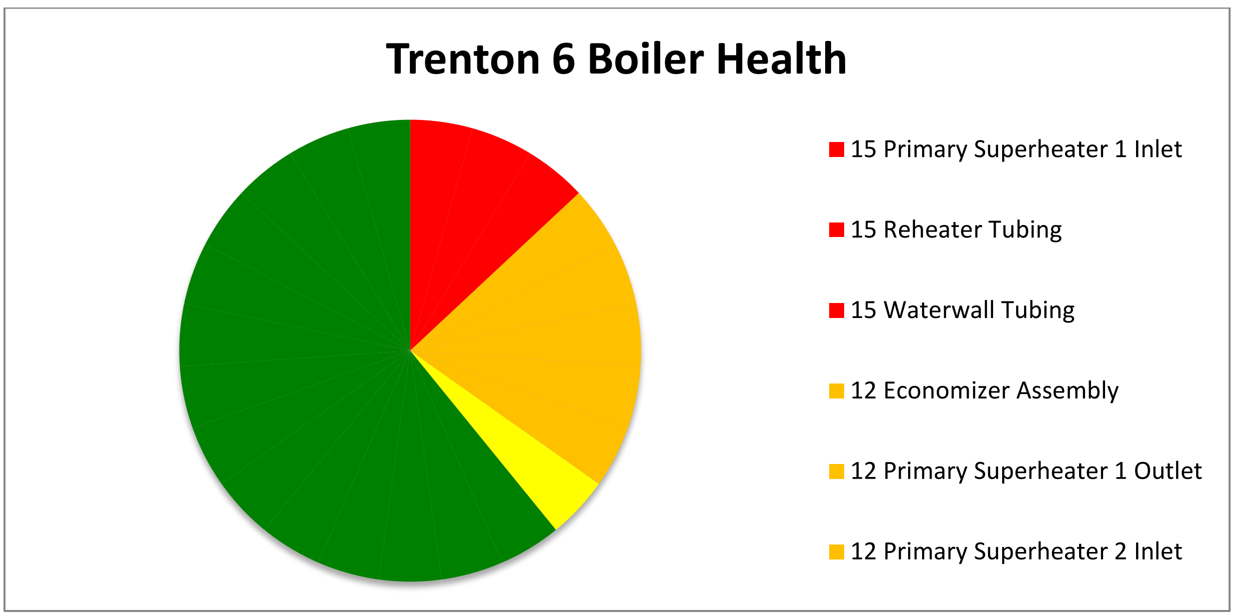
item	Description	Quantity	Unit	Unit Price	Total
1	**Mobilization and demobilization**				
1.1	Mobilization	1	L.S.	[redacted]	[redacted]
1.2	Demobilization	1	L.S.	[redacted]	[redacted]
1.3	water control and silt barriers	1	L.S.	[redacted]	[redacted]
1.4	Access to dam	1	L.S.	[redacted]	[redacted]
Subtotal					[redacted]
2	**Demolition**				
2.1	Concrete Demolition	12	m3	[redacted]	[redacted]
2.2	Surface Preparation	300	m2	[redacted]	[redacted]
Subtotal					[redacted]
3	**Construction**				
3.1	15M Dowels installation	1500	Ea	[redacted]	[redacted]
3.2	Rebar	6	ton	[redacted]	[redacted]
3.3	New Concrete	45	m3	[redacted]	[redacted]
3.4	Hydrotite	5	10 m	[redacted]	[redacted]
3.5	S & I Rock Anchors	10	ea	[redacted]	[redacted]
3.5	Labour	1000	Hour	[redacted]	[redacted]
Subtotal					[redacted]
TOTAL					[redacted]

Request IR-20:

For CI# 49533—TRE6 Boiler Refurbishment: Please provide all supporting documentation that shows that the boiler will need to be refurbished.

Response IR-20:

The figure below shows the health assessment of Trenton Unit 6 boiler. Consistent with NS Power's asset management risk ranking methodology, each piece of major equipment is evaluated on condition (1-5) and criticality (1-5) to produce a risk ranking (1-25). These risk rankings are displayed graphically below to demonstrate the overall health of the boiler. Sections of the boiler that have been evaluated to be in very poor condition are shown in red, while sections which were evaluated to be in acceptable condition are shown in green and are not detailed fully in the graph below.



Evaluation of the primary superheater, reheater and waterwall tubing yielded a risk ranking of 15, meeting NS Power's criteria to take mitigating measures. These sections require selective tube repairs to maintain minimum wall thickness corresponding to American Society of Mechanical Engineers (ASME) specifications. The condition assessments for each section were completed by industry experts in collaboration with internal subject matter experts. Please refer to Attachment 1 for a summary of the 2015 boiler inspection and recommendations completed by the OEM (Original Equipment Manufacturer) which was reviewed as part of the evaluation.

ALSTOM

EXECUTIVE SUMMARY REPORT

Nova Scotia Power Incorporated
Trenton Generating Station
Unit # 6
May/June, 2015 – Shutdown

Summary

The utility boiler for Unit # 6 at Trenton Generating Station was shut down as part of the Planned Annual Maintenance in May/June, 2015.

The major part of the boiler work carried out was the installation of two {2} wall panels on the east wall and six {6} spiral tubes, at {2} bifurcate locations, in the RH Outlet {8th} floor. The visual and ultrasonic survey carried out reveled seven hundred areas {700} totaling twenty-four hundred and seventy-five inches {2475"} identified for pad weld overlay in the upper furnace and ninety one areas {91} totaling eight hundred and sixteen inches {816"} identified for pad welding in the lower furnace.
Water seal dimple plate was replaced.
Replaced sector plates in both "A" & "B" air heaters.

Introduction

During the May/June, 2015 shutdown, the boiler was inspected internally to determine the condition and assessment. The boiler was repaired to ensure the Unit's integrity could be maintained.

Alstom under the Supervision of Shaun Simmons carried out the repairs. Alstom under the Supervision of Mr. Matthew Muise carried out the Non-Destructive Testing and Quality Control functions.

Lower Furnace

The north and south sides of the water seal trough dimple plate were replaced and repairs were carried out on the east and west ends. New chain curtains were also installed.

A visual and UT survey was carried out on the waterwalls with the following noted:

The North Waterwall {Front} was surveyed with fifteen {15} areas for a total of one hundred twelve inches {112"} overlayed with pad welding.

The South Waterwall {Rear} was surveyed with thirty-eight {38} areas for a total of four hundred three inches {403"} overlayed with pad welding.

The East Waterwall {Left} was surveyed twenty-one {21} areas for a total of one hundred forty-nine inches {149"} overlayed with pad welding. There were two {2} Waterwall panels replaced on the East Waterwall. These panels were from Tube 69 – 98 at Elevation 56' to 68'.

The West Waterwall {Right} was surveyed with seventeen {17} areas for a total of one hundred and fifty-two inches {152”} overlayed with pad welding.

All butt welds were radiographed and accepted. All pad welds were MT Inspected and accepted.

In addition to the above inspections, the IR’s were also inspected and rotations recorded and results given to NSPI.

Up Pass # 1 – 9th Floor – 56.6 M

Up Pass # 1 was visual and UT surveyed with one {1} area for a total of one inch {1”} identified for pad weld overlay. This weld was carried out, inspected and found acceptable.

Up Pass # 2 – 8 2/3 Floor – 54.0 M

Up Pass # 2 was visual and UT surveyed with one hundred and thirty-seven {137} areas for a total of four hundred and forty-four inches {444”} identified for pad weld overlay. These welds were carried out, inspected and found acceptable. In addition to the above, fifteen {15} shields were replaced during this shutdown.

Up Pass # 3 – 8 1/3 Floor – 51.8 M

Up Pass # 3 was visual and UT surveyed with one hundred and sixteen {116} areas for a total of three hundred and sixteen inches {316”} identified for pad weld overlay. These welds were carried out, inspected and found acceptable. In addition to the above, sixty-one {61} shields identified for replacement, with forty nine {49} being replaced during this shutdown.

Up Pass # 4 – 8th Floor – 49.2 M

Up Pass # 4 was visual and UT surveyed with forty-five {45} areas for a total of four hundred and ninety-three inches {493”} identified for pad weld overlay. These welds were carried out, inspected and found acceptable. There was also two {2} bifurcate replacements which consisted of a total of six {6} spiral overlayed tubes installed. There was 10% radiography carried out with no failures. In addition to the above, one hundred and eighty-eight {188} shields were replaced during this shutdown.

Up Pass # 5 – 7 ½ Floor – 46.4 M

Up Pass # 5 was visual and UT surveyed with eighty-one {81} areas for a total of three hundred and fifty-nine inches {359”} identified for pad weld overlay. These welds were carried out, inspected and found acceptable. In addition to the above, one hundred and twenty-seven {127} shields identified for replacement, with one hundred and eight {108} being replaced during this shutdown.

Up Pass # 6 – 7th Floor – 43.5 M

Up Pass # 6 was visual and UT surveyed with thirty-one {31} areas for a total of one hundred eighty-six inches {186”} identified for pad weld overlay. These welds were carried out, inspected and found acceptable.

Up Pass # 6 - Under Bulkhead

Up Pass # 6 {under bulkhead}, was visual and UT surveyed with two hundred and twenty-three {223} areas for a total of five hundred and seventy-two inches {572”} identified for pad weld overlay. These welds were carried out, inspected and found acceptable. In addition to the above, twenty-one {21} shields were replaced during this shutdown.

Down Pass # 1 – 8 2/3 Floor – 54.0 M

Down Pass # 1 was visual and UT surveyed with six {6} areas for a total of fifty-four inches {54"} identified for pad weld overlay. These welds were carried out, inspected and found acceptable.

Down Pass # 2 – 8 1/3 Floor – 51.6 M

This Section was visual inspected with six (6) shields identified for replacement.

Down Pass # 3 – 8th Floor – 49.2 M

This Section was visual inspected with two (2) shields identified for replacement.

Down Pass # 4 – 7th Floor – 43.5 M

Down Pass # 4, {economizer header}, was visual and UT surveyed with forty-six {46} areas for a total of fifty inches {50"} identified for pad weld overlay. These welds were carried out, inspected and found acceptable.

Steam Drum

There was a visual inspection carried out in the steam drum. There was one can on the west end that had hole in plate and there were two {2} ¼" indications in the box. These areas were repaired and inspected.

Deaerator

All attachment, circumferential and longitudinal welds in the Deaerator Storage Tank were inspected visually and with Wet Fluorescent Magnetic Particles with no defects noted during this shutdown. The attachment welds in the Deaerator Heater were visually and with Wet Fluorescent Magnetic Particles. No defects were noted. An ultrasonic thickness survey was carried out in the Heater on a few eroded areas with no repairs required. The weld on the center nozzle, on the heater side, was eroded and required to be repaired. This weld was repaired, inspected and accepted.

Blow Down Tank

The Blow Down tank was visually inspected with cracking of the liner to shell evident. These cracks were repaired and accepted.

Headers

Headers were not inspected.

Turbine

Turbine LP rotor diaphragms and upper and lower casings were Wet Fluorescent Magnetic Particles inspected. There were repairs done to the casing faces. In addition to the casings there were indications on some of the diaphragms and all findings were reported to NSPI.

Air Heater

During the 2015 shutdown the stationary sector plates were replaced in both "A" & "B" sides.

"B" Boiler Feed Pump

During the 2015 shutdown there was a repair done, {weld overlay}, on the "B" Boiler feed pump discharge nozzle .

Miscellaneous

There were several attemporator lines cut to allow for internal inspections. Feed water line, SH lines and cold reheat line.

Conclusions and Recommendations

During the next Planned Shutdown, the following areas should be surveyed in addition to the normal boiler survey:

- Full water wall survey.
- Review UT readings in RH outlet for possible tube replacements. (Several tubes were shielded due to low UT readings)
- Due to the amount of pad welding carried under the bulkhead via swing stage, May 2015, re-inspect these areas to ensure tube integrity is maintained.
- Header inspections should be carried out.
- Inspect the I-Beams between the Air Heater and the ductwork due to cracking identified May 2013.
- Review possibility of replacing discharge nozzle on "B" boiler feed pump.
- Due to leak on the North wall just under the Primary SH Inlet, shortly after running the unit up, visual and MPI inspection should be carried out on all existing pad welds.
- Inspect wall tube that was pad welded with E9018. East wall tube # 97 @ elevation 121'.

Request IR-21:

For CI# 47687—POT Boiler Chemical Recondition: please provide the utilization of the POT Unit #2 for the past 3 calendar years, and please describe how often Chemical Treatment needs to be completed on this unit.

Response IR-21:

The table below represents Point Tupper utilization in terms of capacity factor, operating hours and starts for the last three years calendar years.

	Capacity Factor	Operating Hours	Unit Starts
2013	61%	6493	3
2014	77%	8258	4
2015	74%	7860	3

The frequency of chemical reconditioning is dependent on multiple operating factors including water chemistry, unit load, and unit starts. This type of reconditioning would be expected to be completed once in Point Tupper's operating life based on projected future utilization.

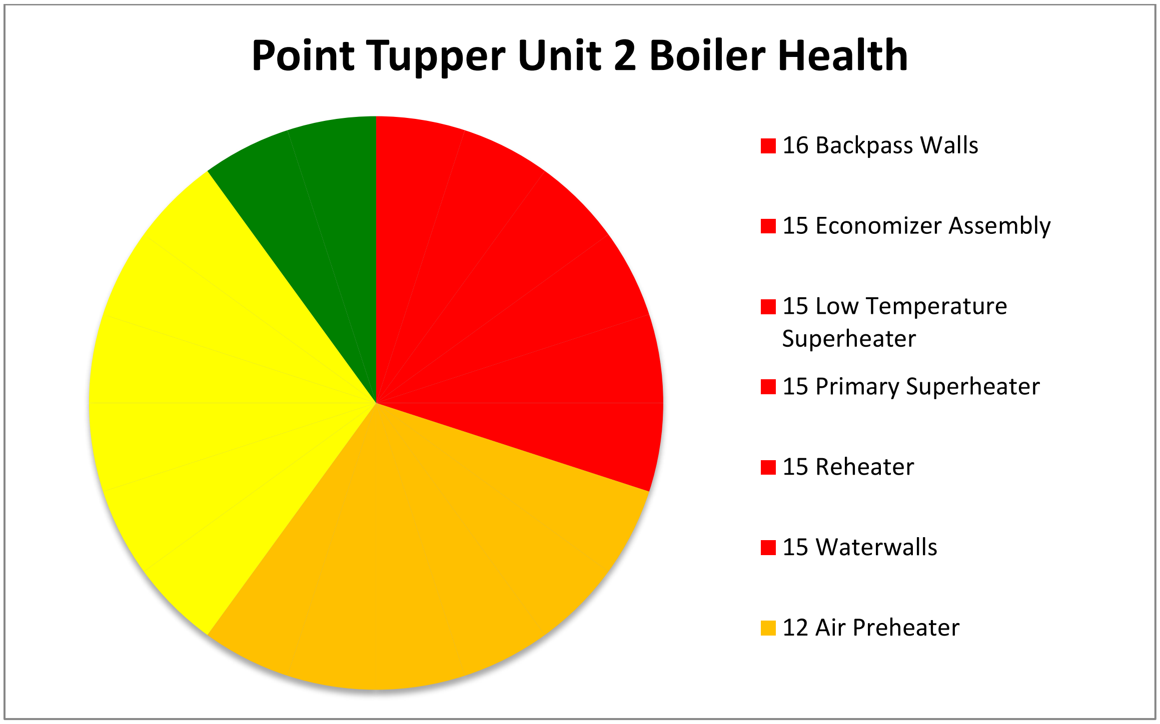
Request IR-22:

For CI# 49419—POT Boiler Refurbishment 2017: Please provide all supporting documentation that shows that the boiler will need to be refurbished.

Response IR-22:

The figure below shows the health assessment of Point Tupper Unit 2 Boiler. Consistent with our asset management risk ranking methodology, each piece of major equipment is evaluated on condition (1-5) and criticality (1-5) to produce a risk ranking (1-25). These risk rankings are displayed graphically to show the overall health of asset. The condition assessments were completed by industry experts with collaboration with internal subject matter experts. The economizer assembly, superheater, reheater and waterwall tubing yielded a risk ranking above 15. These sections require selective tube and piping repairs to maintain minimum wall thickness corresponding to American Society of Mechanical Engineers (ASME) specifications. Please refer to Attachment 1 for a summary of outage inspections and recommendations completed by the boiler original equipment manufacturer.

The figure below is a graphical representation of the Point Tupper Unit 2 boiler health. The areas of the chart represent the risk rating of the various boiler components (Red representing the greatest risk, Green representing the least risk) to provide visual summary of the overall asset condition and an indication of the number of components that require mitigating measures.


Point Tupper Unit 2 Boiler Health
16 Backpass Walls
15 Economizer Assembly
15 Low Temperature Superheater
15 Primary Superheater
15 Reheater
15 Waterwalls
12 Air Preheater

ALSTOM

EXECUTIVE SUMMARY REPORT

Nova Scotia Power Incorporated
Pt. Tupper Generating Station
Unit # 2
August, 2015 – Shutdown

Summary

The utility boiler for Unit # 2 at Pt. Tupper Generating Station was shut down as part of the Planned Annual Maintenance in August 2015.

The major part of the boiler work carried out was the sixteen {16} HTSH Finish Bends replaced for a total of thirty-three {33} butt welds. There were twenty-four {24} bends and ten {10} straight tube sections for a total of sixty-two {62} butt welds replaced in the Front Re-Heat section. Tubes and bends were replaced due to low UT measurements. All RH butt welds and 10% of HTSH welds were radiographed. There were also five (5) wall tubes replaced, one (1) on the west wall due to previous tube leak and three (3) sample tubes, one (1) on the east slope and two (2) on the south wall, and one (1) tube for access on the south wall. In addition a full boiler survey was carried out with all findings reported to NSPI Engineering. There was also one {1} tube replaced at the economizer header and two {2} tube replacements in LTSH 2. A nozzle at the DA Heater shell was replaced. There were also four {4} air heater coils replaced, {North bank}.

Introduction

During the August 2015 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. Shaun Simmons carried out the repairs. Alstom under the Supervision of Mr. Matthew Muise carried out the Non-Destructive Testing. Safety Officer for this shutdown was Mr. Dwayne Boudreau. Mr. Matthew Muise carried out QA functions.

Lower Furnace

A thickness survey was carried out with thirty-one areas {31} for a total of two hundred and thirty-two inches {232"} identified for pad weld overlay on the North Water-wall. Also there were twelve (12) IR's with cracked membrane. These areas were repaired, inspected with Color Contrast Magnetic Particles and found acceptable.

The South Water-wall was surveyed with twelve areas {12} for a total of one hundred and fifteen inches {115"} identified for pad weld overlay. Also there were eleven (11) IR's and four (4) observation doors with cracked membrane. These areas were repaired, inspected with Color Contrast Magnetic Particles and found acceptable. There were two (2) sample tubes taken from the south wall.

The East Water-wall was surveyed with fourteen areas {14} for a total of one hundred and four inches {104"} identified for pad weld overlay. Also there were nine (9) IR's and seven (7) observation doors with cracked membrane. These areas were repaired, inspected with Color Contrast Magnetic Particles and found acceptable. There was one (1) sample tube taken from the east wall.

The West Water-wall was surveyed with twenty-two areas {22} areas for a total of one hundred and seventy-three inches {173”} identified for pad weld overlay. Also there were twelve (12) IR’s and three (3) observation doors with cracked membrane. These areas were repaired, inspected with Color Contrast Magnetic Particles and found acceptable.

The wear areas identified on the above walls at the IR levels with thickness less that 0.140” were repaired.

In addition to the IR repairs, the following areas with measurements less than 0.140” were pad welded in the corners:
Corner # 1 – one {1} pad weld for a total eighteen inches {18”} was repaired.
Corner # 2 – none required.
Corner # 3 – six {6} pads welds for a total of nineteen inches {19”} were repaired.
Corner # 4 – none required.

All above areas were inspected with Color Contrast Magnetic Particles and found acceptable.

There were four {4} pad welds for fifty-two inches {52”} on the north side and one {1} pad weld for three inches {3”} on the south side of the slope of the bull-nose to side walls. All pad weld areas were overlayed, inspected with Color Contrast Magnetic Particles and found acceptable.

Upper Furnace

HTSH

This section was surveyed with sixteen {16} bends replaced due to wall thickness measurements below minimum requirements. These tubes were replaced and 10% of butt welds were radiographed. Hinge pins and slip lock spacers were also replaced during this outage. Attachment welds were visually inspected as well as with Liquid Penetrant Inspection.

Front RH

The Front RH section was surveyed with twenty-four {24} bends and ten {10} straight sections identified for replacement. These tubes were replaced and all butt welds were radiographed. Hinge pins, slip lock spacers and twenty-eight (28) shields were replaced during this outage.

Rear RH

The Rear RH section was UT surveyed with no mechanical work required.

LTSH # 2 – 5th – 4th Floors

There were one hundred and ten {110} areas for a total of one hundred and fifty-eight inches {158”} identified and repaired. In addition to the pad welds there were two (2) tube replacements due to low UT readings. The repaired areas were re-inspected and found acceptable.

LTSH # 1 - 4th – 3 ½ Floors

There were eighty-five {85} areas for a total of one-hundred and six inches {106”} identified and repaired. The repaired areas were re-inspected and found acceptable.

Upper Economizer - 3 ½ - 3rd Floors

This section was surveyed with fourteen {14} areas for a total of twenty-nine inches {29"} required for pad weld overlay. These repaired areas were inspected and found acceptable.

Lower Economizer - 3rd - 2 2/3 Floors

This section was surveyed with six {6} repairs for a total of eleven inches {11"}. These repaired areas were inspected and found acceptable. The casing on the economizer inlet header was removed. A UT survey was carried with one (1) tube stub replaced due to low UT reading. The butt weld was radiographed and accepted.

Steam Drum

The Steam Drum internals were removed for access for visual and Fluorescent Contrast Magnetic Particles could be carried out. Both head to shell welds as well as all head attachment welds on the heads and approximately 80% of longitudinal and circ welds were inspected. There were no defects noted.

Deaerator

The Heater section was visually and UT inspected. There were no UT readings below min wall. Due to low UT readings from the previous year, the 6" HP condensate nipple in the DA Heater was replaced. Butt welds were radiographed and attachment to shell was MPI inspected and accepted.

The lower half of circumferential, longitudinal and attachment welds inside the Deaerator Storage were visually and Fluorescent Contrast Magnetic Particle. There was no staging installed this year. In addition to the weld inspections there were UT readings taken on the shell. No defects or low readings were found.

Blow-Down Tank

A visual and UT thickness survey was carried out in the blow-down tank. Cracking was detected in the liner attachment welds. These indications were excavated, re-welded, and re-inspected. In total there were fifty linear inches {50"} at the top attachment weld and fifty-seven linear inches {57"} at the bottom attachment weld.

Turbine

During this shutdown there was a repair made to LHS Interceptor Valve Cover Bottom.

Conclusions and Recommendations

During the next Planned Shutdown, the following areas should be surveyed in addition to the normal boiler survey as identified by NSPI Engineering:

Access and survey the bottom slope of the bull-nose.
Duplicate the UT survey on the HTSH Bends in Group A, B and C.
Carry out a complete UT survey in the Front RH section, Note: there were four (4) tubes that were near min wall but not replaced.
Due to the extent of pad welding in LTSH1-2, re-inspect all elements to ensure boiler integrity.
Remove Economizer inlet doors and carry out UT inspection on all header tube ligaments.
Due to accessibility, replace lower casing of Economizer Inlet header with new bolted doors.
Inspect Deaerator heater for wall thickness loss.

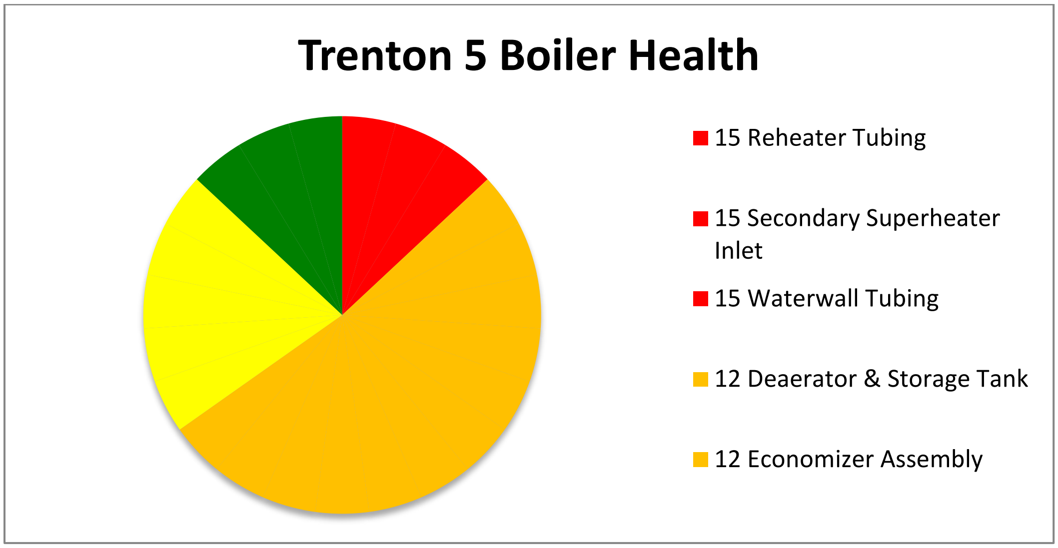
Request IR-23:

For CI# 49536—TRE5 Boiler Refurbishment 2017: Please provide all supporting documentation that shows that the boiler will need to be refurbished

Response IR-23:

The figure below shows the health assessment of Trenton 5 Boiler. Consistent with our asset management risk ranking methodology, each piece of major equipment is evaluated on condition (1-5) and criticality (1-5) to produce a risk ranking (1-25). These risk rankings are displayed graphically to show the overall health of asset. The condition assessments were completed by industry experts with collaboration with internal subject matter experts. Sections of the superheater, reheater and waterwall tubing yielded a risk ranking of 15. These sections require selective tube repairs to maintain minimum wall thickness corresponding to American Society of Mechanical Engineers (ASME) specifications. Please refer to Attachment 1 for a summary of outage inspections and recommendations completed by the boiler original equipment manufacturer.

The figure below is a graphical representation of the Point Tupper Unit 2 boiler health. The areas of the chart represent the risk rating of the various boiler components (Red representing the greatest risk, Green representing the least risk) to provide visual summary of the overall asset condition and an indication of the number of components that require mitigating measures.


Trenton 5 Boiler Health
15 Reheater Tubing
15 Secondary Superheater Inlet
15 Waterwall Tubing
12 Deaerator & Storage Tank
12 Economizer Assembly

EXECUTIVE SUMMARY REPORT

Nova Scotia Power Incorporated
Trenton Generating Station
Unit # 5
May – July 2015 Shutdown

Summary

The utility boiler for Unit # 5 at Trenton Generating Station was shut down in May 2015 for annual inspection and maintenance.

The boiler inspection revealed wall thinning in the SSH Outlet Section. There were seven {7} tubes replaced in this area during this shutdown. There was additional tube replacements carried out as defined in the following sections.

Introduction

During the 2015 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. Shaun Simmons carried out the repairs. Alstom under the Supervision of Mr. Matthew Muise carried out the Non-Destructive Testing / Quality Assurance and Mr. Ernie Aker carried out Safety Officer function.

Lower Furnace

There was no inspection carried out in the lower furnace in 2015.

Cold Re-Heat - Up Pass # 6 - Tubes 1-20 – 8th Floor

The survey of this section was done from the top going down and revealed twelve {12} areas identified for a total of fifty-one inches {51"} for pad weld overlay. These areas were repaired and inspected with Color Contrast Magnetic Particles. There were eight {8} shields identified for replacement. In addition, there were two {2} tubes off saddles.

Secondary SH Inlet – Up Pass 5 - 6 – Tubes 1-24 – 8-8 ½ Floor

The survey of this section revealed twenty-six {26} areas for a total of thirty-four inches {34"} identified for pad weld overlay. These areas were repaired, inspected and found acceptable. In addition, sixteen {16} shields were identified for replacement.

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.

Secondary SH Intermediate – Up Pass 4-5 – Tubes 25-56 – 8 ½ - 9th Floor

The survey of this section revealed no pad welds and six {6} shields required. In addition, there are fourteen {14} platens off wall supports.

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. There were four {4} areas for thirty-two {32} inches identified for pad weld overlay. These areas were repaired and inspected. There were three {3} shields identified for replacement. There were seven {7} tubes replaced due to wall thinning. In addition, there are approximately 80% of the tubes misaligned.

Re-Heat 2 Intermediate – Up Pass 2 - 3 – Tubes 11-30; 9 ½ - 10th Floor

The survey of this section revealed three {3} areas for a total of ten inches {10"} identified for pad weld overlay. These areas were repaired, inspected and found acceptable. There were also two {2} shields identified for replacement. There was one {1} tube replaced due to wall thinning. In addition, there was one {1} platen off wall support.

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 no pad weld overlay required. Also, there were nineteen {19} shields identified for replacement. In addition to the nineteen {19} shields, there were fourteen {14} tubes that were shielded due to low UT readings. In addition, there were four {4} tubes replaced due to wall thinning.

Crossover Tubes - Up Pass 1 – 10 ½ Floor

The survey of this section revealed eighteen {18} areas for a total of twenty-two inches {22"} identified for pad weld overlay, upper division wall. There were no shields required.

Primary SH 3 – Down Pass # 1-2 – Tubes 5-20 - 10 ½ - 10th Floor

The survey of this section revealed ten {10} areas for a total of forty-two inches {42"} identified for pad weld overlay. These areas were repaired and found acceptable. There were sixteen {16} shields identified for replacement. In addition, there are seven {7} tubes off saddles.

Primary SH 2 – Down Pass # 2-3 – Tubes 21-44 – 10-9 1/2 Floor

The survey of this section revealed twenty-one areas {21} for a total of seventy-two inches {72"} identified for pad weld overlay. These areas were repaired and found acceptable. Also there were eight {8} shields identified for replacement. In addition, there are six {6} tubes off saddles.

Primary SH 1 – Down Pass # 3-4 – Tubes 45-66 - 9 ½ - 9th Floor

The survey of this section revealed eleven {11} areas for a total of forty-nine inches {49"} identified for pad weld overlay. These areas were repaired and found acceptable. There was also one {1} shield identified for replacement during this shutdown. .

Primary SH 1 – Down Pass # 4-5 – Tubes 67-70 – 9th – 8th 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 accepted. There were two {2} shields identified for replacement during this shutdown. In addition, there were two {2} platens off of the wall supports.

West, Center and East Economizer – 8th Floor

There were fifteen areas {15} for a total of seventy-four inches {74”} in the West Economizer. There were four {4} areas for a total of fifty-four inches {54”} in the Center Economizer. There were twenty-one {21} areas for a total of seventy inches {70”} in the East Economizer. All above areas were repaired and inspected. There was one {1} shield in the East Economizer identified for replacement.

Boiler Access Doors

During this shut down there were four {4} access doors replaced, doors #’s, 8-5, 8 ½-3, 9-4 and 10 ½-1.

Headers & Front Vestibule

There was no inspection performed at the headers by ALSTOM.

Steam Drum

A visual and Magnetic Particle internal inspection was carried out in the West and East ends of the steam drum. There were several indications found at the attachment welds to the box. 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 one {1} area in the shell. This area was repaired with pad weld overlay and MPI inspected and accepted. . Magnetic Particle and Ultrasonic thickness was carried out on two {2} pervious repairs on the shell. No defects were noted. In addition to the internal inspection there were three {3} headers replaced on the blowdown lines to the tank, # 1, 3 & 4. Please see section six {6} of the 2015 QA Binder.

Deaerator Heater and Storage Tanks

There was a visual UT survey carried out in the DA Heater. There was one {1} area 2” x 2” in the DA Heater which required weld overlay. This area was repaired and MPI inspected and accepted. There was a visual carried out in the DA Storage.

Tubular Air Heater

There was no inspection performed in the tubular air heater.

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.

Bag House

There were a total of nineteen hundred and seventy-two {1972} bags replaced. These were replaced in modules 3, 6, 7 and 8.

Boiler Feed Water Line

There was a section of boiler feed water line replaced on line 5.1 before and up to the block valve, (South Line), 4 welds in total. These welds were required to be PWHT and radiographed. Please see section 8 of the 2015 QA manual for additional information and reports.

ESV Valve Covers

During this shut-down ALSTOM, with guidance from Siemens, repaired three {3} ESV valve covers. Please see section 9 of the 2015 QA manual for additional information and reports.

Conclusions and Recommendations

During the next Planned Shutdown, the following areas should be surveyed in addition to the normal boiler survey:

-Review UT data and existing pad welds on the water-walls, NSPI Engineering investigate the feasibility of replacing wall panels.
-Re-install the QUIK-DECK to access the Cold RH Section.
-Re-inspect the Front and Rear Support Bifurcate tubes.
-Review UT data and re-inspect the shielded tubes in the Sec SH Outlet for possible tube replacements for 2016.
-Review UT data in the RH Finish section for possible tube replacements for 2016. Twenty-three {23} tubes have been tentatively identified for replacement at this time.
-Carry out inspection of bifurcate tubes on the division wall from front & rear sides.
-Carry out a full boiler survey for tube shield identification locations and establish a tube shield drawing,

Request IR-24:

For CI# 47953—LIN Railcar Positioner Upgrade: Please provide any supporting documentation that leads to the conclusion that refurbishment of the coal positioner is a more cost effective solution than replacement.

Response IR-24:

The proposed project includes refurbishment of some components of the existing, proven system (structure and hydraulic pistons), and replacement of others (motors, lines and hoses) where the components have become obsolete and the parts required for refurbishment are unavailable. Replacement of the structure and hydraulic pistons is not required based on an evaluation of their current condition, and risk is better mitigated through refurbishment. The current project plan optimizes the use of existing components through refurbishment, while replacing those where support and parts are unavailable due to obsolescence. Full replacement of all components was evaluated to be more costly than the replacement of some components and refurbishment of others based on NS Power's experience and expert internal engineering assessments.

Request IR-25:

For CI# 49430—LIN CW Pump Refurbishment 2017: Please provide supporting documents that explain if CW pumps on Unit #2 were found to require refurbishment in 2017, investment on Unit #2 could still be the best option.

Response IR-25:

The Cooling Water (CW) pumps are required to allow the unit to operate. Lingan Unit 2 is required to meet capacity requirements until its planned retirement. Refer to NSUARB-IR-48 for more information regarding unit retirement. To meet this requirement, equipment on this unit must be maintained in serviceable condition. While NS Power is managing risks on Lingan Unit 2 and, where possible, mitigating risks by means other than capital investment, there are still risks that may need to be addressed with investment. The CW pumps are interchangeable across all four Lingan units. Therefore, in the case of Unit 2 retirement, the pumps, whether refurbished or not, will be utilized as full spares or parts for the other Lingan units. Analysis on a decision to invest in a CW Pump or other equipment on unit 2 would be made if a deficient condition is identified via inspection and assessment.

Request IR-26:

For CI# 49431—LIN Mill Refurbishment 2017:

(a) Please describe the condition assessment that determines whether a component needs to be replaced or refurbished.

(b) What is the extended life expectancy of the components that are being refurbished?

(c) Please provide supporting documents that anticipate the requirement to refurbish two of the sixteen mills annually will be reduced to a single mill for 2018

Response IR-26:

(a) The mills are selected for refurbishment based on condition assessments, driven by the maintenance strategy. When the criteria are met for refurbishment the mill is disassembled and inspected. Components are assessed through measurement of material loss, visual inspection, and engineering assessment, utilizing the Original Equipment Manufacturer's (OEM's) specifications as a baseline. If it is determined the component can be returned to an acceptable level through refurbishment, and refurbishment is more cost-effective than replacement, this approach would be taken. Examples of parts that are typically refurbished are the mill rolls assemblies, exhauster assembly, and bearings.

(b) The extended life expectancy of the components that are being refurbished is dependent on unit utilization and fuel blend. Historically, major mill refurbishments are required every four years.

(c) Annual mill refurbishments were forecasted to be reduced to one mill by 2018 due to the forecasted utilization of the Lingan Generating Station. Please refer to NSUARB IR-48 for the anticipated capacity factors of the units at the Lingan Generating Station.

Request IR-27:

For CI# 49057—TRE6 Excitation System Replacement:

(a) Please describe NS Power's overall AVR program.

(b) Please provide any supporting documentation that shows it is no longer possible to source OEM spare parts or receive technical services for this equipment.

Response IR-27:

(a) NS Power's AVR program is led by the Electrical Reliability Team as part of the Asset Management Reliability Program. Standardized condition assessments are completed to identify equipment risk rankings. These risks can be mitigated by a number of measures including capital investment, re-design, or applying operating limitations. NS Power identified AVR systems for replacement due to no availability of spare parts and technical support. The table below outlines AVR systems replacements. Lingan Units 1 & 2 are not currently selected for capital investments due to forecasted utilization. AVR components replaced on Lingan Units 3 & 4 are being utilized on Lingan Units 1 & 2 as they are lower utilization units.

	Excitation System Replacement Date
Lingan G1	N/A
Lingan G2	N/A
Lingan G3	2015
Lingan G4	2016
Pt. Aconi G1	2014
Pt. Tupper G2	2015
Trenton 5	2009
Trenton 6	Planned 2017
Tufts Cove G1	Planned 2018
Tufts Cove G2	2013

	Excitation System Replacement Date
Tufts Cove G3	2012
Wreck Cove G1	2015
Wreck Cove G2	2014

(b) The Excitation System and Automatic Voltage Regulator (AVR) for Trenton 6 was manufactured by Westinghouse Canada, and installed and commissioned in 1991. Westinghouse Canada no longer exists and different parts of the company were sold to different manufacturers such as SIEMENS for the power generation side, Eaton/Cutler Hammer for circuit breaker and industrial controls, and Basler Electric for the regulator division but did not include the Westinghouse Canada regulator division. Through discussions with these vendors, sourcing the required parts is no longer an option.

Request IR-28:

For CI# 49675—TUC2 Cooling Water Piping Refurbishment:

(a) Was an EAM analysis conducted for this project? If not, why not? If so, please provide a copy.

(b) What is the extended life expectancy of piping that will be refurbished?

Response IR-28:

(a) An EAM was not conducted for this project. The majority of capital investment is made at the Tufts Cove Generating Station in order to maintain the unit's safe and reliable operation and to meet system stability and capacity requirements. Projects at Tufts Cove are not based on avoided replacement energy costs; therefore an EAM was not completed.

(b) The extended life expectancy of the piping that will be refurbished is 20 years based on historical plant utilization. Based on the current forecasted retirement date of Tufts Cove #2 (2032) this piping refurbishment will not be required again on this unit.

Request IR-29:

Reference CI#49992, 2017 Transmission Right-of-Way Widening 69kV

(a) Please explain the increase due to AO from $4.5M to $5M as provided in the introduction section.

(b) Provide a document that describes in detail the 69kV Transmission Right-of-Way Widening Plan.

(c) Please provide a map of all 69kV lines in Nova Scotia and indicate line numbers for each line.

(d) How many 69kV transmission lines do not require widening the Right-of-Way width because the existing width is sufficient? Please provide studies and or documentation that justifies NSPI's decision to not include these lines in the Right-of-Way Widening Plan.

(e) NSPI's proposes to increase the Right of Way width from 20 to 30-40 meters. Please provide the justification for the proposed width.

(f) For each of the transmission lines on the table included on page 2 of 4, please provide the existing right of way length. Explain why these lines were chosen.

(g) Based on a high-level assessment, the cost per mile differs for each of the elements on the table on page 2 of 4. Please indicate how the cost was assessed and provide documentation that describes this process.

(h) Was NSPI engaged in voluntary negotiations with landowners neighboring the existing Right of Way? If yes, please provide documentation related to these negotiations. Was eminent domain exercised in any of the elements on page 2 of 4?

(i) On page 2 of 4, NSPI states that "Prioritizing the widening of the 69kV transmission rights-of-way based on customer count and redundancy will provide the largest reliability benefit." Please provide documentation that ranks all existing 69kV transmission lines by customer count and redundancy.

Response IR-29:

(a) The proposed $4.5 million per year that was originally presented in the Post-Tropical Storm Arthur Vegetation Management Stakeholder Consultation Report (please refer to Attachment 1, page 16), did not include Administrative Overhead (AO). The amount including AO is $5.4 million, not $5.0 million that was incorrectly stated in the submission for CI 49992. Please also refer to NSUARB IR-63 part (f).

(b) Please refer to Attachment 1, Section 3.1, for the background of the 69kV Transmission Right-of-Way Widening (ROW) plan. Please also refer to Attachment 2 for the 2016-2023 69kV Right-of-Way Widening Analysis by line.

(c) Please refer to Attachment 3.

(d) NS Power has determined that all 69kV lines have sections that require ROW widening.

(e) NS Power utilizes proprietary software (Optimal Clear Width Calculator) to determine the optimal ROW clear width for transmission lines. The calculator utilizes the following parameters: line height, dominant tree height, tree species and vegetation density to calculate the required increased ROW width and the associated performance improvement. The following table illustrates an example of this tool being utilized to improve performance by 90 percent on L-5531 by increasing the right of way width by 5 meters on each side of the right of way (from 20 meters to 30 meters).

Optimal Clear Width Calculator - Assessment of Increased Security Through Reduction of Tree Risk

Plot Number	Line Height (m)	Dominant Tree Height (m)	Tree Species	Density (trees/ha)	Cleared Width (m)	Increased Width (m)	Security Increase (%)
5531 - 1	7.3	18.5	Spruce	2300			
5531 - 2	7.2	23.0	Spruce	900			
5531 - 3	7.5	18.0	Spruce	1500			
Summary					10	5	90

(f) Please refer to Attachment 4. The transmission lines are prioritized based on customer count/type and redundancy in the transmission system. Priority Group 1A (high customer count – no redundancy) and 1B (high customer count – redundancy) were selected for widening in 2017. One line in Priority Group 1C (industrial customer – no redundancy) will also be started in 2017 and will carry over into 2018.

(g) Please refer to Attachment 2. The Estimated Widening Cost per kilometer is consistent for all lines ($12,800/km for Level 1 Priority Group and $11,700/km for Level 2 Priority Group). The Project Easement Cost varies by line and is primarily associated with the expected number of customers per kilometer of line, which translates to either greater or lesser costs associated with the number of property easements acquired.

(h) For CI 49992, voluntary negotiations with landowners owning property adjacent to existing rights of way have not commenced. The Company does not anticipate that expropriation will be required.

(i) Please refer to Attachment 2 for the transmission line rankings by Priority Group.

Nova Scotia Utility and Review Board

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

Post-Tropical Storm Arthur

Vegetation Management

Stakeholder Consultation Report

February 13, 2015

TABLE OF CONTENTS

LIST OF APPENDICES

1.0 INTRODUCTION

At the outset, Nova Scotia Power ("NS Power") would like to thank stakeholders for their active and valuable participation. NS Power is of the view that the Stakeholder Consultation Process was very beneficial and productive. The process created an avenue for NS Power and other stakeholders to share their detailed information on vegetation management programs, as well as NS Power's program's impact on improving power reliability. A dialogue was initiated with all stakeholders involved and the process gave each stakeholder the opportunity to raise issues and dive deeper into vegetation management practices throughout the province of Nova Scotia.

NS Power is committed to continuing this dialogue with each stakeholder after the Stakeholder Consultation Process has ended by conducting regular vegetation management information sessions, creating committees to discuss tree species priorities, and finding program coordination opportunities with each stakeholder. NS Power will be embarking on a vegetation management engagement strategy in 2015.

According to the Union of Nova Scotia Municipalities ("UNSM"), "the UNSM views the report as a good first step. Going forward we are pleased that NSPI will maintain ongoing and regular dialogue with municipalities". NS Power agrees with this statement and believes it reflects the general impression of the participants. NS Power looks forward to continued collaboration with stakeholders on vegetation management practices.

2.0 OVERVIEW OF PROCESS

Post-tropical storm Arthur impacted the province of Nova Scotia on July 5, 2014 leaving 245,000 NS Power customers without power over the course of an eight-day period. By July 12, 2014 all customers had their power restored.

The Nova Scotia Utility and Review Board ("UARB") ordered NS Power to conduct an internal review of its state of preparedness and response to post-tropical storm Arthur and file an in-depth report with the UARB by August 19, 2014. In its report, NS Power concluded that more than 90 percent of the customer outages were due to tree contacts and sections 8 and 9 of that report covered current vegetation management practices and restoration due to vegetation contacts.

After NS Power filed its report, the UARB engaged Liberty Consulting ("Liberty") to review NS Power's response to post-tropical storm Arthur. Liberty submitted its report to the UARB on September 9, 2014 and made 32 recommendations related to NS Power's storm practices.

The UARB issued a decision on October 6, 2014 wherein it directed NS Power to implement Liberty's recommendations, as well as certain other recommendations of the Formal Intervenors and to file an update with the UARB on its progress to date by October 31, 2014. The UARB's decision also included a request for a formal review of the NS Power vegetation management and storm hardening practices. The review was to start on October 21, 2014 and conclude on February 9, 2015 with a final decision from the UARB.

In order to ensure the vegetation management review was a collaborative process, NS Power recommended augmenting the proposed review by 3.5 months in order to enable NS Power to conduct a stakeholder consultation process. The intent of the process was for all stakeholders to work together in developing a common understanding of vegetation management efforts and to work towards developing a unified vegetation management process going forward.

On October 26, 2014 the UARB issued an order agreeing to the process proposed by NS Power and its revised timeline. The stakeholder consultation process began on October 27, 2014 and concludes on February 13, 2015 with the filing of a final report summarizing the results of the stakeholder process.

The formal stakeholders that were involved in the stakeholder consultation process are as follows:

1. Nova Scotia Department of Energy (NS-DOE)
2. Nova Scotia Transportation Infrastructure Renewal (TIR)
3. Union of Nova Scotia Municipalities (UNSM)
4. Halifax Regional Municipality (HRM)
5. Nova Scotia Department of Natural Resources (NS-DNR)
6. Small Business Advocate (SBM)
7. Consumer Advocate (CA)
8. Liberty Consulting Group
9. Ms. Queenie Acker (Independent Customer)

Four group stakeholder meetings were held, as well as a number of individual meetings with stakeholders, to discuss their respective objectives of participating in the process. Terms of Reference and an Issues List were created in the first group stakeholder meeting with input from all stakeholders in attendance. A copy of the Terms of Reference and the Issues List are attached as Appendices A and B respectively. NS Power reported on the status of each issue and provided background data for each item in the group stakeholders meetings. Minutes from each meeting are included in Appendices C-G.

The first individual meeting was held with the Department of Natural Resources ("DNR") on December 9, 2014 and the following outcomes were agreed upon:

1. Starting in 2015, DNR will require all harvesters with work on crown land to submit Geographical Information System ("GIS") data files of the areas where they are harvesting. This information will be accessible to NS Power, which will allow it to prioritize efforts to mitigate issues relating to thin strips of trees being left behind by harvesters in certain areas. Of note, is that thin strips of trees are generally left behind for two reasons: (a) aesthetics or (b) safety in terms of not being able to work near power lines.

2. The NS Power Forestry team will ensure that a representative attends the Woodlot Owner events hosted three times a year by DNR. This will provide more opportunities for woodlot owners to share harvesting information with NS Power.

3. DNR provided a direct contact within their department for coordination on widening of crown lands. NS Power will work directly with this team to ensure that the approval process is efficient.

NS Power also met with the Halifax Regional Municipality ("HRM") vegetation team multiple times throughout the process and discussed the following:

1. Both parties agreed to review the existing Vegetation Management Memorandum of Understanding that had recently expired and create a new Service Agreement for vegetation work within HRM. As both HRM and NS Power conduct vegetation management within the HRM, the efforts to promote cross efficiencies as set out in the MOU will continue to be a component of the pending Service Agreement.

2. It was agreed that a Street Tree Committee would be formed with members from NS Power, HRM, Landscape Nova Scotia, and Subdivision Developers to discuss the "right tree in the right location" approach and compatible species of trees for power lines.

An individual meeting was also held with representatives from Transportation Infrastructure Renewal ("TIR") on January 15, 2015 and the following was agreed upon:

1. NS Power and TIR will meet on a semi-annual basis to communicate priorities of each party's vegetation right-of-way management program and discuss areas of work that can be completed through a coordinated approach. Rural and remote geographical areas will have a renewed focus.

2. NS Power will share its annual vegetation management plan on a yearly basis with TIR.

3. TIR Operations Managers will meet with NS Power Forestry Coordinators on a regular basis to discuss priorities.

In addition to the foregoing, NS Power also conducted a Vegetation Management workshop with all available representatives from the Union of Nova Scotia Municipalities ("UNSM") in Truro on January 9, 2015. The purpose of the workshop was to start an ongoing dialogue between NS Power and UNSM on vegetation management in Nova Scotia. The workshop included presentations on vegetation practices from NS Power, Halifax Regional Municipality and the Town of Truro. A round table discussion was also conducted to capture feedback from the municipalities on the proposed recommendations for the final stakeholder report. The feedback received from the municipalities that were in attendance was that they did not feel comfortable supporting a rate increase for vegetation management, as they felt it was not their position to speak for rate payers.

NS Power has committed to meeting on a quarterly basis with members of UNSM to discuss upcoming priorities of the NS Power vegetation management program and to work toward greater coordination/efficiencies with the vegetation programs being managed by individual municipalities. NS Power recognizes that there can be significant differences in vegetation practices between towns and rural units, and will work with UNSM to try and ensure these differences are taken into account in the NS Power vegetation management program.

3.0 NS POWER DISCUSSION & RECOMMENDATIONS

The objectives NS Power set out to achieve as part of the stakeholder consultation process are directly linked to the following two key recommendations contained in Liberty's report on NS Power's response to post-tropical storm Arthur:

A. Develop a comprehensive plan for widening 69 kV line corridors. The highest priority for widening involves line sections where adjacent land clearing operations have left a thin strip of trees.

B. Develop a comprehensive plan for reclaiming and/or widening the overgrown ROW corridors. The Integrated Vegetation Management (IVM) program has reduced tree events per length in normal weather, but it has not addressed overgrown ROWs sufficiently. NS Power should estimate costs, schedule options and funding options.

Liberty had two additional recommendations for vegetation management in its report that did not end up being reviewed in detail during the stakeholder consultation process. Those two additional recommendations were as follows:

C. Develop a cyclical program for three phase lines being aerially trimmed along the highways (Asset Protection and Urban Management). Normal industry practice for long term reduced unit costs and consistent reliability consists of cyclical trimming on a feeder basis. The three phase line segments should represent a priority, because they are more susceptible to tree contact outages.

D. For the worst performing feeder program, use a weighted multi-year performance evaluation approach rather than an annual performance method.

NS Power agreed to implement these two recommendations in their vegetation management program and the status of the implementation will be communicated in the next work plan update.

3.1 Liberty Recommendation A: 69 kV Right-of-Way Widening

Develop a comprehensive plan for widening 69 kV line corridors. The highest priority for widening involves line sections where adjacent land clearing operations have left a thin strip of trees.

Liberty made the following comment on page 33 of its report on the Review of NS Power's Response to Post-Tropical Storm Arthur: "69 kV transmission lines are very susceptible to outages from hazard trees. Narrow rights of way contribute significantly to the risk". In response to this concern, NS Power will examine the entire 69 kV transmission system to develop a comprehensive plan for widening rights-of-way associated with this voltage class. Widening of rights-of-way is considered by NS Power to be a contributor to ensuring the reliability of the transmission system. While NS Power does carry out some widening of the 69 kV system, the vast majority of work for preventing trees from falling into the system is associated with individual hazard tree mitigation. Hazard trees are identified as a risk based on poor health, decay or leaning. Mitigation of hazard trees eliminates the outage risk associated with those trees, however, it does not address the issue of the multitude of healthy trees which, during major storms, fail and fall into power lines. In NS Power's view, the only way to mitigate the risk of healthy trees falling into power lines is through right-of-way widening.

An area of high priority will be NS Power's ability to understand where adjacent forest harvest operations are leaving thin buffer strips of trees between cleared area and the power line. Although such narrow strips are identified by line inspection, NS Power is of the view that a more immediate or proactive response is necessary to remove or prevent the tree threat. As such, in addition to the information DNR will obtain from harvesters working on crown land, NS Power will develop a broader engagement strategy with the

Department of Natural Resources, large industry and woodlot owner cooperatives to improve NS Power's awareness of all harvest operations in close proximity to the transmission system.

3.1.1 Widening Potential of the 69 kV Transmission System

The standard right-of-way width of a 69 kV transmission line is 66 feet (20m). As the power line structure is usually in the centre of the right-of-way, it results in a cleared area of 10m each side of the centre line; however, the distance between the forest edge and conductors varies depending on structure type. While this distance provides ample clearance for the safe maintenance and operation of all structure variability, it is not wide enough to prevent many tree species that are tall enough to span the entire width and make contact with the power line when they fall. Increasing the current standard right-of-way width for 69 kV transmission lines to 30m, or in some cases 40m, would significantly reduce the risk of trees contacting the power line. Even at these increased widths, the risk associated with falling trees, while significantly reduced, would not be completely eliminated.

NS Power's records indicate that the right-of-way area of the 69 kV transmission system is approximately 1,400 km in total length. Given that in most cases both sides of the right-of-way are impacted by adjacent trees, the widening effort would be double that total (2,800 km). The potential to widen the 69 kV right-of-way depends on the geographical location of the transmission lines. In some cases, where 69 kV lines exist in more residential neighbourhoods, the potential to widen the right-of-way is diminished. In these areas, NS Power will continue with a hazard tree program approach. By removing the residential portion of urban areas from the widening total, it is estimated that about 2,000 km of forest edge has the potential for widening.

The ability to access the 69kV transmission line right-of-way with tree harvesting machinery is critical for right-of-way widening. The topography or drainage in many areas may prevent site access by machines for removing the trees. NS Power will undertake an analysis of the terrain to better understand the opportunities for mechanical harvesting versus manual operations.

3.1.2 Property Ownership and Widening Privileges

Given that the majority of land in Nova Scotia is privately owned, an aspect of developing the comprehensive right-of-way widening plan will be the analysis of property ownership. As such, obtaining easement rights for widening or hazard tree removal on private property and the associated costs will be factored into the plan. To date, clearing for most widening projects has been completed through informal landowner permission. Developing a new right-of-way width standard would have the impact of potentially doubling the size of the right-of-way, resulting in extensive property clearing. It is recommended that such clearing rights be obtained by NS Power from the property owner through formal grants of easement. Based on its past experiences with the development of new rights-of-way, NS Power has a good understanding of the potential costs associated with easement rights, property valuation, and land agent costs. Such costs would be used as an aspect of the prioritization process.

With respect to publicly owned lands, NS Power will work with the Department of Natural Resources to ensure the approval process on crown land is as efficient as possible.

3.1.3 Stakeholder Discussions

The following comments reflect feedback provided by stakeholders during various meetings held to discuss the 69 kV widening recommendation.

Halifax Regional Municipality ("HRM")

HRM were concerned with the proposal of managing to a greater right-of-way width within the HRM area. HRM advised that such action would be counter-productive with respect to the implementation of its Urban Forest Management Plan. HRM also expressed the view that since at-risk trees are the real issue associated with tree failure, NS Power should consider a more intensive hazard tree removal program within HRM as opposed to full widening of the right of way.

NS Power Response to HRM: NS Power recognizes the importance of the right-of-way widths within the core of the HRM and will work with HRM to find opportunities for both widening and hazard tree removal based on transmission line location and multiple use of the right-of-way. Many of the 69 kV transmission rights-of-way in HRM are located in neighbourhoods where widening is not possible and therefore outside the scope of NS Power's comprehensive plan. Where there is the ability to increase the width, NS Power's preferred approach is to widen the right-of-way.

Nova Scotia Department of Natural Resources ("DNR")

DNR has no direct access to cutting operations on private land; however, it has committed to assisting NS Power as much as possible with data access for harvesting on provincial land. DNR is designing a new harvest tracking database, which functions on voluntary participation. This new database could provide NS Power with additional information on private land; however, this project is still in the development stage. All data associated with harvesting provided by DNR will assist NS Power in discovering new harvests adjacent to power lines for proactive removal of buffer strips. DNR has recommended that NS Power establish working relationships with the largest forest industry companies, woodlot cooperatives, and other agencies, such as the Association for Sustainable Forestry, for obtaining harvesting site layout data.

NS Power Response to DNR: NS Power is committed to communicate regularly with all those who work in Nova Scotia's forests through a province-wide engagement strategy that will be developed and implemented in 2015. In addition to establishing contacts with those with harvest records, NS Power will actively participate in already existing workshops and forums designed by DNR to inform and educate woodlot and property owners about best vegetation management practices. NS Power will focus on the safety of harvesting trees adjacent to power lines and the risks associated with leaving thin buffer strips. An element of the comprehensive plan for widening 69 kV transmission rights-of-way will take into account the possibilities of First Nation's restrictions on crown land, which will influence the prioritization process.

3.1.4 Financing

Right-of-way widening is essentially the creation of a new right-of-way adjacent to an existing right-of-way. The costs associated with the landowner contact, easement acquisitions and land-clearing have been determined to be capital expenses. At the outset of the widening program (estimated to begin in 2016), NS Power intends to utilize a capital routine for widening rights-of-way.

3.1.5 69 kV Right-of-Way Widening Recommendations

Given the magnitude of the length of the 69 kV transmission system, in developing the comprehensive plan, NS Power will make determinations for widening based upon a prioritization process. Through the stakeholder consultation process, NS Power was able to gain an increased understanding of the importance of trees to the well-being of more populated areas. As a result, NS Power will give careful consideration to a more site specific plan for 69 kV rights-of-way.

Recommendation 1

The distance between the forest edge and the transmission conductor is dependent on the transmission structure type. Conductor affixed to 'H-frame' structures is closer to the wooded edge than conductor strung on single-pole structures. NS Power will determine areas of greater risk associated with shorter distances due to differing structure types, thereby determining the optimum right-of-way on a line-by-line basis. NS Power recommends increasing the right-of-way width for 69 kV 'H-frame' construction to 40m and for 69 kV lines where the structure type is single-pole, NS Power recommends increasing the right-of-way width to 30m.

Recommendation 2

69 kV transmission lines are often dedicated to large industry, entire towns or suburbs. Higher priority will be given in such cases where there is no alternative means to transmit power to that area. Conversely, lower priority will be given in situations where redundancy of transmission supply exists. NS Power recommends increasing the 69 kV right-of-way width to 40m for areas where no alternative transmission supply exists and increasing the 69 kV right-of-way width to 30m for areas where redundancy exists.

Recommendation 3

Although many of the native tree species in Nova Scotia can grow tall enough to span a 69 kV transmission right-of-way, certain species are of greater concern of failure during major storms. Areas of susceptible species will be identified and a higher priority will be given to these areas over species known to better withstand damaging winds. NS Power recommends increasing the 69 kV transmission line right-of-way width to 40m for an area of higher priority and to 30m for an area of lower priority.

In the event of a conflict among the above three (3) recommendations then Recommendation 1 (structure-type) will prevail over Recommendation 2 or Recommendation 3.

Recommendation 4

The estimated costs to implement the above noted widening recommendations on all 69 kV right-of-ways throughout the province is approximately $36 million. Please refer to Appendix H for the high-level cost analysis associated with this recommendation. NS Power recommends, starting in 2016, spending $4.5 million per year for a period of 8 years on 69 kV transmission right-of-way widening.

Recommendation 5

In addition to the development of a comprehensive widening plan, NS Power recommends implementing an engagement strategy in 2015, which will give the NS Power Forestry team a greater opportunity for interacting with the forest industry, woodlot owners and harvesting companies in order to increase the potential for both preventative measures or timely reaction to be taken when harvest operations are adjacent to 69 kV rights-of-way. In the HRM area, NS Power will develop an engagement strategy for interacting with housing development companies to proactively remove buffer strips prior to building construction.

3.2 Liberty Recommendation B: Distribution Right-of-Way Program

Develop a comprehensive plan for reclaiming and/or widening the overgrown ROW corridors. The Integrated Vegetation Management (IVM) program has reduced tree events per length in normal weather, but it has not addressed overgrown ROWs sufficiently. NS Power should estimate costs, schedule options and funding options.

Activities within the scope of the existing NS Power distribution right-of-way management program are carried out through a blend of reactive and predictive management approaches; with the majority of work being carried out under the preventative program. Preventative work activities are scheduled for full feeder sections and are grouped into the following categories: Asset Renewal, Asset Protection, Urban Management, and Sustainability.

Asset Renewal involves the reclaiming of rights-of-way. The area is cleared of tree growth and trees adjacent to the right of way are trimmed or topped to achieve long-term control of all growth with the potential to impact reliability. Control treatment options include mowing, manual cutting and chipping, herbicide application (cut stump and foliar treatments), as well as trimming.

Asset Protection involves the management of feeder lines that are defined by the lack of space within the roadside right-of-way. Trees that are both in and adjacent to the right-of-way are trimmed for clearance around the conductors and ground clearing is carried out less frequently.

Similar to projects under Asset Protection, *Urban Management* projects are defined by the lack of space for power line infrastructure, and the management of that space is compounded by conflicting interests; mainly the desire to have municipal street trees exist in the same space.

Sustainability defines feeder lines where previous management of the right-of-way has resulted in the control of all incompatible vegetation both below and adjacent to the conductors. The right-of-way is more frequently managed from the ground by means of cutting, mowing and herbicide application and trimming is carried out less frequently.

Liberty made the following comment on page 36 of its report on the Review of NS Power's Response to Post-Tropical Storm Arthur: "Since 2005, NS Power has improved its vegetation management practices by implementing an integrated vegetation management plan (IVM) for distribution. NS Power's pace of addressing the vegetation issues, however, is slow". The below recommendation is NS Power's response to addressing this pace.

3.2.1 Distribution Right-Of-Way Budget Recommendation

The current budget for vegetation management is $10.4M annually, of which approximately $3M relates to Asset Renewal, Asset Protection and Urban Management efforts. This budget allows NS Power to manage the vegetation in pockets of distribution feeders. However, in order to move the vegetation management program to a sustainable level there is a significant amount of the vegetation program that must still be implemented. There is approximately 10,875 km of distribution right-of-way remaining to reclaim throughout the province and at the current budget for vegetation management it is estimated to take approximately 32 years (at $3M per year) to get the program to a sustainable level. The table below shows the estimated costs to reach a sustainable level:

Vegetation Management Type	Length of Right of Way (km)	Cost per Kilometer ($)	Total ($)
Urban	1,205	6,485	7,814,425
Asset Protection	2,560	8,172	20,920,320
Asset Renewal	7,110	9,700	68,967,000
Total	**10,875**	**N/A**	**97,701,745**

In addition to the increased reliability improvements, upon completion of the reclamation effort, NS Power estimates that its annual vegetation management budget could be reduced indefinitely, as it would be primarily focused on sustainability. In addition, the storm budget could be reduced, as there would be fewer failed trees to remove and less damage to repair.

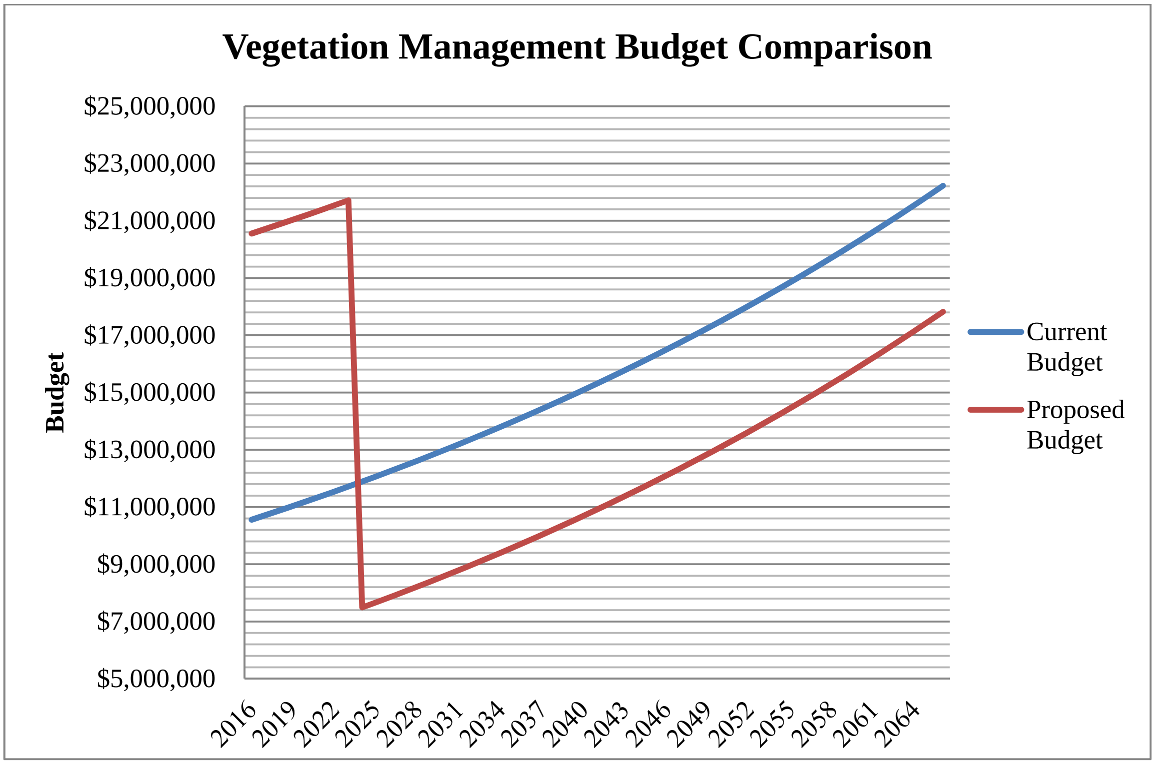
Given the estimated cost, there was considerable conversation with and among stakeholder participants regarding potential impact on affordability. Although an acceleration of the program was supported by participants, their general preference was to do so without creating increased rate pressure.

Obviously, one way to avoid increased rate pressure would be to maintain the status quo. This would mean that the annual budget for vegetation management would stay at $10.4M (plus inflation) for the next 32 years. The vegetation program would continue using integrated management techniques focusing on areas of lesser reliability and working with stakeholders to ensure coordination in all areas of the program. After 32 years the program would be at a sustainable level and the vegetation management and storm response budgets could be correspondingly reduced on a go forward basis.

Although maintaining status quo meets the desire to avoid rate pressure, there was discussion amongst the participants as to whether one could potentially utilize the projected vegetation management and storm response savings (to be realized upon reaching a sustainable program) to support the program's acceleration without adding rate pressure. Ideas such as deferring or capitalizing the accelerated expenses were discussed as possibilities. The primary benefit of this potential approach is that customers would be able to receive the reliability gains from an accelerated program much sooner than the status quo approach while avoiding upward rate pressure.

For context, it is estimated that the distribution right-of-way reclamation program could reach a sustainable level in 8 years if the vegetation management budget was increased by $10M per annum ($10.4M to $20.4M) – resulting in an estimated annual spend on Asset Renewal, Asset Protection and Urban Management of about $13M. If this amount was expensed, this acceleration would increase rate pressure by approximately 1 percent. Once again, by accelerating the distribution vegetation program, customers would receive the reliability benefits much sooner than the 32-year status quo approach.

The following graph illustrates the current budget versus the proposed budget for the next 50 years if the program was to be accelerated from 32 to 8 years:



Recommendation 6

Although there was not the opportunity to canvas this concept in great detail with the stakeholder group, based on initial stakeholder feedback and on the basis that reaching a sustainable level of the vegetation management program will result in improved reliability sooner and reduced costs on an ongoing basis, NS Power recommends pursuing an option that would utilize future reduced costs (savings) to support the acceleration of the program now, while working to avoid additional rate pressure in the future (i.e., utilize future expected savings to fund the present program).

4.0 CONCLUSION

We would like to thank the Board for the opportunity to conduct the stakeholder sessions and thank stakeholders for their active and valuable participation. The sharing of information and views among the participants has been invaluable and will only serve to make the remaining portion of the Vegetation Management and Storm Hardening review process that much more productive. We look forward to participating in the remainder of the review process, continuing collaboration with stakeholders and ultimately achieving a Vegetation Management and Storm Hardening program that brings the most value to our customers.

All of which is respectfully submitted.

Nova Scotia POWER An Emera Company

November 26, 2014

Vegetation Management Stakeholder Engagement Process

Terms of Reference

1) Objective

To collaboratively develop recommendations to the NS-UARB on the future Vegetation Management and Storm Hardening practices for NS Power. Specifically, the final recommendations will focus on two items:

i) Development of the future standard right-of-way widths for 69kV transmission lines throughout Nova Scotia

ii) Establishment of the pace of spend for the annual NS Power vegetation management of distribution line right-of-ways

2) Introduction

A direct outcome of the NS-UARB review of NS Power's State of Preparedness and Response to Post-Tropical Storm Arthur was a formal review of NS Power's Vegetation and Storm Hardening Practices. The original timeline for the review was from October 21, 2014 to February 9, 2015, but NS Power requested a 3 ½ month extension to complete a Stakeholder Engagement process prior to the formal review, which extended the timeline to May 25, 2015. Individual stakeholders were consulted on this proposal and Transportation Infrastructure Renewal, Department of Natural Resources, Union of NS Municipalities, Halifax Regional Municipality, and the Department of Energy were all in agreement to this collaborative approach.

3) Approach

In support of the development of recommendations for the NS Power Vegetation Management and Storm Hardening practices, NS Power will:

a) Consult and collaborate with all stakeholders to gain and share knowledge and experience with vegetation management and storm hardening;
b) Consider successful approaches used in other jurisdictions for annual vegetation management programs and practices;
c) Meet individually with stakeholders to discuss options for jointly achieving objectives;

Nova Scotia POWER An Emera Company

November 26, 2014

d) Build consensus on recommendations for future vegetation management and storm hardening practices;
e) Create drafts of documentation for review and input from stakeholders;
f) Prepare and file a Stakeholder Engagement Final Report to the NS-UARB; and
g) Implement required changes based upon the NS-UARB decision.

4) Scope

As indicated in the NS-UARB Supplemental Order M06321, the Vegetation Management and Storm Hardening Stakeholder Engagement process will begin on October 27, 2014 and end on February 6, 2015. The final deliverable will be the filing of a report summarizing the recommendations developed by NS Power and the registered stakeholders. The following items are 'in-scope' for the Final Report:

a) Standards for 69 kV transmission line right-of-ways throughout the province
b) Pace and spend of the annual NSPI distribution line vegetation management program
c) Stakeholder Objective List developed during November 24 Kick-Off Meeting
d) Off-Right-of-Way tree management program
e) 'Storm Hardening' practices as applicable to vegetation management

5) Consultation Framework

NS Power will seek stakeholder input throughout the process, and will schedule four (4) stakeholder sessions to facilitate direct stakeholder input.

A timeline for meetings and filings is provided below for the engagement process. The final report summarizing the Stakeholder Engagement process will be filed by NS Power on February 6, 2015.

6) Timeline Summary

a)	Stakeholder Kick-Off Meeting	Nov. 14, 2014
b)	Stakeholder In-Person Meeting #1	Nov. 24, 2014
c)	Meet with Individual Stakeholders	Week of Dec. 1

Nova Scotia POWER An Emera Company

November 26, 2014

d)	Stakeholder In-Person Meeting #2	Dec. 11, 2014 (rescheduled to Dec. 12, 2014)
e)	Meet with Individual Stakeholders	Week of Dec. 15
f)	Stakeholder In-Person Meeting #3	Jan. 7, 2015 (rescheduled to Jan. 13 due to UNSM meeting on Jan. 9)
g)	Meet with Individual Stakeholders	Week of Jan. 12
h)	Stakeholder In-Person Meeting #4	Jan. 21, 2015 (rescheduled to Feb. 2 due to winter storm)
i)	Circulate Final Report for Review	Week of Jan. 26 (rescheduled to Feb. 6)
j)	File Final Report with NS-UARB	Feb. 6, 2015 (rescheduled to Feb. 13)

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Stakeholder	Issue	Action	Notes
Union of NS Municipalities	UNSM dos not speak for municipalities directly, therefore UNSM will ensure that they engage in this process	Conduct Municipality Stakeholder Session in Truro on January 9 with CAO's, Mayors and Public Works employees	Meeting held on January 9, 2015
	Would like to see more conversations with developers on tree education when a new subdivision is being built	NS Power is a member of Landscape Nova Scotia and awards a "Right Tree in the Right Place" Award annually to one of it's members. NS Power will work with Landscape NS to strengthen this program through education of contractors, awareness with Municipalities and through website support. Also, through this stakeholder process, NS Power could initiate a program, administered by the munipalities for subdivision development plans which include tree planting to be reviewed by Landscape NS.	Reviewed in Dec. 12 group stakeholder meeting
	Municipalities believe there is inconsistency in how Vegetation Management is done. Possibly related to who is the contractor doing the work	This speaks to a certain extent about social license. There is a consistent specification for vegetation management work however, the extent to which it is implemented may be inconsistent depending on customer expectations and is not related to the vegetation contractor. There is often a dicotomy in relation to the customer expectation for vegetation management and this dicotomy exists within municipal units or is represented by a municipal unit. Generally speaking, in rural areas, customers expect an improvement over previous management work (cut more trees). Contrarily, customers in more urbanized areas expect similar outcomes to those of the past as there is a greater concern for ensuring mature tree growth is maintained rather than eliminated. Based upon customer interaction and acceptance for tree clearing, NS Power may implement more agressive standards to dramatically improve the reliability and sustain the right of way. Such work would include mature tree removal along the edge of the right of way and selective herbicide application to prevent hardwood regrowth. In areas where this level of management is less desirable by the residents, NS Power would implement traditional methods of reclearing around the lines for improved clearance which may include some tree cutting within the right of way only.	Reviewed in Dec. 12 group stakeholder meeting
	Power outages are directly related to Vegetation Management, but what other options are there to decrease outages	Storm hardening' the power system can take several paths in addition to widening rights of way; including installing stronger insulators for conductor, adding additional guy wires to poles, installing sectionalizing devices, upgrading equipment in substations, etc.	Reviewed in Dec. 12 group stakeholder meeting
	How much of a rate increase would be required for an increased NS Power annual vegetation mangement program?	Strawman for an increase in the annual vegetation management program will be presented in January 26 meeting	Reviewed in Feb. 2 group stakeholder meeting
	Most power outage events are caused by trees that are off-ROW	Discuss power outage event history	Reviewed in Dec. 12 group stakeholder meeting
	Disagree with compatible tree definition. NS Power program does not line up with HRM mandate	NS Power is not prepared to accept a definition for compatibility that allows for trees to grow in close proximity to power lines.	Reviewed in Dec. 12 group stakeholder meeting
	Storm Hardening' is not just about vegetation management. It also includes equipment/infrastructure management	Agreed. However, for the context of this stakeholder process, it should be recognized that right of way widening be the only form of strom hardening.	Reviewed in Dec. 12 group stakeholder meeting
	What is the purpose of expanding the width of ROW's? It is too extreme to widen ROW's only for hazard trees	Widening the right of way reduces the line exposure to trees, thereby reducing the risk that a tree will fail and fall on the power line.	Reviewed in Dec. 12 group stakeholder meeting

Halifax Regional Municipality	Ensure that a generalized approach for vegetation management is not used across the province. Urban programs should be different than rural	In almost all cases, NS Power aligns vegetation management opportunties with current land use. In areas where public use of the right of way is high, the use is recognized and plans are implemented to accomodate that use. Where there is no public use, then NS Power may choose to implement more aggressive strategies for improving reliability and the sustainability of the right of way.	Reviewed in Dec. 12 group stakeholder meeting
	Recommend creating a committee with NS Power and various agencies to oversee 'Right Tree in Right Place' and vegetation in new subdivisions	Added to list from Dec. 12 meeting	Reviewed in Jan. 13 group stakeholder meeting
	Provide more context on options like tree wire, covered feeder cable and hendrix conductor	Locations where these applications are in service and reliability stats for these feeders will be discussed in January 13 meeting	Reviewed in Jan. 13 group stakeholder meeting
Department of Natural Resources	Notification of harvesting taking place on land adjacent to NS Power transmission or distribution ROW's	DNR will be requiring contractors to submit GIS shape files of harvest areas that could potentially be shared with NS Power	Reviewed in Dec. 12 group stakeholder meeting
Transportation Infrastructure & Renewal	No issues noted at this time		
Small Business Advocate	Clarify why an edge of ROW tree is topped by NS Power instead of removed	Topping would be implemented when NS Power has limited rights for widening the right of way width. Topping of softwood trees would sustain the tree growth while eliminating the amount of branches subjected to high winds, thereby causing the tree to fall or break. Topping effectively eliminates the exposure of trees falling into the lines without full removal.	Reviewed in Dec. 12 group stakeholder meeting
	Why are transmission ROW's managed different than distribution ROW's?	Alternative land use of the right of way and adjacent land use requires a much higher level of consideration on distribution, whereas on transmission, the area being managed is very remote and management has little impact on alternative uses of the area.	Reviewed in Dec. 12 group stakeholder meeting
	What vegetation practices are most effective for Arthur-type conditions? Would like to see an analysis of this	NS Power has conducted a reliability analysis of distribution feeders located in the valley area with those in the Northern area of the province during Arthur. It has been determined that while storm conditions were similar, those rights of way that were cleared of all tree growth as opposed to being trimmed only, performed better than those that were not.	Reviewed in Dec. 12 group stakeholder meeting
	Will widening ROW's eliminate the potential for trees to fall into power lines?	No. Widening ROW's mitigates the risk by increasing the probability that a tree will fall without making contact with the power line, either because it was not tall enough or due to the fact that there is more clear area to fall into.	Reviewed in Dec. 12 group stakeholder meeting
	What types of trees fell into power lines during Arthur?	Two tree types that either broke or fell over completely were aspen species and spruce/fir species.	Reviewed in Dec. 12 group stakeholder meeting
	What types of transmission events occurred during Arthur?	Individual trees fell from the adjacent forest onto the power line.	Reviewed in Dec. 12 group stakeholder meeting
	Would like to see an analysis on the vegetation management that has been done on the transmission lines that were affected during Arthur. What was the hazard tree program for those transmission lines? Has any outreach been done with adjacent property owners?	Will review with stakeholders in January 13 meeting	Reviewed. in Jan. 13 group stakeholder meeting. Additional columns added to spreadsheet to provide context
Consumer Advocate	How will customers be asked to pay for Vegetation Management or other initiatives?	Vegetation management is part of NS Power's rate base and any increase to the program will affect rates	Reviewed in Dec. 12 group stakeholder meeting
	Are there cost sharing options?	Strawman was used to review cost options	Reviewed in Feb. 2 group stakeholder meeting

Industrial Group	No issues noted at this time		
Department of Energy	Undergrounding power lines is an issue and DOE would like to discuss costs of undergrounding as part of the stakeholder	Will be discussed in more detail in first Stakeholder meeting in January	Reviewed in Dec. 12 group stakeholder meeting
Liberty Consulting	NS Power has a very comprehensive vegetation mangagement program, but a better action plan is needed to address legacy issues. In some cases a cyclical approach is needed	Action Plan will be developed as part of the Stakeholder Process recommendations	Reviewed in Dec. 12 group stakeholder meeting
	Some power utilities have different ROW standards for single-phase lines vs. three-phase lines	Will consider as part of final recommendations	Reviewed in Jan. 13 group stakeholder meeting

Vegetation Management Stakeholder Engagement Process

Meeting Minutes

1223 Lower Water St, Halifax

November 24, 2014

In Attendance
Halifax – Angus Doyle, John Charles, John Simmons, Kevin Osmond
Liberty Consulting Group – Larry Nunnery
NS Power – Greg Blunden, Matt Drover, Rob Young, Nicole Godbout, David Rodenhiser, Linda Lefler, Mark Peachey, Paul Casey
NSDOE – Peter Craig
UNSM – Betty MacDonald, Lyle Goldberg, Brian Cullen (CAO, Municipality of Pictou County)

Via WebEx
NSTIR – Barb Baillie
Small Business Advocate – Alex Cochis
NSDNR – Allan Eddy
Consumer Advocate – Erin Cain
Industrial Group – Maggie Stewart

Items to issue to parties:
- Terms of Reference
- Vegetation Management presentation
- 'Storm Hardening' definition contributed by John Charles
- Soft copy of Halifax urban forest plan contributed by John Charles

Items requested for next meeting:
- Analysis of what Vegetation Management or Storm Hardening practices were most effective in the Valley in terms of withstanding PTS Arthur. (SBA)
- Map of provincial 69 kV lines (UNSM)

Minutes

HRM
- Halifax would like to clarify that most outage events are trees that are off-ROW
- Dislike the use of 'amenity tree' wording

- Disagree with compatible tree definition; NS Power program does not line up with HRM mandate
- This stakeholder process is also about Storm Hardening, which is not just about Vegetation Management. John Charles provided a definition of Storm Hardening to the group
- What is the purpose of widening the width of ROW's? It's too extreme to widen ROW's just for hazard trees
- The MOU with Halifax is a symbol of ongoing collaboration and an example for other Municipalities
- Want to ensure that a generalized approach for vegetation management is not used as part of this process

UNSM

- Power outages are a function of Vegetation Management, but what other options are there to decrease outages?
- Would like to see more conversations with developers on tree education when a new subdivision is being built
- Would like to see a map of 69kV lines throughout the province
- UNSM dos not speak for municipalities directly so UNSM will ensure that they engage in this process
- Municipalities believe there is inconsistency in how Vegetation Management is done. Possibly related to who is the contractor doing the work.
- How is vegetation management done for Municipal Utilities?

Small Business Advocate

- Clarify why an edge of ROW tree is topped by NS Power instead of removed
- Why are transmission ROW's managed different than distribution ROW's?
- What vegetation management practices are most effective for the Arthur type conditions? Would like to see an analysis of this as part of the stakeholder process
- Will widening ROW's eliminate the potential for trees to fall into power lines?
- What types of trees fell into lines during Arthur?
- What types of transmission events occurred during Arthur?

Consumer Advocate

- How will customers be asked to pay for Vegetation Management or other initiatives? Are there cost sharing options?

Industrial Group

- Similar concerns to the Consumer Advocate

NSDOE

- Undergrounding power lines is an issue and DOE would like to discuss costs of undergrounding as part of the stakeholder process
- There is undergrounding related info already available on Tomorrow's Power website, but needs to be communicated/promoted to customers

Liberty Consulting

- NS Power has a very comprehensive vegetation mangagement program, but a better action plan is needed to address legacy issues. In some cases a cyclical approach is needed
- 'Storm Hardening' is related more to infrastructure issues. Undergrounding is being done in other jurisdictions with the City helping to share the costs

NS Power

- Agreed to include context around 'Storm Hardening' in Terms of Reference
- NS Power is a member of Landscape Nova Scotia
- The 'Right Tree in the Right Place' is not the main focus of the stakeholder process, as it is not specifically applicable to vegetation management improvements for storms
- Topping hazard trees rather than completing removing them ensures the tree stays alive, but removes the danger to the power line. This will reduce the potential for hazard trees to fall into power lines, but does not completely eliminate the risk
- Current practice for ROW widths:
    - 69 kV – 20 m
    - 138 kV – 30 m
    - 230 kV – 40 m
    - 345 kV – 50 m
- NS Power will bring provincial map of 69kV lines to one-on-one meeting with UNSM

- 'Compatible trees' mean the tree won't grow tall enough to reach the power line. If the wires are lower (secondary) then a shorter tree is required. Mandate is that no vegetation will encroach on the power lines from underneath
- Municipal Utilities are public utilities and perform their own Vegetation Management

Next Stakeholder Meeting
Will be held on December 11 from 9:00am to 12:00pm at the Westin Hotel in Halifax

M06321 Vegetation Management and Storm Hardening

2014-12-12 Full Stakeholder Meeting Minutes

Present

Small Business Advocate	Alex Cochis – via WebEx
NS Transportation and infrastructure Renewal (TIR)	Mark Peachey
NS Department of Natural Resources (DNR)	Don Cameron
HRM	Angus Doyle, John Simmons, Kevin Osmond, John Charles
Union of Nova Scotia Municipalities	Betty MacDonald, Lyle Goldberg
NS Department of Energy (DOE)	Peter Craig
The Liberty Consulting Group (on behalf of UARB)	Larry Nunnery, John Sherrod – via WebEx
NS Power	Matt Drover, Greg Blunden, Paul Casey, Dave Rodenhiser, Bev Ware, Rob Young, Linda Lefler

Items to issue to parties from this meeting

- Updated Issues List
- PowerPoint Presentation on Issues list

Items requested at this meeting

- Analysis of effectiveness of Vegetation Management practices in preventing Transmission outages; specifically related to the transmission lines that were out during Arthur
- Information from NS Power and UNSM in preparation for the NS Power - municipalities meeting in Truro on January 9.

Minutes

Matt Drover and Rob Young went through the Issues list with the aid of a powerpoint presentation.

Comments from group:

HRM

- Right tree in the right place is utility-centric. Trees by the roadway meet resident's needs more than trees in the back yard. Aesthetic values higher.
- Most developers are members of the Canadian Society of Landscape Architects. Trees need to be included in the concept plan but often they are an afterthought. If trees are

planned ahead of time perhaps the conflict with power poles could be avoided. HRM is looking at amending the subdivision bylaw. NSHBA, NS Power and other groups should participate in a committee to discuss issues like this as they plan placement of trees as well.

- When power poles originally installed, were the ROW's clear of trees?

NS Power

- In most cases ROW's were clear of trees when power poles originally installed.
- Arthur related outages were due to trees too close to the power lines.
- It was many healthy trees that broke; they were hazard trees, but not danger trees. It was the trees as shown on the right of the Roadside Management slide that caused the outages.

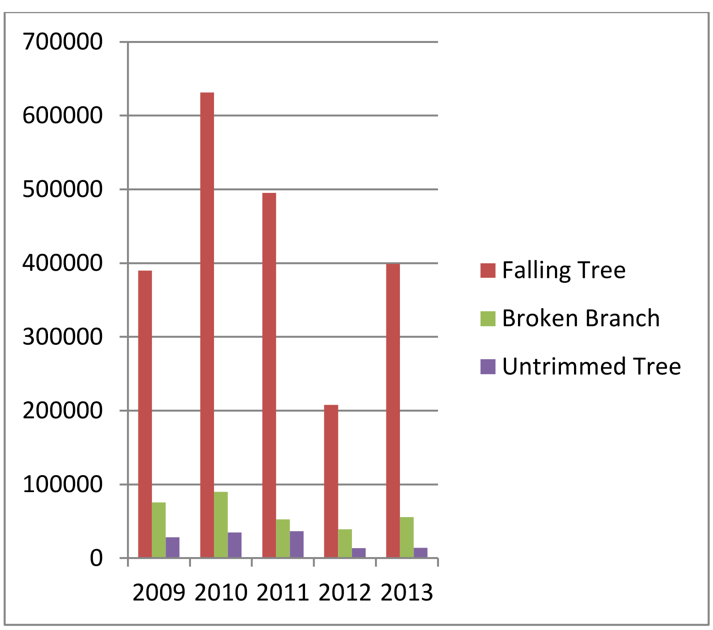
UNSM asked if there was a risk of flooding if clearing is done near a watercourse?

NS Power: we maintain a buffer zone near streams.

SBA asked what it means to "re-establish distribution right of way?"

NS Power: it is about the growth under and to the side of the road ROW. Re-establishing or reclaiming is needed to cut all the incompatible vegetation. Cutting from the ground to the sky. It is a 20 foot clearance on each side of the ROW, since 2003.

Tree caused outage slide



SBA requested the study of effectiveness in avoiding storm outages of the hazard tree program on transmission segments, specifically affected by Arthur. Also, how many landowners were contacted in the cycle before Arthur and what was the response?

NS Power

- Will provide this analysis for the next meeting, as we had taken the previous request mean a distribution analysis. 100% of the Transmission outages were caused by off-ROW trees.
- 90% of the transmission outages during Arthur were caused by trees and off the tree related outages, 100% were due to off-ROW trees.
- A hazard tree is any outside-ROW tree tall enough to fall on the line. They are identified by condition, way of growth (leaning) and rotting. A danger tree is in the ROW, already in a dangerous zone; requires action immediately.
- During Arthur, many trees that fell weren't hazard trees, just tall but healthy trees.

HRM noted that for red spruce trees, even if they are healthy, it's the species that is the issue.

NS Power

- The 69 kV ROW widening is not done by species. The intent is to decrease the number of trees that are capable of falling on the transmission line. Most of the ROW's are bounded by soft wood forests and are considered trees that could fail. It's a question whether a 20 m ROW is wide enough.
- Landowners ask about topping the trees instead - removing the crown which will cause the tree to blow over. Next stakeholder meeting we will talk about the 69 kV program.
- With DNR, NS Power wants to get an understanding of harvest lots near transmission lines. NS Power will harvest trees close to wires for the woodlot owner, but sometimes they are not aware of this (small woodlot owners)

DNR indicated that 70% of woodlots in Nova Scotia are privately owned, and DNR has no role there. For Crown land, they know in advance and will give notice to NS Power.

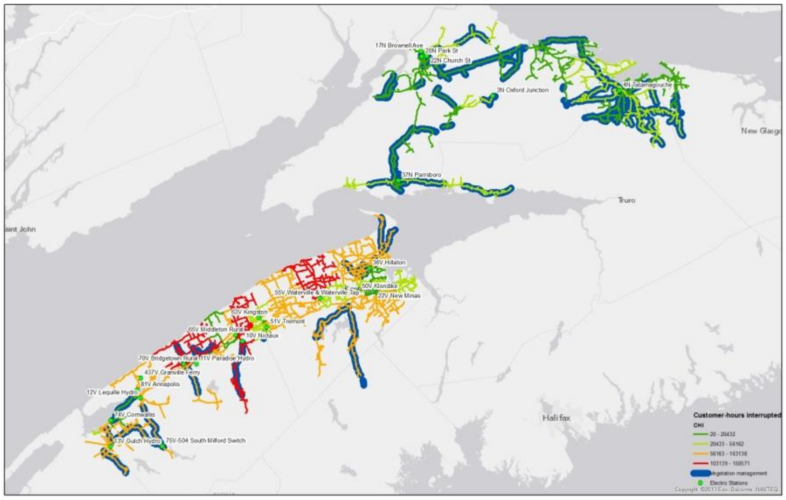
NS Power will work with DNR to try to expand reach.

SBA asked about the reclaiming the ROW slide.

NS Power: in Cumberland County we have done reclaiming and it decreased the time to restore an outage.

UNSM asked if that was in consultation with the municipality?

NS Power indicated that it was mostly with TIR.



<u>DNR</u>

- There is a 20 metre buffer around water courses. There is no requirement otherwise for SMZs (Special Management Zones). When DNR educates landowners, it's to have wider green belts, cut hazard trees, and leave smaller growth.
- There was a tree committee in Truro, which was a cooperative project and worked well.

NS Power: the 20 meter buffer is not an issue, buut landowners may leave trees because they are not confident to cut near a power line.

UNSM: how much is NS Power spending on tree trimming. NB Power has increased vegetation management.

NS Power is currently spending $10.4 million annually on vegetation management. Changes to the spending or a new proposal will be an outcome of this process. If the program is increased, there will be an effect on rates.

Department of Energy: undergrounding should be discussed at the January meeting.

HRM: NS Power initial Arthur report gave information on shielded cable – is that still part of the conversation?

NS Power: there are a few technologies related to covered cable; rubber shielded or Hendrix cables, but the trees need to be trimmed to the same clearance. Sometimes used to meet other design needs, for example, Keltic Drive in Sydney.

Liberty – ROW Management slide – is there a different ROW standard for 1-phase or 3-phase?

NS Power: The picture on the left-hand side of slide is 3-phase and is inadequate from a standard point of view. The right-side of the slide is adequate for a 1-phase line. Sometimes inconsistency is fine, but not a disparity of service between urban and rural.

Note: Slide 9 is customer hours not outages.

Round table

UNSM: the municipalities will raise issues other than Vegetation Management at January 9 meeting in Truro and we will have to ensure that the conversations come back to VM.

DNR (per conversations Matt Drover):

- DNR will supply some info from harvester contractors on where harvests occur.
- NS Power will join DNR education sessions for woodlot owners.
- DNR will work with NS Power to discuss options for acquiring land permits on crown land

Next steps

- Individual meetings will be scheduled with TIR and HRM.
- Municipalities meeting in Truro scheduled for January 9.
- Next larger stakeholder meeting will be scheduled for January 13.

M06321 Vegetation Management and Storm Hardening

Union of NS Municipalities Workshop – Truro Holiday Inn
January 9, 2015

In Attendance:

Unit Name	Job Title	First Name	Last Name
Town of Port Hawkesbury	Chief Administrative Officer	Maris	Freimanis
Town of Truro	Councillor	Tom	Chisholm
Town of Truro	Director of Public Works	Andrew J.	MacKinnon, P.Eng.
Town of Truro	Urban Forestry Coordinator	Andrew	Williams
Town of Westville	Superintendent of Public Works & Water/Wastewater Services	Samuel	Graham
Town of Wolfville	Director of Public Works	Kevin	Kerr, P.Eng.
CBRM	Manager – Public Works North	Louis	Ferguson
CBRM	Manager, Public Works East Division	John	Phalen
CBRM	Manager , Public Works Central Division	Allan	Clarke
County of Colchester	Deputy Mayor	Bill	Masters
County of Colchester	Councillor	Tom	Taggart
County of Colchester	Mayor	Bob	Taylor
County of Colchester	Chief Administrative Officer	Ramesh	Ummat
County of Cumberland	Councillor	Ernie	Gilbert
County of Cumberland	Warden	Keith	Hunter
District of Digby	Warden	Linda	Gregory
District of Digby	Councillor	Maritza	Adams
District of St. Mary's	Deputy Warden	David	Clark
Department of Natural Resources	Regional Forester	Donald Scott	Cameron, BScF, RPF
Environmental Sciences—Dalhousie University	Assistant Professor	Carol	Goodwin
Halifax	Planner	John	Charles
Halifax	Urban Forester/Acting Superintendent of Parks	John	Simmons
UNSM	Policy Analyst	Lyle	Goldberg
UNSM	Municipal Sustainability Coordinator	Debbie	Nielsen
NS Power	Senior Manager	Matt	Drover
NS Power	Forestry Manager	Rob	Young
NS Power	Project Manager	Linda	Lefler
NS Power	Regulatory Council	Brian	Curry
NS Power	Senior Communications Advisor	Beverley	Ware

Items to issue to parties from the workshop:

- Summary of NS Power Vegetation Management Program
- Rob Young's Presentation on Vegetation Management

Minutes

- Matt Drover (NSPI) gave an overview of the Vegetation Management Stakeholder engagement process and the timelines involved.

- Rob Young (NSPI) gave a presentation on the current vegetation management practices that are conducted at NS Power and an overview of the program itself.
- A question was asked regarding options for installing underground power lines rather than trimming trees? NS Power responded that they are not opposed to installing underground lines but there is an incremental cost to install new power lines underground. Not to mention all of the existing overhead lines that would still feed the new underground lines. From reliability standpoint undergrounding power lines is not a cost effective solution.
- A discussion occurred regarding NS Power interaction with municipalities when vegetation management is happening in their area. District of St. Mary's indicated they have had great success with meeting with NS Power before prior to work being done. NS Power indicated that this workshop is a start of a dialogue between NS Power Forestry department and UNSM. The plan is to meet on a more regular basis going forward.
- A question was asked regarding the mitigation of hazard trees and why they are being topped and all branches being removed? NS Power responded that hazard trees on the edge of power line right-of-ways are topped so that they are not tall enough to fall into a power line during a storm and cause an outage.

- Halifax Regional Municipality (John Charles and John Simmons) gave a presentation on their Urban Forest Management plan and talked about the various ways they interact with NS Power.
- A discussion was had regarding street trees and the value they bring to a municipality. Most municipalities agreed with HRM.
- Most municipalities indicated that it would be difficult for them to have a similar vegetation program as HRM due to their size.

- The Town of Truro (Andrew Williams) gave a presentation on Truro's vegetation management program and the interactions that they have with NS Power.
- Andrew urged all municipalities to have a similar program to Truro.
- Andrew indicated that in some cases Truro's vegetation objectives may not align with NS Power's objectives, but he works closely with the NS Power Forestry Coordinators and they often come to an agreement that benefits everyone.

- The Town of Yarmouth was scheduled to give a presentation on their program, but due to the weather had to send their regrets.

- Lunch

- After lunch NS Power discussed their recommendations for the outcome of the Stakeholder Engagement process:
    1. Develop a comprehensive plan for widening 69kV transmission right-of-ways throughout the province that would focus on the criticality of the transmission line and take into consideration urban requirements, customer requirements and any other factors that affect the delivery or use of the power line. Increased right-of-way widths would be recommended in some cases, which involves obtaining easements from property owners and the cost to physically widen the right-of-way.

    2. The current budget for NS Power's transmission and distribution vegetation management program is $10.4M annually, which at the current rate of will take about 30 years to get to a sustainable level of vegetation management. NS Power is proposing to recommend increasing the annual budget by an agreed upon amount, which would also increase power rates, but would allow NS Power to get the program to a sustainable level much faster.

- NS Power then led a workshop for the remainder of the afternoon where each table discussed their responses to three questions posed by NS Power:
    1. How much of an increase in power rates would municipalities be willing to agree to in order to complete our vegetation management program faster? Ultimately improving reliability sooner.
    2. Would municipalities be willing to work with NS Power to promote increases in 69kV ROW width standards? Are you comfortable with our recommendation of a comprehensive plan using criticality of the transmission line as a driver?
    3. Given that branches and limbs in close proximity fail during wind events, what is your position for establishing trees in the same right of way space as power lines? Is the need for an urban forest a significant priority even though there may be a significant impact on reliability under storm conditions? What activity has your town taken to mitigate the potential for outages while maintaining a healthy urban forest?

M06321 Vegetation Management and Storm Hardening

2014-01-13 Full Stakeholder Meeting Minutes

Present

La Capra (on behalf of Small Business Advocate)	Alex Cochis – via WebEx
Small Business Advocate	Ellen Burke – via phone
Consumer Advocate	Erin Cain
Individual	Queenie Acker- via phone
Halifax	John Simmons
Union of Nova Scotia Municipalities	Lyle Goldberg
NS Department of Energy (DOE)	Peter Craig
The Liberty Consulting Group (on behalf of UARB)	Larry Nunnery John Sherrod – via phone
NS Power	Matt Drover, Rob Young, Paul Casey, Brian Curry, Bev Ware, Linda Lefler

Items to issue to parties from this meeting

- Issues List
- Hendrix Feeder analysis
- PTS Arthur Transmission analysis

Items requested at this meeting (documented in Issues List)

- Cost of Hendrix installation (will be discussed at next meeting)
- Historical data on the cyclic Vegetation Management on the transmission lines affected by Arthur
- Vegetation Management strategy and IVM plan for transmission and distribution systems

Minutes

Item 1: Matt Drover and Rob Young went through the Issues list, speaking to the following remaining items.

UNSM

- *UNSM does not speak for municipalities directly.*

NS Power had a session on January 9 to which all municipal representatives were invited, and UNSM has assisted in providing information and contacts. This workshop was the beginning of a dialogue and the members of UNSM – regular meetings will be held going forward.

- *How much of a rate increase would be required for an increased NS Power annual vegetation management program?*

  NS Power presented an indication of the upward pressure on rates for a 15 million dollar annual increase in spending.

  HRM
- Recommended creating a committee with NS Power and various agencies to oversee 'Right Tree in Right Place' and vegetation in new subdivisions

- *Provide more context on options like tree wire, covered feeder cable and Hendrix conductor*

  A summary of the experience with Hendrix conductor was provided. While the Hendrix cable has performed well, outages were still caused by adjacent lines not using Hendrix. NS Power is continuing to assess it.

  SBA
- *Would like to see an analysis on the vegetation management that has been done on the transmission lines that were affected during Arthur.*

  The analysis was provided and discussed. NS Power will provide historical data on the cyclic Vegetation Management on these lines, and meet with Alex Cochis to discuss the assumptions.

  Liberty
- *Some power utilities have different ROW standards for single-phase lines vs. three-phase lines*

• Lyle Goldberg asked if clear cutting behind poles limits NS Power's ability to do work, and is there any discussion with DNR to modify clear-cutting rules. Rob Young indicated the buffer is only for waterways, and most landowners want to cut to the road. NS Power is in favour of increased buffer zones near highways with power lines. This will be included in the final report.

• Peter Craig asked about outages caused by "in-Right-of-Way" trees vs "off-Right-of-Way trees". Ninety percent of the transmission outages in Arthur were caused by trees and 100% of the tree events were caused by off-Right-of-Way trees.

• John Simmons asked about the criteria for hazard trees. Even healthy trees of certain species can be hazardous, for example red spruce, trembling aspen. This is the type of vegetation on Right-of-ways NS Power is looking to widen. John emphasized that they agree with removed spruce but don't agree with cutting all backyard trees. (Caledonia Road example).

• Rob Young provided clarification on the Hazard Tree definition ???

Item 2: Larry Nunnery asked about other Liberty recommendations. Matt confirmed they will also be reflected in an Action plan.

Item 3: Discussion of workshop with municipal reps (UNSM) on January 9. The municipalities do not seem to support a rate increase. Feedback indicated town and rural areas have different ideologies for clearing. Main streets need special consideration, and different towns have different abilities. Cost sharing should be equitable. The municipalities would welcome more visits and their Annual general meeting is a good place to visit as it will have 300 officials in attendance – NS Power agreed. Municipalities are interested in seeing the MOU between NS Power and HRM when concluded and seeing which of the approaches might be adopted for their areas.

Item 4: Final Report Recommendations

- Recommendation 1: Develop a comprehensive plan for widening 69kV transmission right-of-ways throughout the province that would focus on the criticality of the transmission line and take into consideration urban requirements, customer requirements and any other factors that affect the delivery or use of the power line. Increased right-of-way widths would be recommended in some cases, which involves obtaining easements from property owners and the cost to physically widen the right-of-way.

- Recommendation 2: The current budget for NS Power's transmission and distribution vegetation management program is $10.4M annually, which at the current rate of will take about 30 years to get to a sustainable level of vegetation management. NS Power is proposing to recommend increasing the annual budget by an agreed upon amount, which would also increase power rates, but would allow NS Power to get the program to a sustainable level much faster. NS Power will obtain stakeholder input about a plan to increase spend for Vegetation Management.

- John Simmons - qualified support, but not for a rate increase

- Peter Craig – is the current budget inflation adjusted? *NS Power: a standard increase in the budget will relate to escalation in contracts*

- Alex Cochis – what internal criteria will NS Power use to allocate spending with municipalities? Do the municipalities identify areas of priority for Integrated Vegetation Management? *NS Power: there are three ways Vegetation Management is executed:*
    i. *Reliably in relation to observed poor feeder performance (reactive). This spend has dropped over time due to improvements in reliability*
    ii. *Vegetation overgrowth*

iii. Sustainability, managed from the ground up

- Alex Cochis asked to see this strategy. *NS Power will send him the Vegetation Management strategy and IVM plan for transmission and distribution systems*

- Peter Craig pointed out only a General Rate Application (GRA) can increase power rates. *NS Power indicated they are trying to assess support of an increase in the vegetation management budget. The spending on Vegetation Management would be much greater than the amount spent on restoration after a storm, because it is designed for long term power reliability improvements*

Item 5: Larry Nunnery asked if NS Power is meeting CSA Standard 22.3. *NS Power replied that in some cases it is not being maintained due to the funding that is required to manage all power lines in the province.*

Final Vegetation Management Group Stakeholder Meeting Minutes

La Capra (on behalf of Small Business Advocate)	Alex Cochis – via WebEx
Small Business Advocate	Ellen Burke – via WebEx
Consumer Advocate	Erin Cain
Individual	Queenie Acker- via phone
NS Transportation and Infrastructure Renewal (TIR)	Stephen MacIsaac
Halifax	John Simmons, John Charles
Union of Nova Scotia Municipalities	Betty MacDonald
The Liberty Consulting Group (on behalf of UARB)	Larry Nunnery, John Sherrod, John Antonuk – via WebEx
NS Power	Matt Drover, Rob Young, Paul Casey, Brian Curry, David Landrigan, Bev Ware, Linda Lefler

Items to issue to parties from this meeting

Draft NS Power Report to UARB
Verify number of km on Slide 4 for L Nunnery.
Any better available info for Steve MacIsaac on number of km adjacent to TIR ROW.

The following topics were discussed in the final group stakeholder meeting:

1. Issues List

Alex Cochis – easement question about right-of-way widening. The widening NS Power are proposing with our recommendation is more encompassing than edge of ROW hazard tree trimming. This would involve the removal of healthy trees as well to mitigate against fall-ins during storms

The issues list was closed.

2. Update on NS Power and TIR meeting
   - focused on ways to make sure the two groups communicate on regular basis and priorities for work plans are discussed
   - TIR Operations managers to meet regularly with NS Power forestry managers

3. HRM – Service Agreement discussion

- the existing MOU between NS Power and HRM will be replaced with a Service Agreement that is more encompassing and allows for cost sharing options
- Street Tree committee with stakeholders will be created to focus on right tree in the right place and species of trees that are compatible with power lines

4. Recommendation 1:
   NSPI will develop a comprehensive plan for widening 69 kV line corridors. The highest priority for widening involves line sections where adjacent land clearing operations have left a thin strip of trees. This plan will be focused on a number of prioritization factors and will cost $36M to implement – which would be considered a capital expenditure

Alex Cochis - would like to see comparison of edge Vegetation Management approach which we had pursued until this point and was the subject of spreadsheets updated for SBA. NSPI had good reliability from this approach. Edge of ROW management vs km costs of general widening

Rob Young– costs for harvesting are same as costs for edge, but edge has no costs for and acquisition for easements (land agreements, land agents, land valuation). Also, the widening with a harvester- as opposed to individualized with bucket truck which can be more expensive.

Paul Casey - This proposal is more sustainable than what we do now – it focuses on all trees in the ROW (including healthy trees) and does not just target edge of ROW trees

Steve MacIsaac – who will do the work?

Rob Young - 2 foresters and 4 forestry coordinators at NS Power and contractors with forestry technicians

Steve MacIsaac - DOT right of ways – access points, traffic control, etc. Is this all considered?

Rob Young – Yes, and NSPI will also go through people's property and access roads, etc.

Steve MacIsaac - What about people who don't want you to take trees down along properties. Do you expropriate?

Rob – Also where there are sensitive habitats, so we manage with individual tree removal, visit in another way.

Steve MacIsaac – how much of widening will be along provincially owned roads?
Rob – typically not on roads, more remote, forested landscape, back of agricultural properties
Steve MacIsaac – debris, large material – isn't it a hazard for forest fire?
Rob – used as brush matting for machinery, corduroy on softer ground, or property owner will get it themselves
Steve MacIsaac - how many hectares of timber?
Rob - 5000 acres

Matt- sorting and details for different structure types, criticality, etc. will be in the plan

Alex Cochis – for capital expenses NSPI gets a return on it - is the ROW widening capitalized?
Matt- Yes, as in all capital as widening extends the life of the ROW asset
Alex – what is expensed?
Matt - ROW widening is capital. Regular vegetation work in existing ROW is operating expense ($10.4 million/year)
Alex – What about trimming along the side of a ROW?
Matt- if working within the existing ROW its O&M

Larry Nunnery - Slide 4 – 1640 km was the figure I had
Rob – the 69 kV is 1400 km
Larry – is that a subset of the total 69 kV?
Rob Young – we will get back to you (NS Power has responded in a DR to Liberty on this)
Larry - are you widening area you already widened, are you taking more this time?
Rob – yes, the widening area is being expanded

Larry – existing costs was for only widening one edge but now you are doing two edges
Rob – yes
Larry - How much of the 1036 km is in the valley?
Rob – the majority of it

5. Recommendation 2:
   Develop a comprehensive plan for reclaiming and/or widening the overgrown ROW corridors.

<u>Option 1</u>: maintain status quo

Steve MacIsaac – is there growth in option 1?
Matt – yes, it is factored in
Steve - if it is in TIR ROW – our Department has a stance on use of pesticides. Will have to coordinate the use of them together. In last 5 years in west TIR have only used herbicides twice in small amounts. When NSP uses herbicide , TIR receives complaints from public.

Matt – This is an ongoing dialogue, Option 1 is status quo.
Steve – If you expand program, we need to address this material in our ROW together, we will need to invest some of our own funds to address it

Larry – Do you need to reclaim 18,000 km? You had said just 10,937 km needs asset renewal
Matt – the entire ROW length, some of it doesn't have trees or vegetation. The 10,937 km is a rough number based on the estimated amount that does not have vegetation.

<u>Option 2</u>: increase the annual budget, which would affect rates

Option 3: defer or potentially capitalize the costs to increase the vegetation program now and pay it back over time

Betty MacDonald – explain more?
Matt – Spending more now improves reliability now and then spending less later keeps rates stable

John Simmons – proactive approach, cyclic – reduces rates over time. Proactive would reduce costs 40%. This is a great idea

Larry - Do you think existing program is sustainable at 10.4 million? For those 10,000 km you aren't doing anything unless it's an emergency. Your existing plan is not sustainable.

Matt- it's difficult to keep on top of the program over 32 years. Option 2 and 3 get to sustainable rate faster
Steve – how quick could you clear the 1000 hectares?
Matt – with an increase of $25M a year, a sustainable level could be reached in about 5-6 years
Betty – have you done a rate analysis?
Matt – options

1. No rate increase
2. Increasing budget by $15M would be approximately 1.5 %
3. No net increase – it would take time but overall the approach would be net zero.

Larry - About 70% of your lines are single phase. You are widening the ROW for single and 3 phase on same widths. What about not widening single phase as much to save expense?

Matt – We will assess case by case, in some cases may not have to increase the ROW for some single phase – this will be worked out in detailed budgeting.

John Simmons – what about spending on hazard tree impacts? Would this be reduced?
Rob – yes it would.
John Charles - What are other regulatory mechanisms exist?
Dave Landrigan - Spend $7.5 M a year in addition to $10.4 M in 9 years, then $10.4 is reduced to $6M for a long period of time so that the spare room in the budget pays back the amount you have accumulated through a deferral account. Or capitalize the increase in spend, because a 35 year life to these improvements you can depreciate. Or other approaches – hybrids balance between these options.

Alex – from the storm report, were most outages from Transmission or Distribution failures?
Paul – We lost transmission lines during Arthur, but had extensive distribution damage as well – transmission outages contributed to the length of the outage, but majority of outages were in distribution.

Alex - What about edge widening on distribution ROW's?
Rob – yes, distribution ROW widening is capitalized as well. It's administered very similarly, to Transmission ROW widening. It's done by permission only. Areas in the province that were already widened have performed better in general but weren't in the main path of Arthur to demonstrate.

Paul – NS Power has presented the $98M gap on distribution reclamation. Is there any support for the work we need to do? This is about pace.

John Simmons – Agree with distribution approach – makes sense, but looking at the fall-ins on transmission, address trees of risk instead of clear-cut option.
Rob – we have a hazard tree program annually on 69 kV and other transmission ROW's. But like Arthur or hurricanes show, that activity doesn't storm harden the system. In a storm it's hard to determine which trees will fail (even healthy trees fail), so it's a mitigation approach, there will still be hazard trees even after widening.

Paul – We are trying to prevent 6 day and longer outages, there will always be outages, but we need to build sustainable ROW's and prevent the expensive damage and long outages. Case by case – for lines deep off road in woods, we need a different clearing than side of road, difference between 3 day outage and 4 hour outage. No one size fits all.

Steve – operationally, heights of trees are varied. Standard width ROW – what about basing it on height of trees in the area? Cape Breton trees are max 15 metres, but in south shore 25 metres.
Matt – Good point, which is why each Transmission line will be looked at separately.
Matt – the Transmission outages cause the first couple outage days, after that it was distribution outages

Alex - What is the final process, who will see the draft report?
Matt- we will ask the UARB for an extension of a week due to the winter storms so we can issue draft to stakeholders.

Alex Cochis – your other improvements based on Liberty suggestions will help shorten outages, address model with Transmission outages etc. and address scenario planning differently

Paul – yes, but still had many trees on one feeder in Arthur, which is why vegetation management is such a significant focus.

6. Next steps

Matt - Report out by Friday Feb 6 to all stakeholders. Stakeholders will have until Tuesday Feb 10 to submit comments, then NS Power will file the following Friday, Feb 13. Then the UARB process resumes.

7. Round table

Betty – will update the UNSM board on Friday
Matt- will work ongoing with UNSM

Erin Cain – the main thing – option 3 – The CA would like a chance to look at it more closely, our preference is never an increase in rates, so option 3 is worth looking at.

John Simmons – appreciate the opportunity

John Charles – open question to all – opportunity to comment initially on the report - do we reserve judgment to respond as intervenors to respond at some point in future. Is NSPI looking for an endorsement of the report form stakeholder group?
Dave L – yes, we would like to know if there are any objections, the report isn't the be all end all – won't have a finite number of recommendations that all sign off on. The report should not handcuff you in positions on material items.

Betty – we can't bring every municipality to the table on this, our intent is to say all efforts made. UNSM will send to all members, but we can't say we endorse
Matt - any UNSM comments helpful

Steve MacIsaac – capitalizing and depreciating – my understanding of depreciation is a fixed amount every year, 20% per year, the quicker you get it done the less it costs to borrow money so he favors Option 3. Secondly, for TIR operations, how many km will be adjacent to TIR ROW, the TIR gets pressure to clear its ROWs. We will want to put a push forward to keep up, need to bring to deputy minister.
Paul – We use straight line depreciation over life of asset – Transmission line 35 years. ROW widening becomes part of the asset so we depreciate over life of transmission line.
Paul – There are gates to go through to determine if an expenditure is capital, and the threshold very small to denote as capital
Dave L /Paul – to capitalize would have to pass hurdles, accountants will have final say
Steve – do you have a summary of km adjacent to TIR ROW?

Rob – the majority of distribution is in road ROW, most is rural road ROW. We contact property owners and work with TIR – will increase frequency of meetings. We do send notifications monthly. Both single phase and 3 phase feeders are on road ROW's. Ground clearing, herbicide, mowing – are all part of Integrated Vegetation Management. Span by span approach depending on what is growing there, as it's a different species mix in locations.

Adjournment

Widening Cost Analysis for Increasing Provincial 69 kV from 20m to 30/40m

Description of Work By Line

Area	Total Length (km)	Total Widen Potential (km of line)	Linear Length (km of forest edge)	Clearing Width One Side (m)	Total Widen Area - 2 Sided (acres)	Total Widen (acres)
Provincial 69 kV	1400	1036	2072	10	5120	5120

Cost Analysis for Land Acquisition

Average Number of Properties / km	Estimated Total Number of Properties	Easement Cost/customer $1k/ea ($k)	Average Property Size (acres)	Cost/acre ($)	Total Customer Cost ($k)	Land Agent Cost ($500/cust) ($k)	Consultant Evaluation Estimate ($k)	Total Property Cost ($k)
7	7252	7,252	< 1acre	0	7,252	3,626	250	11,128

Cost Analysis for Forestry Work

Equipment	Cost ($/day)	Line Length Completed / day (km)	Estimated Number of Days	Cost/km	Cost for Linear Length ($k)	Total Harvest Cost ($k)	Comments
Harvester	2,000	0.5	2072	4,000	4,144	24,864	Under typical forestry conditions
X/C Bucket	2,000	0.1	10360	20,000	20,720		Where access permits

Total Cost of Property Acquisition and Harvest estimated at approximately ($M): $ 35.99

NOTE 1: Assumption that all properties are less than an acre. Additional costs for land rights are required for larger holdings.
NOTE 2: Assumption that the land on both sides of the right of way is one property.
NOTE 3: Assumption that the Land Agent does not have to make repeated visits to negotiate settlement.
NOTE 4: Total property valuation (appraisal of forest land) is estimated at $.25M
NOTE 5: The harvester is predicted to complete only half the entire length, a cross country bucket will be required for the balance.

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

2016-2023 69kV Right of Way Widening Analysis

Expected Project Year	Priority Group	Line Number	Total Line Length (km)	Widen Potential Forest Edge (km)	Total Widen Length (km)	Estimated Widening Cost ($)	Projected Easement Cost ($)	Estimated Total Cost ($) (No A/O)	Estimated Total Cost ($) (with A/O)
2016	1A*	L-5023	1.2	0.36	0.72	$ 9,166.94	6,138	15,305	18,366
2016	1A	L-5024	4.7	3.40	6.80	$ 87,040.00	72,122	159,162	190,994
2016	1A	L-5039	9.52	4.60	9.20	$ 117,760.00	26,087	143,847	172,616
2016	1A	L-5040	42.3	37.40	74.80	$ 957,440.00	188,744	1,146,184	1,375,420
2016	1B	L-5054	23.4	21.00	42.00	$ 537,600.00	296,159	833,759	1,000,510
2016	1A	L-5502	6.1	5.44	10.88	$ 139,292.27	59,846	199,138	238,965
2016	1A	L-5510	71.1	63.90	127.80	$ 1,635,840.00	402,039	2,037,879	2,445,455
2017	1A	L-5521	4.5	0.65	1.30	$ 16,623.82	46,035	62,659	75,191
2017	1A	L-5524	35.4	29.00	58.00	$ 742,400.00	115,088	857,488	1,028,985
2017	1A	L-5550	33.7	18.95	37.90	$ 485,135.75	202,554	687,690	825,228
2017	1A	L-5559	38.7	32.80	65.60	$ 839,680.00	343,728	1,183,408	1,420,090
2017	1B*	L-5037	3.7	3.57	7.14	$ 91,454.85	33,759	125,214	150,257
2017	1B	L-5055	20.8	17.00	34.00	$ 435,200.00	69,053	504,253	605,103
2017	1B	L-5555	15.5	11.12	22.24	$ 284,646.41	205,623	490,269	588,323
2017	1C*	L-5025	30.2	8.02	16.05	$ 205,388.80	332,987	538,375	646,050
2018	1C	L-5017	18.4	13.11	26.22	$ 335,640.33	274,676	610,316	732,379
2018	1C	L-5053	25.7	20.70	41.40	$ 529,920.00	368,280	898,200	1,077,840
2018	1C	L-5500	12.5	8.36	16.71	$ 213,934.88	135,036	348,971	418,765
2018	1C	L-5501	7.6	1.80	3.60	$ 46,111.25	59,846	105,957	127,148
2018	1C	L-5534	8.4	6.22	12.44	$ 159,244.29	121,226	280,470	336,564
2018	1C	L-5564	19.1	11.23	22.45	$ 287,410.57	121,226	408,636	490,363
2018	1C	L-5572	13.6	8.40	16.80	$ 215,040.00	201,020	416,060	499,271
2018	1C	L-5573	15.8	9.90	19.80	$ 253,440.00	242,451	495,891	595,069
2018	1D*	L-5022	15.0	11.10	22.20	$ 284,160.00	44,501	328,661	394,393
2018	1D	L-5019	3.4	3.10	6.20	$ 79,360.00	9,207	88,567	106,280
2018	1D	L-5028	29.0	15.15	30.30	$ 387,821.78	113,553	501,375	601,650
2018	1D	L-5035	0.8	0.61	1.22	$ 15,601.76	58,311	73,913	88,695

2016-2023 69kV Right of Way Widening Analysis

Expected Project Year	Priority Group	Line Number	Total Line Length (km)	Widen Potential Forest Edge (km)	Total Widen Length (km)	Estimated Widening Cost ($)	Projected Easement Cost ($)	Estimated Total Cost ($) (No A/O)	Estimated Total Cost ($) (with A/O)
2019	1C	L-5026	47.5	19.16	38.32	$ 490,555.46	313,038	803,593	964,312
2019	1D	L-5003	13.5	5.85	11.69	$ 149,692.30	174,933	324,625	389,550
2019	1D	L-5004	12.1	6.90	13.80	$ 176,640.00	56,777	233,417	280,100
2019	1D	L-5011	9.3	5.20	10.40	$ 133,120.00	53,708	186,828	224,193
2019	1D	L-5029	20.2	16.23	32.47	$ 415,603.21	127,364	542,967	651,560
2019	1D	L-5031	19.8	19.45	38.90	$ 497,976.91	145,778	643,754	772,505
2019	1D	L-5047	3.1	0.20	0.39	$ 5,013.71	15,345	20,359	24,430
2019	1D	L-5048	5.5	4.37	8.75	$ 111,969.95	99,743	211,712	254,055
2019	1D	L-5058	39.3	33.40	66.80	$ 855,040.00	176,468	1,031,508	1,237,809
2019	1D	L-5505	11.5	9.10	18.20	$ 232,960.00	127,364	360,324	432,388
2019	1D	L-5537	3.4	3.22	6.44	$ 82,457.13	59,846	142,303	170,763
2020	1D	L-5539	8.4	5.44	10.87	$ 139,149.70	135,036	274,186	329,023
2020	1D	L-5548	17.1	4.46	8.91	$ 114,064.92	87,467	201,531	241,838
2020	1D	L-5551	9.7	6.23	12.46	$ 159,505.72	144,243	303,749	364,498
2020	1D	L-5571	6.4	3.80	7.59	$ 97,203.20	52,173	149,376	179,251
2020	1D	L-5575	12.6	8.20	16.40	$ 209,863.43	115,088	324,951	389,941
2020	1D	L-5579	41.1	38.50	77.00	$ 985,600.00	468,023	1,453,623	1,744,347
2020	2A*	L-5044	3.8	3.37	6.75	$ 74,697.98	67,518	142,216	170,659
2020	2A	L-5506	8.4	4.41	8.82	$ 97,603.72	148,847	246,450	295,740
2020	2A	L-5511	31.7	28.00	56.00	$ 619,920.00	199,485	819,405	983,286
2020	2A	L-5533	13.1	7.86	15.71	$ 173,956.28	136,571	310,527	372,632
2020	2A	L-5538	7.5	4.67	9.34	$ 103,412.42	67,518	170,930	205,117
2020	2B*	L-5036	3.4	0.11	0.22	$ 2,428.71	7,673	10,101	12,121
2020	2B	L-5508	1.7	0.52	1.05	$ 11,581.28	18,414	29,995	35,994
2021	2B	L-5576	20.2	9.40	18.80	$ -	-	-	-
2021	2A	L-5014	10.8	2.67	5.34	$ 59,116.53	29,156	88,272	105,926
2021	2A	L-5033	12.2	6.70	13.40	$ 148,338.00	87,467	235,805	282,965
2021	2A	L-5046	2.7	1.19	2.38	$ 26,380.47	46,035	72,415	86,899
2021	2A	L-5545	5.2	2.67	5.34	$ 59,116.90	81,329	140,445	168,534
2021	2A	L-5546	12.5	6.87	13.75	$ 152,200.67	196,416	348,617	418,340

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

2016-2023 69kV Right of Way Widening Analysis

Expected Project Year	Priority Group	Line Number	Total Line Length (km)	Widen Potential Forest Edge (km)	Total Widen Length (km)	Estimated Widening Cost ($)	Projected Easement Cost ($)	Estimated Total Cost ($) (No A/O)	Estimated Total Cost ($) (with A/O)
2021	2A	L-5565	18.9	16.80	33.60	$ 371,952.00	162,657	534,609	641,531
2021	2C*	L-5027	104.5	92.30	184.60	$ 2,043,522.00	391,298	2,434,820	2,921,783
2021	2C	L-5561	15.0	11.22	22.44	$ 248,382.99	161,123	409,505	491,407
2021	2D*	L-5016	6.7	5.60	11.20	$ 123,984.00	64,449	188,433	226,120
2022	2A	L-5015	19.0	15.90	31.80	$ 352,026.00	133,502	485,528	582,633
2022	2A	L-5021	7.2	5.20	10.40	$ 115,128.00	85,932	201,060	241,272
2022	2D	L-5020	9.2	8.90	17.80	$ 197,046.00	78,260	275,306	330,367
2022	2D	L-5030	2.9	0.71	1.41	$ 15,646.52	12,276	27,923	33,507
2022	2D	L-5056	4.0	3.10	6.20	$ 68,634.00	21,483	90,117	108,140
2022	2D	L-5057	2.2	1.35	2.71	$ 29,995.39	7,673	37,668	45,201
2022	2D	L-5512	6.5	5.70	11.40	$ 126,198.00	79,794	205,992	247,190
2022	2D	L-5531	23.9	20.10	40.20	$ 445,014.00	136,571	581,585	697,901
2022	2D	L-5532	96.3	87.00	174.00	$ 1,926,180.00	715,077	2,641,257	3,169,508
2023	2D	L-5050	15.9	15.40	30.80	$ 340,956.00	82,863	423,819	508,583
2023	2D	L-5530	67.5	39.40	78.80	$ 872,316.00	237,848	1,110,164	1,332,196
2023	2D	L-5535	64.3	58.30	116.60	$ 1,290,762.00	644,490	1,935,252	2,322,302
2023	2D	L-5536	20.2	12.49	24.99	$ 276,632.29	260,865	537,497	644,997
2023	2D	L-5547	19.5	10.94	21.88	$ 242,231.45	263,934	506,165	607,399

*** Level 1 Priority - H-Frame Construction**

1A	High Customer Count - No Redundancy
1B	High Customer Count - Redundancy
1C	Industrial Customer - No Redundancy
1D	Low Customer Count

*** Level 2 Priority - Single Pole Construction**

2A	High Customer Count - No Redundancy
2B	High Customer Count - Redundancy
2C	Industrial Customer - No Redundancy
2D	Low Customer Count

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

2017 Plan - 69kV Right of Way Widening

Expected Project Year	Priority Group	Line Number	Total Line Length (km)	Widen Potential Forest Edge (km)	Total Widen Length (km)	2017 Plan (km)	Comment
2017	1A*	L-5039	9.52	4.60	9.20	9.2	2016 Carry Over
2016	1A	L-5040	42.3	37.40	74.80	8.0	2016 Carry Over
2017	1A	L-5502	6.1	5.44	10.88	1.1	2016 Carry Over
2017	1A	L-5510	71.1	63.90	127.80	3.0	2016 Carry Over
2017	1A	L-5521	4.5	0.65	1.30	1.3	2017 Plan
2017	1A	L-5524	35.4	29.00	58.00	58.0	2017 Plan
2017	1A	L-5550	33.7	18.95	37.90	37.9	2017 Plan
2017	1A	L-5559	38.7	32.80	65.60	65.6	2017 Plan
2017	1B*	L-5037	3.7	3.57	7.14	7.1	2017 Plan
2017	1B	L-5055	20.8	17.00	34.00	34.0	2017 Plan
2017	1B	L-5555	15.5	11.12	22.24	22.2	2017 Plan
2017	1C*	L-5025	30.2	8.02	16.05	4.9	Planned also for 2018

*** Level 1 Priority - H-Frame Construction**

1A High Customer Count - No Redundancy
1B High Customer Count - Redundancy
1C Industrial Customer - No Redundancy
1D Low Customer Count

*** Level 2 Priority - Single Pole Construction**

2A High Customer Count - No Redundancy
2B High Customer Count - Redundancy
2C Industrial Customer - No Redundancy
2D Low Customer Count

Request IR-30:

Reference CI# 47954, L7012 Replacements and Upgrades

(a) On page 1 of 3, NSPI states that the "work was prioritized based on transmission inspection results". Please provide a document that includes these results and the prioritization criteria used for choosing this work over other.

(b) According to NSPI, the line was built in 1982 and has an estimated life of 45 years. Why are these assets being replaced 10 years before their estimated end of life?

(c) On page 1 of 3, NSPI states that "replacing the existing deteriorated assets is more cost effective than rebuilding the entire line" Please provide the analysis utilized to justify this statement.

Response IR-30:

(a) Please refer to Attachment 1 for inspection results of the structures identified for replacement in this project. The transmission inspection program includes the following criteria:

Poles		
Plumbness	Ground-line rot	Top rot
Cap condition	Animal/insect damage	Lightning damage
Bonding/grounding condition	Ground-line erosion	Vegetation condition
Drainage		
Cross Brace, Spars Cross Arms		
Breakage	Cracking	Twisting

Hardware		
Rust	Breakage	Bends
Anchoring		
Guys	Preforms	Anchor rods
Anchor logs		
Insulators		
Cracking	Breakage	Sleeve condition
Insulator noise	Clamp/pin condition	Tie condition
Uplift		
Clamps		
Damage	Movement	Deformation
Rust		
Corona Ring		
Damage	Loose connections	
Vibration Dampers		
Stockbridge/Torsional	Weight condition	Drooping
Conductor		
Breakage	Rust	Burns
Pitting	Sag	Splice condition
Overheating		
Spacers		
Clamp insert		
Environmental		
Vegetation	Danger trees	Erosion
Run-off	Fire risk	Noise
Clearance	Encroachments	ID numbers
Danger signs	Ladder	Fencing/guarding
Aircraft markers	Warning lights	
Steel Lattice		
Bending	Missing members	Bolt condition
Grillage/leg condition	Paint condition	Surface rust/damage
Anchor bolt condition	Nut condition	Concrete condition
Rebar condition	Grounding condition	
Steel Pole		
Cross-arm welds	Cross-arm connections	Mast welds
Drainage holes	Rock anchor condition	

Line Disconnect Switches		
Accessibility	Mat condition	Handle condition
Insulator condition	Contacts	Leads
Grounds/jumpers		

(b) The 45 year estimated life is an average; some assets will fail before this estimated useful life and others will survive past the estimated useful life. Asset replacements are based on a number of parameters of which age is only one. Large sections of this line are located in or around marshes or wetlands and, for environmental reasons, have untreated poles installed, which accelerates the deterioration of the poles. Several other factors also contribute to structures deteriorating before their end of estimated useful life, such as the weather conditions, wildlife damage (wood peckers, osprey nests, ants), exposure to severe weather events (hurricanes, ice storms), etc.

(c) Engineering experience indicates an estimated $600,000 per kilometer for the construction of a new 230 kV transmission line. This results in a cost of $83.4 million to build a line to replace L7012. The cost of the L7012 replacements and upgrades proposed in this project is $4.4 million. In addition, the construction of a new transmission line would require significant lead time before construction begins in order to complete the new line design and secure the necessary right-of-way easements. During the design and construction of the new transmission line, the existing transmission line would remain in-service to maintain service reliability and would require regular maintenance which would add to the overall costs.

Str #	Comments	Recommendations
L7012,006	RIGHT SPAR ARM WEATHERING CRACKS FROM CENTER PHASE TO RGHT PHASE. COTTER PIN MISSING ON RIGHT PHASE.	install cotter key on right phase, repair right ohgw bond, replace right 9100mm spar arm
L7012,008	RIGHT AND LEFT SPAR ARM HAVE MAJOR WEATHERING CRACKS 2/3 OF BOTH SPAR ARMS.	replace both 9100mm spar arms and re-insulate 3 x 12/phase
L7012,009	LEFT SPAR ARM WEATHERING CRACKS FROMLEFT POLE TO LEFT PHASE. BOTH LEFT AND RIGHT POLE HAVE ANT ACTIVITY. RIGHT POLE SOUNDS HOLLOW.	remove 70' 230-tg-o, install 70' 230-tg-o
L7012,014	LEFT SPAR ARM MAJOR WEATHERING CRACKS FROM CENTER PHASE TO LEFT PHASE.	replace left 9100mm spar arm and re-insulate 3 x 12/phase, install 7012 on both sides
L7012,018	MINOR WEATHERING CRACKS IN LEFT POLE FROM CENTER PHASE TO LEFT PHASE. ALSO LEFT POLE SOUNDS HOLLOW AT BASE.	replace left 70' pole, re-insulate 3 x 12/phase
L7012,031	RIGHT POLE BONDING WIRE BROKEN AT TOP.	repair right bond wire (ohgw)
L7012,040	LEFT SPAR ARM MINOR WEATHERING CRACKS CENTER PHASE. LARGE WEATHERING CRACKS ON LEFT POLE AT BASE ALSO ANT ACTIVITY. SOUNDS HOLLOW.	replace left 70' pole, re-insulate 3 x 12/phase, gc violation=5.7m taken 125m from 40 towards 39. excavate mound, install 4 on both sides and 7012 on both sides
L7012,044	LEFT POLE BOTTOM BOLT THAT CONNECTS X BRACE IS BACKED OUT ALSO AT BASE OF POLE LARGER WEATHERING CRACKS. LEFT POLE HAS ANTS	replace left 70' pole, re-insulate 3 x 12/phase
L7012,049	BOTH LEFT AND RIGHT POLE SOUND HOLLOW AT BASE.	remove 70' 230-tg-0, install 70' 230-tg-o
L7012,050	STRUCTURE OK, MISSING ID'S	install 5 on both sides
L7012,051	BOTTOM BOLT ON LEFT POLE THAT CONNECTS X BRACE HAS BACKED OUT 3''.	tighten bottom x-brace bolts/ install 7/8" palnut
L7012,052	LEFT POLE SOUNDS HOLLOW ON ONE SIDE.	replace left 70' pole
L7012,058	RIGHT POLE SOUNDS HOLLOW AT BASE.	replace right 70' pole
L7012,060	6 GUY WIRES COULD BE TIGHTENED SHOULD BE CHECKED LATER ON DUE TO SNOW DEPTH.	tighten 6 guy wires/ install 6 guy guards, install 6 on both sides
L7012,062	LARGE WEATHERING CRACKS ON RIGHT POLE 2/3 OF POLE	replace left 65' pole
L7012,066	BOTH SPAR ARMS HAVE MAJOR WEATHERING CRACKS UNDER CENTER PHASE SHOULD BE REPLACED.	replace both 9100mm spar arms, re-insulate 3 x 12/phase, install 7012 on both sides
L7012,077	RIGHT POLE SOUNDS HOLLOW AND ANT ACTIVTY.	replace right 70' pole
L7012,083	LEFT POLE SOUNDS HOLLOW AT BASE LARGE WEATHERING CRACKS AS WELL.	replace left 70' pole

Str #	Comments	Recommendations
L7012,085	LEFT POLE SOUNDS HOLLOW AND ANT ACTIVITY.	replace left 70' pole
L7012,091	RIGHT POLE SOUNDS HOLLOW AT BASE. LEFT SPAR ARM MINOR WEATHERING CRACKS FROM CENTER PHASE TO LEFT PHASE.	replace right 70' pole
L7012,094	RIGHT POLE HOLLOW AT BASE.	replace right 70' pole
L7012,097	RIGHT POLE HOLLOW WITH MAJOR WEATHERING CRACKS 2/3 OF POLE.	replace right 70' pole
L7012,098	LEFT POLE SOUNDS HOLLOW ON ONE SIDE ALSO MAJOR WEATHERING CRACKS STARTING AT BASE AND GOING UP TO X BRACE	replace left 70' pole
L7012,102	LEFT SPAR ARM MAJOR WEATHERING CRACK UNDER BOLT THAT CONNECTS TO X BRACE.	replace left 9100mm spar arm, re-insulate 3 x 12/phase
L7012,104	RIGHT POLE MAJOR WEATHERING CRACKS 2/3 OF POLE. LEFT POLE ANT ACTIVITY. LARGE CRACK AT BASE OF LEFT POLE	replace with 70' 230-TG-0, remove 70' poles
L7012,109	RIGHT POLE SOUNDS HOLLOW.	replace right 70' pole, re-insulate 3 x 12/phase
L7012,112	LARGE CRACK ON RIGHT SPAR ARM UNDER CENTER PHASE.	replace right 9100mm spar arm, re-insulate 3 x 12/phase
L7012,115	LEFT POLE MAJOR WEATHERING CRACK HOLE POLE TOP TO BOTTOM.	replace left70' pole, re-insulate 3 x 12/phase
L7012,118	RIGHT POLE SOUNDS HOLLOW AT BASE ALSO HAS LARGE WEATHERING CRACKS AT BASE OF POLE.	replace right 70' pole, re-insulate 3 x 12/phase
L7012,123	RIGHT POLE SOUNDS HOLLOW ON ONE SIDE AND HAS ANTS. LEFT POLE HOLLOW ON ONE SIDE AND HAS ANTS AS WELL. LARGE WEATHERING CRACKS ON LEFT POLE.	replace 70' 230-TG-0 with 70' 230-TG-0
L7012,125	LEFT SPAR ARM MAJOR CRACK ACROSS THE GRAIN BETWEEN LEFT POLE AND LEFT PHASE	replace left 9100mm spar arm, re-insulate 3 x 12/phase
L7012,131	GROUNDWIRE FRAYED AT CONNECTION TO OHGW.	repair ohgw bond, re-insulate 3 x 12/phase
L7012,133	BOTH RIGHT AND LEFT POLE SOUND HOLLOW AT BASE. RIGHT POLE HAS ANT ACTIVITY. RIGHT SPAR ARM MINOR CRACKS FROM CENTER PHASE TO RIGHT POLE . END OF RIGHT SPAR ARM SAGGING WHERE RIGHT PHASE IS.	replace with 70' 230-TG-0 with 70' 230-TG-0
L7012,145	1 OF 12 INSULATORS BROKE ON LEFT PHASE	re-insulate 3 x 12/phase
L7012,146	ANTS IN BOTH POLE. LEFT SPAR ARM LARGE CRACK WHERE IT BOLTS TO LEFT POLE.	replace 65' 230-TG-0 with 65' 230-TG-0

Str #	Comments	Recommendations
L7012,149	LEFT SPAR ARM HAS LARGE CRACK WHERE IT BOLTS TO LEFT POLE. LEFT POLE SOUNDS HOLLOW AT BASE	replace left 65' pole, replace left 9100mm spar arm, re-insulate 3 x 12/phase
L7012,150	DAMAGED INSULATORS	re-insulate 3 x 12/phase, install on both sides
L7012,156	RIGHT SPAR ARM HAS A LARGE CRACK FROM CENTER PHASE TO RIGHT POLE.	replace right 9100mm spar arm, re-insulate 3 x 12/phase
L7012,157	LEFT SPAR ARM HAS MAJOR WEATHERING CRACKS UNDER CENTER PHASE TO LEFT PHASE. RIGHT SPAR ARM HAS MINOR WEATHERING CRACKS. BOTH SHOULD BE REPLACE.	replace both 9100mm spar arms, re-insulate 3 x 12/phase, install 7012 on both sides
L7012,167	X BRACE SINKING INTO LEFT SPAR ARM.	replace left 9100mm spar arm, re-insulate 3 x 12/phase
L7012,170	LEFT POLE LARGE CRACK AT BASE AND SOUNDS HOLLOW.	replace left 70' pole, re-insulate 3 x 12/phase, install 17 on both sides
L7012,172	RIGHT ARM COMPRESSING WHERE ARM CONNECTS TO BRACE.	replace right 9100mm spar arm, re-insulate 3 x 12/phase
L7012,174	RIGHT SPAR ARM MINOR CRACK UNDER CENTER PHASE. LEFT SPAR ARM MINOR CRACK FROM LEFT POLE TO LEFT PHASE. LEFT POLE HAS ANTS AND SOUNDS HOLLOW ON ONE SIDE. LEFT X BRACE HAS MINOR CRACKS 2/3 OF BRACE.	replace with 65' 230-TG-0, remove 65' poles
L7012,175	RIGHT POLE SOUNDS HOLLOW ON ONE SIDE.	replace right 70' pole, re-insulate 3 x 12/phase
L7012,177	RIGHT POLE HOLLOW.	replace right 75' pole, re-insulate 3 x 12/phase
L7012,178	DAMAGED INSULATORS	re-insulate 3 x 12/phase
L7012,180	DAMAGED INSULATORS	re-insulate 3 x 12/phase, install 18 on both sides
L7012,183	LEFT POLE ANT ACTIVITY AND SOUNDS HOLLOW ON ONE SIDE.	replace left 70' pole, re-insulate 3 x 12/phase
L7012,199	6 GUY WIRES SHOULD BE TIGHTENED.	tighten 6 guys, install 6 guy guards
L7012,200	LEFT SPAR ARM MAJOR WEATHERING CRACKS FROM RIGHT POLE TO LEFT POLE.	replace right 9100mm spar, re-insulate 3 x 12/phase, install 20 on both sides
L7012,201	DAMAGED INSULATORS	re-insulate 3 x 12/phase
L7012,212	RIGHT POLE SOUNDS HOLLOW	replace right 65' pole, re-insulate 3 x 12/phase
L7012,214	RIGHT X BRACE 5 WP HOLE. LEFT POLE SOUNDS HOLLOW ON ONE SIDE.	replace left 65' pole, replace right 10700mm spar brace, re-insulate 3 x 12/phase
L7012,229	RIGHT POLE SOUNDS HOLLOW ON ONE SIDE.	replace right 75' pole, re-insulate 3 x 12/phase
L7012,230	DAMAGED INSULATORS	re-insulate 3 x 12/phase, install 7012 and 23 on both sides

Str #	Comments	Recommendations
L7012,235	DAMAGED INSULATORS	re-insulate 3 x 12/phase
L7012,236	DAMAGED INSULATORS	re-insulate 3 x 12/phase
L7012,239	LEFT POLE SOUNDS HOLLOW AT BASE AND HAS ANTS.	replace left 65' pole, re-insulate 3 x 12/phase
L7012,241	LEFT POLE SOUNDS HOLLOW.	replace left 70' pole,re-insulate 3 x 12/phase
L7012,259	1X BRACE STARTING TO ROT WHERE BOLT ATTACHES TO LEFT POLE.	re-insulate 3 x 12/phase, replace left 10700mm spar brace
L7012,262	LEFT SPAR ARM STARTING TO SAG. MAJOR WEATHERING CRACKS IN LEFT SPAR ARM CHANGE BOTH.	replace both 9100mm spar arms, re-insulate 3 x 12/phase
L7012,265	LEFT SPAR ARM STARTING TO SAG ALSO SMALL CRACK UNDER LEFT PHASE.	replace left 9100mm spar arm, re-insulate 3 x 12/phase
L7012,267	RIGHT SPAR ARM STARTING TO SAG.	replace right 9100mm spar arm and re-insulate structure
L7012,271	RIGHT SPAR ARM STARTING TO SAG.	replace right 9100mm spar arm, re-insulate 3 x 12/phase
L7012,273	ANTS IN RIGHT POLE AND SOUNDS HOLLOW ON ONE SIDE.	replace right 70' pole, re-insulate 3 x 12/phase
L7012,283	LEFT SPAR ARM MAJOR CRACK ACROSS THE GRAIN ON TOP OF ARM 2 FEET FROM LEFT PHASE. RIGHT POLE LARGE CRACKS 2/3 OF POLE.	replace left 9100mm spar arm, re-insulate 3 x 12/phase
L7012,284	LEFT SPAR ARM STARTING TO COMPRESS WHERE IT ATTACHES TO X BRACE.	replace left 9100mm spar arm, re-insulate 3 x 12/phase
L7012,289	THE WOOD AT THE BASE OF LEFT POLE IS STARTING TO FLAKE OFF.	replace left 65' pole, re-insulate 3 x 12/phase
L7012,290	RIGHT SPAR ARM STARTING TO FLATTEN OUT WHERE X BRACE CONNECTS TO ARM	replace right 9100mm spar arm, re-insulate 3 x 12/phase and install 29 on both sides
L7012,292	RIGHT SPAR ARM MAJOR CRACK UNDER CENTER PHASE LEFT SPAR ARM LARGE CRACKS 2/3 OFARM. REPLACE BOTH ARMS.	replace both 9100mm spar arms, re-insulate 3 x 12/phase, GC violation=6m taken 70m from 292 towards 293, excavate mound
L7012,294	RIGHT POLE HAS ANTS AND SOUNDS HOLLOW ON ONE SIDE.	replace right 70' pole, re-insulate 3 x 12/phase
L7012,295	RIGHT POLE HAS ANTS AND SOUNDS VERY HOLLOW AT BASE. BOTH SPAR ARMS HAVE MAJOR WEATHERING CRACKS 1/3 OF ARMS. SPAR ARMS AND RIGHT POLE SHOULD BE REPLACED.	replace right 70' pole, replace both 9100mm spar arms, re-insulate 3 x 12/phase
L7012,296	RIGHT SPAR ARM STARTING TO FLATTEN WHERE X BRACE ATTACHES TO ARM. REPLACE BOTH ARMS.	replace both 9100mm spar arms, re-insulate 3 x 12/phase

Str #	Comments	Recommendations
L7012,298	ANTS IN BOTH POLES AND RIGHT POLE SOUNDS HOLLOW ON ONE SIDE. LEFT SPAR ARM LARGE CRACK FROM CENTER PHASE TO LEFT PHASE.	replace with 75' 230-TG-0, remove 75' poles
L7012,301	RIGHT SPAR ARM MAJOR CRACK FROM RIGHT POLE TO RIGHT PHASE.	replace right 9100mm spar arm, re-insulate 3 x 12/phase
L7012,302	LEFT SPAR ARM STARTING TO SAG BAD WHERE LEFT PHASE IS ALSO HAS WEATHERING CRACKS. REPLACE BOTH ARMS.	replace both 9100mm spar arms, re-insulate 3 x 12/phase
L7012,304	BOTH SPAR ARMS STARTING TO COMPRESS AND SAG. LEFT POLE SOUNDS HOLLOW ON ONE SIDE.	replace with 70' 230-tg-0, remove 70' poles
L7012,306	RIGHT SPAR ARM STARTING TO COMPRESS	replace right 9100mm spar arm, re-insulate 3 x 12/phase
L7012,308	RIGHT SPAR ARM IS COMPRESSING AGAINST X BRACE.	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,310	RIGHT SPAR ARM LARGE CRACK FROM CENTER PHASE TO RIGHT PHASE. LARGE CRACK AT BASE OF RIGHT POLE AND SOUNDS HOLLOW ON ONE SIDE.	replace right 70' pole, replace right 9100mm spar arm, reinsulate 3 x 12/phase, install 31 on both sides
L7012,313	RIGHT SPAR ARM HAS LARGE CRACK WHERE BOLT CONNECTS TO RIGHT POLE.	replace right 9100mm spar,reinsulate 3 x 12/phase
L7012,314	BOTH SPAR ARMS ARE STARTING TO COMPRESS WHERE X BRACES CONNECT TO ARMS	replace both 9100mm spar arms, reinsulate 3 x 12/phase, install 7012 on both sides
L7012,315	DAMAGED INSULATORS	reinsulate 3 x 12/phase
L7012,316	RIGHT POLE HAS ANTS AND SOUNDS HOLLOW ON ONE SIDE. BOTH SPAR ARMS ARE STARTING TO COMPRESS	replace right 70' pole, replace both 9100mm spar arms and reinsulate 3 x 12/phase
L7012,318	RIGHT SPAR ARM CRACK ACROSS GRAIN BETWEEN RIGHT POLE AND WHERE X BRACE CONNECTS TO ARM.	replace right 9100mm spar arm,reinsulate 3 x 12/phase
L7012,321	X BRACE BOLT IS BEING SUCKED THROUGH RIGHT SPAR ARM. RIGHT X BRACE WHERE BOLT CONNECTS TO RIGHT POLE AT BOTTOM WOOD IS STARTING TO FLAKE APART.	replace right 9100mm spar arm, replace right 10700mm spar brace, reinsulate 3 x 12/phase
L7012,322	RIGHT SPAR ARM STARTING TO FLATTEN OUT WHERE X BRACE CONNECTS TO POLE.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,324	LEFT SPAR ARM COMPRESSING WHERE X BRACE CONNECTS TO ARM	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,325	DAMAGED INSULATORS	reinsulate 3 x 12/phase
L7012,326	BOTH SPAR ARMS STARTING TO COMPRESS WHERE X BRACE CONNECTS TO ARMS	replace both 9100mm spar arms, reinsulate 3 x 12/phase

Str #	Comments	Recommendations
L7012,339	RIGHT SPAR ARM STARTING TO SAG AND HAS A CRACK WHERE BOLT CONNECTS ARM TO RIGHT POLE.	replace right 9100mm spar, reinsulate 3 x 12/phase
L7012,340	RIGHT SPAR ARM LARGE CRACK CENTER PHASE TO RIGHT POLE	replace right 9100mm spar arm, reinsulate 3 x 12/phase, install 34 on both sides
L7012,341	ANTS IN RIGHT POLE AND SOUNDS VERY HOLLOW SHOULD BE REPLACED.	replace right 70' pole, reinsulate 3 x 12/phase
L7012,342	RIGHT SPAR ARM STARTING TO COMPRESS WHERE X BRACE ATTACHES TO ARM.	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,343	BOTH POLES HAVE ANTS. LEFT POLE STARTING TO SOUND HOLLOW ON ONE SIDE. RIGHT SPAR ARM LARGE CRACK WHERE BOLT ATTACHES TO RIGHT POLE.	replace 70' 230-tg-0 with 70' 230-tg-0
L7012,345	RIGHT SPAR ARM IS COMPRESSING AND STARTING TO SAG.	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,356	LEFT PHASE 1 BROKEN INSULATOR	reinsulate 3 x 12/phase
L7012,361	RIGHT POLE HAS ANTS AND SOUNDS HOLLOW. LEFT POLE SOUNDS HOLLOW ON ONE SIDE. RIGHT SPAR ARM IS STARTING TO SAG.	replace 70- 230-TG-0 with 70' 230-TG-0
L7012,365	RIGHT SPAR ARM A CRACK ACROSS THE GRAIN IS STARTING BETWEEN RIGHT POLE AND RIGHT PHASE.	replace right 9100mm spar arm,reinsulate 3 x 12/phase
L7012,369	SPAR ARM STARTING TO COMPRESS	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,377	LEFT SPAR ARM IS COMPRESSING	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,379	LEFT SPAR ARM IS COMPRESSING RIGHT SPAR ARM MINOR CRACK FROM RIGHT POLE TO RIGHT PHASE	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,381	LEFT SPAR ARM IS STARTING TO SAG	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,383	BOTH SPAR ARMS ARE COMPRESSING SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,387	LEFT SPAR ARM LARGE WEATHERING CRACK HOLE ARM SHOULD BE REPLACED.	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,390	RIGHT SPAR ARM STARTING TO COMPRESS SHOULD BE REPLACED.	replace right 9100mm spar arm,reinsulate 3 x 12/phase, install 39 on both sides
L7012,391	BOTH SPAR ARMS STARTING TO COMPRESS	replace both 9100mm spar arms,reinsulate 3 x 12/phase
L7012,393	RIGHT SPAR ARM STARTING TO SAG	replace right 9100mm spar arm,reinsulate 3 x 12/phase

Str #	Comments	Recommendations
L7012,394	BOTH POLES HAVE ANTS AND SOUND HOLLOW. LEFT SPAR ARM CRACK ACROSS THE GRAIN BETWEEN LEFT POLE AND LEFT PHASE. REPLACE BOTH ARMS.	replace with new 75' 230-tg-o, remove 75' poles
L7012,398	LEFT SPAR ARM STARTING TO COMPRESS.	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,402	DAMAGED INSULATORS	reinsulate 3 x 12/phase
L7012,403	LEFT SPAR ARM IS COMPRESSING	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,404	LEFT SPAR ARM IS STARTING TO COMPRESS.	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,406	RIGHT SPAR ARM IS STARTING TO SAG LEFT POLE HAS ANTS AND SOUNDS HOLLOW ON ONE SIDE.	replace right 9100mm, reinsulate 3 x 12/phase, replace left 70' pole
L7012,409	LEFT SPAR ARM HAS A LARGE CRACK FROM CENTER PHASE TO RIGHT PHASE AND BOTH ARMS ARE STARTING TO COMPRESS.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,410	LARGE CRACK ON RIGHT SPAR ARM UNDER CENTER PHASE. BOTH SPAR ARMS STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 12/phase, install 41 on both sides
L7012,412	BOTH SPAR ARMS STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,413	LEFT SPAR ARM STARTING TO COMPRESS. BOTH SPAR ARMS HAVE LARGE WEATHERING CRACKS.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,414	RIGHT POLE HAS LARGE CRACK AT BASE OF POLE AND SOUNDS HOLLOW ON ONE SIDE. RIGHT SPAR ARM HAS LARGE CRACK WHERE BOLT CONNECTS ARM TO RIGHT POLE.	replace right 70' pole, replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,418	RIGHT SPAR ARM IS STARTING TO SAG AND FORM A CRACK ACROSS THE GRAIN. SHOULD BE REPLACED.	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,424	RIGHT SPAR ARM STARTING TO COMPRESS.	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,427	BOTH SPAR ARMS STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,428	RIGHT SPAR ARM STARTING TO COMPRESS. LEFT POLE HAS ANTS.	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,431	RIGHT SPAR ARM IS COMPRESSING	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,432	BOTH SPAR ARMS ARE STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,434	LEFT SPAR ARM IS COMPRESSING. BOTH ARMS SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,435	RIGHT SPAR ARM IS STARTING TO COMPRESS	replace right 9100mm spar arm, reinsulate 3 x 12/phase

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Str #	Comments	Recommendations
L7012,436	LEFT SPAR ARM IS STARTING TO COMPRESS. BOTH ARM HAVE WEATHERING CRACKS. BOTH SPAR ARM SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,437	RIGHT SPAR ARM ROTTEN AT END WHERE PHASE IS.	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,439	RIGHT SPAR ARM IS COMPRESSING	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,442	LEFT POLE AT GROUND WOOD IS STARTING TO FLAKE OFF. LEFT SPAR ARM HAS ROT WHERE BOLT ATTACHES TO LEFT POLE	replace left 70' pole, replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,444	LEFT SPAR ARM IS STARTING TO COMPRESS	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,445	RIGHT SPAR ARM STARTING TO COMPRESS	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,450	LEFT POLE HAS ANTS. RIGHT SPAR ARM IS COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,451	LEFT SPAR ARM IS ROTTING WHERE PHASES ARE. BOTH ARMS SHOULD BE REPLACED	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,452	LEFT SPAR ARM IS STARTING TO COMPRESS	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,453	RIGHT SPAR ARM HAS SIGNS OF ROT WHERE RIGHT PHASE IS	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,455	RIGHT SPAR ARM IS COMPRESSING AND LEFT SPAR ARM HAS A WEATHERING CRACK FROM CENTER PHASE TO LEFT POLE. BOTH ARMS SHOULD BE REPLACED	replace both 910mm spar arms, reinsulate 3 x 12/phase
L7012,456	LEFT SPAR ARM IS STARTING TO COMPRESS	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,457	BOTH SPAR ARMS ARE COMPRESSING AND SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,459	BOTH SPAR ARM ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,460	DAMAGED INSULATORS	reinsulate 3 x 12/phase (road crossing), install 46 and 7012 on both sides
L7012,461	LEFT SPAR ARM IS COMPRESSING	replace left 9100mm spar arms, reinsulate 3 x 12/phase
L7012,463	LEFT SPAR ARM IS COMPRESSING	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,465	BOTH SPAR ARMS ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,466	BOTH SPAR ARMS ARE COMPRESSING ALSO THE RIGHT ARM HAS A WEATHERING CRACK FROM RIGHT PHASE TO RIGHT POLE.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,470	BOTH SPAR ARMS ARE COMPRESSING	replace both 9100mm spar arms, install 47 on both sides, reinsulate 3 x 12/phase

Str #	Comments	Recommendations
L7012,473	RIGHT SPAR ARM IS COMPRESSING AND CRACKING WHERE XBRACE CONNECTS TO RIGHT ARM	replace right 9100mm spar, reinsulate 3 x 12/phase
L7012,475	BOTH SPAR ARMS ARE COMPRESSING LEFT ONE SAGGING. BOTH SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,476	LEFT SPAR ARM IS STARTING TO COMPRESS	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,477	BOTH SPAR ARMS ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,478	BOTH ARMS ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,479	BOTH SPAR ARMS ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,480	BOTH SPAR ARM ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 12/phase, install 48 on both sides
L7012,481	BOTH ARMS ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,484	BOTH SPAR ARMS ARE COMPRESSING AND THE RIGHT ONE IS ALSO CRACKING WHERE ARM BOLTS TO XBRACE.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,486	BOTH SPAR ARMS ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,491	LEFT SPAR ARM IS ROTTING AT END OF ARM WHERE PHASE IS. SHOULD BE REPLACED.	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,492	RIGHT SPAR ARM IS STARTING TO SAG. BOTH ARMS SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,499	RIGHT SPAR ARM STARTING TO COMPRESS	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,501	1 OF 12 INSULATORS BROKE ON CENTER PHASE.	reinsulate 3 x 12/phase (road crossing)
L7012,503	RIGHT SPAR ARM IS STARTING TO COMPRESS	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,506	BOTH SPAR ARMS ARE COMPRESSING AND HAVE MINOR WEATHERING CRACKS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,508	RIGHT SPAR ARM STARTING TO COMPRESS	replace right 9100mm spar arms, reinsulate 3 x 12/phase
L7012,510	BOTH SPAR ARMS ARE COMPRESSING A LITTLE BIT	replace both 9100mm spar arms, reinsulate 3 x 12/phase, install 51 on both sides
L7012,512	BOTH SPAR ARM STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,515	BOTH SPAR ARMS STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,516	LEFT SPAR ARM IS COMPRESSING .	replace left 9100mm spar arms, reinsulate 3 x 12/phase

Str #	Comments	Recommendations
L7012,517	BOTH SPAR ARMS COMPRESSING A LITTLE BIT	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,518	BOTH SPAR ARMS ARE STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,529	BOTH SPAR ARMS ARE COMPRESSING AND HAVE WEATHERING CRACKS ON THEM. BOTH ARMS SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,530	BOTH SPAR ARMS ARE STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 12/phase, install 53 on both sides
L7012,537	BOTH SPAR ARMS ARE COMPRESS AND SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,539	RIGHT SPAR ARM IS STARTING TO COMPRESS .	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,540	BOTH ARMS BOWING WITH MINOR WEATHERING CRACKS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,541	LEFT SPAR ARM HAS A MAJOR WEATHERING CRACK UNDER CRNTER PHASE	replace left 9100mm spar arms, reinsulate 3 x 12/phase
L7012,542	LEFT SPAR ARM IS COMPRESSING	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,543	BOTH SPAR ARMS ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,544	BOTH SPAR ARMS ARE COMPRESSING AND THE RIGHT ARM HAS A CRACK WHERE THE BOLT CONNECTS THE ARM TO THE RIGHT POLE.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,545	LEFT SPAR ARM IS COMPRESSING	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,546	ANTS IN BOTH POLES AND BOTH SOUND HOLLOW. SPAR ARMS ARE COMPRESSING AND SHOULD BE REPLACED.	replace 70' 230-TG-0 with 70' 230-TG-0
L7012,550	BOTH SPAR ARMS ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 12/phase, install 55 on both sides
L7012,551	LEFT SPAR ARM IS STARTING TO COMPRESS	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,553	BOTH SPAR ARMS ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,554	BOTH SPAR ARMS ARE COMPRESSING AND SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,555	BOTH SPAR ARMS ARE STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,558	BOTH ARMS ARE COMPRESSING SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,562	1 CHIPPED INSULATOR RIGHT PHASE. LEFT SPAR ARM STARTING TO COMPRESS	replace left 9100mm spar arm, reinsulate 3 x 12/phase

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Str #	Comments	Recommendations
L7012,564	BOTH ARMS ARE COMPRESSING BUT THE LEFT IS WORSE.	replace both 9100mm spar arms, reinsulate 3 x 12/phase (road crossing)
L7012,565	DAMAGED INSULATORS	reinsulate 3 x 12/phase (road crossing)
L7012,566	BOTH SPAR ARM ARE STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,568	LEFT SPAR ARM STARTING TO COMPRESS	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,569	LEFT SPAR ARM IS COMPRESSING AND SHOULD BE REPLACED.	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,571	RIGHT PHASE I CHIPPED INSULATOR. RIGHT SPAR ARM STARTING TO COMPRESS	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,572	LEFT SPAR ARM IS COMPRESSING.	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,573	RIGHT SPAR ARM IS STARTING TO COMPRESS AND ALSO HAS WEATHERING CRACKS FROM RIGHT POLE TO RIGHT PHASE.	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,574	LEFT SPAR ARM IS STARTING TO SAG	replace left 9100mm spar arms, reinsulate 3 x 12/phase
L7012,575	BOTH SPAR ARMS ARE STARTING TO COMPRESS AND HAVE WEATHERING CRACKS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,577	LEFT SPAR ARM STARTING TO FLATTEN	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,580	RIGHT SPAR ARM STARTING TO FLATTEN	replace right 9100mm spar arms, reinsulate 3 x 12/phase, install 58 on both sides
L7012,581	BOTH SPAR ARMS ARE STARTING TO FLATTEN. LEFT SPAR ARM HAS A WEATHERING CRACK UNDER CENTER PHASE	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,585	RIGHT SPAR ARM STARTING TO COMPRESS	replace right 9100mm spar arms, reinsulate 3 x 12/phase
L7012,586	BOTH POLES HAVE ANTS. BOTH POLES SOUND HOLLOW LEFT POLE SOUNDS VERY HOLLOW.	replace 75' 230-TG-0 with 75' 230-TG-0
L7012,587	CENTER PHASE HAS 2 BROKEN INSULATORS.	reinsulate 3 x 12/phase
L7012,589	RIGHT SPAR ARM STARTING TO FLATTEN	replace right 9100mm spar arm, reinsulate 3 x 12/phase
L7012,590	RIGHT POLE HAS ANTS AND SOUNDS HOLLOW ON ONE SIDE. ALSO HAS LARGE WEATHERING CRACK AT BOTTOM OF POLE. BOTH SPAR ARMS ARE STARTING TO COMPRESS AND HAVE WEATHERING CRACKS	replace 70' 230-TG-0 with 70' 230-TG-0, install 59 on both sides
L7012,591	BOTH SPAR ARMS ARE STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 12/phase

Str #	Comments	Recommendations
L7012,592	LEFT SPAR ARM STARTING TO COMPRESS AND HAS WEATHERING CRACKS RIGHT POLE HAS ANTS AND MINOR WEATHERING CRACKS.	replace left 9100mm spar arms, reinsulate 3 x 12/phase
L7012,593	LEFT SPAR ARM IS STARTING TO COMPRESS	replace left 9100mm spar arm, reinsulate 3 x 12/phase
L7012,594	BOTH SPAR ARMS ARE COMPRESSING AND SHOULD BE REPLACED	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,598A	DAMAGED INSULATORS	reinsulate 3 x 12/phase
L7012,599	DAMAGED INSULATORS	reinsulate 3 x 12/phase
L7012,600	DAMAGED INSULATORS	reinsulate 3 x 14/phase, install 60 on both sides
L7012,601	BOTH SPAR ARMS STARTING TO FLATTEN.	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,602	RIGHT SPAR ARM STARTING TO COMPRESS	replace right 9100mm spar arm, reinsulate 3 x 14/phase
L7012,603	BOTH ARMS BOWING WITH MINOR WEATHERING CRACKS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,605	RIGHT SPAR ARM STARTING TO COMPRESS	replace right 9100mm spar arms, reinsulate 3 x 14/phase
L7012,606	BOTH SPAR ARMS STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,607	BOTH SPAR ARMS ARE STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 12/phase
L7012,609	BOTH SPAR ARMS ARE COMPRESSING AND HAVE MAJOR WEATHERING CRACKS. BOTH ARMS SHOULD BE REPLACED	replace both 9100mm spar arms, reinsulate 3 x 12/phase (road crossing)
L7012,610	BOTH SPAR ARMS ARE COMPRESSING AND HAVE WEATHERING CRACKS	replace both 9100mm spar arms, reinsulate 3 x 14/phase (road crossing) install line and str id's
L7012,611	BOTH SPAR ARE COMPRESS A LITTLE BIT	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,612	DAMAGED INSULATORS	reinsulate 3 x 14/phase
L7012,613	BOTH SPAR ARMS ARE STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,615	DAMAGED INSULATORS	reinsulate 3 x 14/phase (crosses L5572 and L5573)
L7012,616	BOTH SPAR ARMS ARE STARTNG TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,617	BOTH ARMS BOWING WITH MINOR WEATHERING CRACKS	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,618	LEFT SPAR ARM IS COMPRESSING. BOTH ARMS SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,619	RIGHT SPAR ARM MINOR WEATHERG CRACK FROM RIGHT POLE TO RIGHT PHASE.	replace both 9100mm spar arms, reinsulate 3 x 14/phase

Str #	Comments	Recommendations
L7012,620	LEFT SPAR ARM IS STARTING TO COMPRESS	replace left 9100mm spar arms, reinsulate 3 x 14/phase, install 62 on both sides
L7012,621	LEFT SPAR ARM IS COMPRESSING	replace left 9100mm spar arms, reinsulate 3 x 14/phase
L7012,622	3 OF 14 INSULATORS BROKE ON CENTER PHASE	reinsulate 3 x 14/phase,(crosses rr tracks), tighten 2 guys
L7012,623	LEFT SPAR ARM STARTING TO COMPRESS	replace left 9100mm spar arms, reinsulate 3 x 14/phase, (crosses rr tracks)
L7012,624	DAMAGED INSULATORS	reinsulate 3 x 14/phase
L7012,625	DAMAGED INSULATORS	reinsulate 3 x 14/phase
L7012,626	DAMAGED INSULATORS	reinsulate 3 x 14/phase
L7012,629	DAMAGED INSULATORS	reinsulate 3 x 14/phase
L7012,630	DAMAGED INSULATORS	reinsulate 3 x 14/phase, install 63 on both sides
L7012,631	DAMAGED INSULATORS	reinsulate 3 x 14/phase
L7012,632	DAMAGED INSULATORS	reinsulate 3 x 14/phase
L7012,633	2 OF 14 INSULATORS BROKE ON RIGHT PHASE	reinsulate 3 x 14/phase
L7012,634	LEFT SPAR ARM STARTING TO COMPRESS.	replace left 9100mm spar arms, reinsulate 3 x 14/phase
L7012,635	RIGHT SPAR ARM IS COMPRESSING	replace right 9100mm spar arms, reinsulate 3 x 14/phase
L7012,636	2 INSULATOR BROKE. 1 CENTER 1 RIGHT PHASE.	reinsulate 3 x 14/phase
L7012,637	RIGHT SPAR ARM STARTING TO COMPRESS	replace right 9100mm spar arm and re-insulate 3 x 14/phase
L7012,638	1 CHIPPED INSULATOR CENTRE PHASE	reinsulate 3 x 14/phase
L7012,639	DAMAGED INSULATORS	reinsulate 3 x 14/phase
L7012,640	BOTH SPAR ARMS ARE COMPRESSING.	replace both 9100mm spar arms, reinsulate 3 x 14/phase, install 64 on both sides
L7012,641	EYE BOLT SHOULD BE TIGHTENED ON LEFT POLE WHERE LEFT PHASE CONNECTS TO LEFT POLE . ONLY 2 THREADS SHOWING.	tighten center phase eyebolt, install 3/4" pal nut
L7012,642	BOTH SPAR ARMS ARE COMPRESSING AND THE RIGHT ARM HAS WEATHERING CRACKS. BOTH ARM SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,645	BOTH SPAR ARMS ARE COMPRESSING AND HAVE WEATHERING CRACKS. ARMS SHOULD BE REPLACED	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,648	BOTH SPAR ARMS ARE COMPRESSING AND HAVE WEATHERING CRACKS SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 14/phase

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Str #	Comments	Recommendations
L7012,650	BOTH SPAR ARMS ARE A STARTING TO FLATTEN. BOTH ARMS SHOULD BE REPLACED DUE TO THAT IT CROSSES OVER A HORSE TRACK	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,651	BOTH SPAR ARMS ARE STARTING TO COMPRESS	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,652	BOTH SPAR ARMS ARE COMPRESSING AND HAVE WEATHERING CRACKS. SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 14/phase (crosses hwy 28)
L7012,655	DAMAGED INSULATORS	reinsulate 3 x 14/phase
L7012,656	BOTH ARMS ARE STARTING TO FLATTEN. ALSO HAVE MINOR WEATHERING CRACKS.	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,658	BOTH SPAR ARMS ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 14/phase (crosses mahon rd)
L7012,659	BOTH ARMS ARE COMPRESSING	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,660	BOTH SPAR ARMS ARE COMPRESSING AND HAVE WEATHERING CRACKS. BOTH ARMS SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 14/phase, install 66 on both sides
L7012,661	DAMAGED INSULATORS	reinsulate 3 x 14/phase
L7012,662	BOTH SPAR ARMS COMPRESSING AND LEFT ROTTEN WHERE IT BOLTS TO POLE.	replace both 9100mm spar arms, reinsulate 3 x 14/phase, install 7012 on both sides (crosses Roaches rd)
L7012,663	BOTH SPAR ARMS ARE COMPRESSING AND SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,664	RIGHT SPAR ARM IS COMPESSING A LITTLE	replace right 9100mm spar arms, reinsulate 3 x 14/phase
L7012,665	BOTH SPAR ARMS ARE COMPRESSING AND SHOULD BE REPLACED	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,666	CENTER PHASE HAS 2 BROKEN INSULATORS ON THE VERTICAL STRAIN. LEFT PHASE 3 BROKEN.	re-insulate idlers 3 x 14/phase
L7012,667	BOTH SPAR ARMS ARE STARTING TO FLATTEN	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,668	BOTH SPAR ARMS ARE COMPRESSING, RIGHT PHASE 1 BROKEN INSULATOR	replace both 9100mm spar arms, reinsulate 3 x 14/phase
L7012,670	1 OF 14 INSULATORS BROKE ON LEFT PHASE	reinsulate 3 x 14/phase, install 67 on both sides
L7012,673	BOTH SPAR ARMS ARE COMPRESSING AND THE LEFT ARM HAS WEATHERING CRACKS. BOTH ARMS SHOULD BE REPLACED.	replace both 9100mm spar arms, reinsulate 3 x 14/phase, install 7012 on both sides

Request IR-31:

Reference CI# 49948, Isolated Transmission Structure replacements

(a) Please provide a more detailed breakdown of the contract cost comparison table provided on page 2 of 5 (page 473 of document N-1).

(b) Please provide analysis that confirms the following statement on page 2 of 5 "Replacing the existing deteriorated assets is more cost effective than rebuilding the entire line."

Response IR-31:

(a) The helicopter costs are calculated using the estimated helicopter time in hours required to complete the replacements and the hourly rate for the helicopter. The hourly rate for the helicopter includes the helicopter, pilot, and fuel costs. The environmental matting costs are calculated using the estimated number of mats required to access all the structures and the cost to install each mat. Please refer to the table below for the estimated number of helicopter hours required and the estimated number of mats required.

Line (# Structures)	Helicopter - Estimated Hours Required	Traditions Method - Estimated # of Mats Required
L6021 (24 Structures)	86	1,685
L6021 (27 Structures)	112	1,660
L6021 (26 Structures)	109	2,000
L6024 (18 Structures)	98	1,740

(b) Engineering experience indicates an estimated $430,000 per kilometer for the construction of a new 138 kV transmission line. This results in a cost of $73.2 million to build a line to replace L6021 and L6024. The cost of the isolated structure replacements and upgrades proposed in this project is $3.8 million. In addition, the construction of a new transmission line would require significant lead time before construction begins in order to complete the new line design and secure the necessary right-of-way easements. During the design and construction of the new transmission line, the existing transmission line would remain in-service to maintain service reliability and would require regular maintenance which would add to the overall costs.

Request IR-32:

Reference CI# 49815, 2017/2018 Steel Tower Refurbishment

(a) Please identify the 17 transmission lines that require replacement and provide their age.

(b) Did NSPI evaluate other refurbishment options? If no why? If yes, please provide the analysis that justifies replacement.

(c) Please provide the results of the inspection as described on page 1 of 4.

Response IR-32:

(a) Seventeen transmission lines had structures identified as potential candidates for steel refurbishments. These structures require further scoping to identify the scope of damage, and to determine the required refurbishment to mitigate the risk of a tower failure. Since the 2017 ACE Plan submission, additional lines have been identified as part of the transmission inspection program, bringing the total to 21 transmission lines with identified deficiencies, which are listed in the table below.

Line	Age
L5003	60
L5042	57
L5049	50
L6001	57
L6003	49
L6005	37
L6007	49
L6010	38
L6012	37
L6014	57
L6033	39

Line	Age
L6038	28
L6040	57
L6507	25
L6535	56
L6551	56
L7018	32
L8001	40
L8002	40
L8003	25
L8004	24

(b) The towers identified in this project will not be completely replaced; only a small percentage of the towers on these lines have deficiencies identified. These deficiencies are on smaller tower components which are being replaced, reinforced, or protected via a cold galvanizing coating. Each tower is evaluated on a case-by-case basis by a qualified engineer to determine the level of refurbishment required to mitigate the risk of a tower failure. Based on the extent of the deficiency and the location of the deficiency on the tower, the engineer determines whether the steel tower component should be replaced, reinforced or coated.

(c) Below are the inspection results for five towers which will be targeted for steel tower refurbishments in 2017. The recommendations for all of these structures, based on the transmission inspection program, are for an engineer to assess the steel to determine whether a refurbishment is required, and to prioritize the work based on the engineer's assessment. Please refer to Attachment 1 for an example of an assessment completed by an engineering firm. This document outlines the scope of work required to mitigate the risk of a tower failure, and provides a timeline for when the work should be completed. Similar assessments will be completed on towers identified in the inspection program. The results of these engineering assessments will allow NS Power to prioritize tower refurbishments in order to maximize the total risk mitigated by the 2017 Steel Tower Refurbishment Program.

Str #	Comments	Recommendations
L6014-007	HORIZONTAL STRAIN INSULATOR HARDWARE IS RUST, AS IS MOST OF THE HARDWARE (NUTS AND BOLTS) ON THE STRUCTURE. TWO BENT MEMBERS. CONCRETE FOOTINGS ARE CRACKING	Engineer to assess steel and concrete footings
L8001-070	GUY WIRES A LITTLE BIT SLACK SHOULD BE TIGHTENED. ALSO SIGNS OF RUST ON 1 SET OF ANCHOR RODS.	Engineer to assess steel
L8001-076	RIGHT LEG IS POOLING IN WATER AND RUSTING. 1 SET OF GUY WIRES LOOSE.	Engineer to assess steel
L6038-004	TOWER LEGS/GRILLAGE ALL RUSTY (FLAKING)	Engineer to assess steel
L6040-012	HARDWARE AND SOME MEMBERS RUGGED. FOOTINGS ARE RUSTED AT THE CONCRETE LEVEL	Engineer to assess steel

1

VARCON INC. consulting engineers
Dartmouth NS, Fredericton NB, Barrie ON, Edmonton AB, Calgary AB, Burnaby BC. www.varcon.net

October 21, 2016

Attention: Grant Fraser, Project Manager; **Nova Scotia Power**
Subject: L6014-007 Site Investigation

Dear Mr. Fraser:

As per your request, Varcon Inc. has visited the site to further investigate various structure issues documented during the asset inspection programs. Varcon Inc. visited the site on October 20, 2016 and visually inspected the tower foundations and structure paint.

Below is a summary of our findings.

- There are cracks in the concrete of all four (4) of the tower base foundations, possibly caused by an Alkali-silica reaction (ASR) and exacerbated by freeze-thaw damage.
- There are gaps between the tower leg base plates and the concrete piers. Moisture is infiltrating these spaces and is causing some light corrosion of the base plates.
- Two (2) bent diagonals were found in the bottom panel of the structure on the Easterly and Westerly faces, the damage appears to have been caused by external forces (i.e. machinery).
- The structure paint is generally in fair condition and is flaking off the structure, the member galvanizing appears to be intact and the structure does not appear to be corroding due to the loss of paint.

Based on our findings, review of the information and knowledge of lattice structures we summarize our findings with the following recommendations (timeframe).

- The cracks in the tower foundations should be sealed with an epoxy to prevent further water infiltration and deterioration due to the resulting freeze thaw effects. If the sealing of the cracks is broken within a year it will confirm there is active damaging effects within the concrete (ASR or corrosion). (1-6 months)
- The gaps beneath the base plates should be cleaned, dried, and sealed with either a non-shrink grout or an epoxy to prevent further water infiltration and corrosion. (1-6 months)
- The bent diagonals should be replaced with similar size and grade material. (1-2 years)
- The structure paint should be re-evaluated for any further deterioration at a later date. (1-2 years)

We trust the forgoing is satisfactory. If you have any questions or comments, please contact the undersigned.

Sean Hayman, P.Eng., PhD., MScE.
Director of Engineering
sean.hayman@varcon.net

REGISTERED PROFESSIONAL ENGINEER
DATE Oct. 28,2016
F. J. Weatherby
9836
PROVINCE OF NOVA SCOTIA

Appendix A: Photos


Ph 1 – Foundation cracks (1 of 3).


Ph 2 – Foundation cracks (2 of 3).


Ph 3 – Foundation cracks (3 of 3).


Ph 4 – Gap beneath base plate.


Ph 5 – Bent tower diagonal (2 places).


Ph 6 – Paint condition (typ.).

Request IR-33:

Reference CI# 49774, L5527 Replacement and Upgrades

(a) Please provide documentation that describes NS Power's inspection program. Include criteria for replacement vs rebuild.

(b) Provide analysis that justifies "replacing the existing deteriorated assets is more cost effective than rebuilding the entire line."

(c) Provide the history of any replacements of deteriorated assets associated with L5527 since the line was built in 1966.

Response IR-33:

(a) Please refer to Attachment 1 for inspection results of the structures identified in this project. Please refer to SBA IR-30 part (a) for the breakdown of the inspection criteria. Please also refer to part (b) for the comparison between replace and rebuild.

(b) Engineering experience indicates an estimated $300,000 per kilometer for the construction of a new 69 kV transmission line. This results in a cost of $17.1 million to build a line to replace L5527. The cost of the L5527 replacements and upgrades proposed in this project is $1.5 million. In addition, the construction of a new transmission line would require significant lead time before construction begins in order to complete the new line design and secure the necessary right-of-way easements. During the design and construction of the new transmission line, the existing transmission line would remain in-service to maintain service reliability and would require regular maintenance which would add to the overall costs.

(c) NS Power's current work management system was implemented in 2010 and data prior to this is unavailable. The table below provides details on work completed on L5527 since 2010.

Year	# of Structures	Type	Work Description
2010	1	Routine T001	Replaced Structure due to large split in pole
2013	1	Routine T001	Retied Insulators
2013	8	Routine T001	Replaced Broken Ties (7 Structures), Replaced Timber (1 Structure)
2014	40	Routine T001	Replaced 4 structures and 30+ arms near Canso due to Ice Storm
2014	3	Routine T001	Replaced 1 Structure and Re-insulated 2, permanent repairs after Ice storm
2014	1	Routine T001	Replaced broken Down Guy
2015	56	CI 44979	Replaced 32 Structures and Cross Arms on 24 Structures
2015	1	Routine T001	Repaired Broken Conductor
2015	1	Routine T001	Repaired Broken Conductor
2015	1	Routine T001	Repaired Broken Conductor
2016	1	Routine T001	Replaced Damaged Insulators and Eye Bolts
2016	2	Routine T001	Repaired damaged conductor

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Str #	Comments	Recommendations
L5527-004	ARMOUR RODS BEGINNING TO UNRAVEL	replace center and right armour rods
L5527-005	LEFT CONDUCTOR ARMOUR RODS BEGINNING TO UNRAVEL	replace left armour rods
L5527-012	HOLLOW POLE	replace with 40' 69-DT-3, remove old 40' poles
L5527-022	ARMOUR RODS NO LONGER IN CLAMPS	install armour rods on all 3 phases
L5527-026	LEFT ARMOR ROD FRAYING	install armour rod on left phase
L5527-028	RIGHT ARMOR ROD FRAYING	replace right armour rod (2/0)
L5527-030	RIGHT ARMOR ROD FRAYED	replace right armour rod (2/0)
L5527-031	RIGHT POLE NOW HAS 6 WOODPECKER HOLES	re-insulate 1 x 5/phase idler
L5527-060	HOLLOW POLE	replace with 50' 69-t-post, remove old 50' pole, transfer 1 side guy, install 2 cribs, install 6 on both sides
L5527-062	HOLLOW POLE	replace with 40' 69-tpost-1, remove 40' pole
L5527-066	HOLLOW POLE	replace with 60' t-post-1, transfer insulators
L5527-067	HOLLOW POLE	replace with 60' t-post-1/ transfer insulators
L5527-068	DAMAGE TO BASE OF POLE	replace with 55' 69-t-post-1
L5527-071	POLE HOLLOW	replace with 40' 69-tpost-1
L5527-072	CROSS ARM ROTTING	replace 69-tpost timber/ transfer insulators
L5527-075	POLE ROTTEN	replace 55' 69-tpost-1/ transfer insulators
L5527-078	CROSS ARM ROTTING	replace 69-tpost timber/ transfer insulators
L5527-082	X ARM CRACKED RIGHT SIDE	replace 69-tpost timber/ transfer insulators
L5527-084	X ARM WEATHERED	replace 69-tpost timber/ transfer insulators
L5527-089	X ARM ROTTING	replace 69-tpost-1 timber/ transfer insulators
L5527-099	ARMOR ROD UNRAVELLED	replace unravelled armour rod
L5527-102	POLE HOLLOW	replace with 45 x 2 and 1 x 50' 138-DT-3, transfer single pole insulator (jumper carrier) for center phase
L5527-103	HOLLOW POLE INSECT DAMAGE	replace with 40' 138 dt-3, remove 40' poles
L5527-106	POLE HOLLOW	replace 50' 69-tpost-1, transfer insulators
L5527-109	HOLLOW POLE	replace 45' 69-tpost -1 / transfer insulators
L5527-122	POLE ROTTEN	replace with 55' 69-tpost-1, remove 55' pole/ transfer insulators
L5527-130	ARMOR ROD ON CENTER PHASE BEGINNING TO FRAY	replace center phase armour rod

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Str #	Comments	Recommendations
L5527-133	POLE SOUNDS HOLLOW	replace 55' 69-tpost-1/ transfer insulators
L5527-135	ANTS, POLE HOLLOW	replace with 65' 69-tpost-1/ transfer insulators
L5527-139	NO DAMPERS YET	re-insulate 3 x 5/phase idlers
L5527-140	CENTRE POLE HOLLOW, LEFT & RIGHT HAVE SPLITS	replace with 55' 138-DT-3, remove 55' poles, install 14 on both sides
L5527-141	steep gully to the right of structure	reinsulate 3 x 5/phase idlers
L5527-142	pole base hollow. bolt in xarm and pole badly rusted	replace with 40' 69-tpost-1/ transfer insulators
L5527-144	arm showing signs of rot	replace 69-tpost-1 timber, transfer insulators
L5527-147	line splice is old type , xarm rotting	replace 69-tpost-1 timber/ transfer insulators, replace 2/0 sleeve
L5527-148	pole rotten and hollow xarm tilting from pole. 2 old splices	replace with 35' 69-tpost-1, transfer insulators
L5527-159	brown insulators and ants in poles, poles sound hollow	replace with new 50' 138-DT-3, remove 50' poles
L5527-164	wood pecker holes all poles, idler timber rot	replace with new 138-DT-3 (1 x 40', 1 x 45', 1 x 50' pole)
L5527-166	xarm seems to have slight sag	replace 69-tpost timber/ transfer insulators
L5527-173	xarm looks rotten	replace 69-tpost timber/ transfer insulators
L5527-178	pole top rotten arm weathered	replace with new 50' 69-tpost-1, transfer insulators
L5527-180	Xarm cracked and rotting	replace 69-tpost timber/ transfer insulators
L5527-184	right pole hollow and ants	replace with new 138-DT-3 (45')
L5527-187	4 large wp holes one you can see right through under xarm	replace 40' 69-tpost-1, transfer insulators
L5527-189	old insulators, guys beginning to rust	re-insulate 3 x 5/phase idlers
L5527-190	poles sound hollow, all thin insulators	replace with 40' 138-DT-3, install 19 on both sides
L5527-194	woodpecker holes at top of structure adjacent to cross arm hardware. some rot in cross arm.	replace with new 40' 69-tpost-1/ transfer insulators
L5527-196	rotting xarm	replace 69-tpost timber/ transfer insulators
L5527-202	old insulators	re-insulate 3 x 5/phase insulators
L5527-215	very hollow at base	replace 40' 69-t-post-1
L5527-220	3 fingertrap splices	replace 3 quick sleeves with 2/0 compression
L5527-223	pole hollow, small crack in xarm	replace with 40' 69-tpost-1, transfer insulators
L5527-229	hollow pole	replace 40' 69-tpost-1, transfer insulators

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Str #	Comments	Recommendations
L5527-232	arm rotting, insulators leaning	replace 69-tpost timber/ transfer insulators
L5527-233	large wood pecker hole where xarm bolts attach to pole. arm twisting	replace with 40-tpost-1/ transfer insulators
L5527-236	hollow pole	replace with new 60' t-post-1/ transfer insulators
L5527-240	arm twisting from pole	replace 69-tpost timber/ transfer insulators
L5527-241	guy snapped off from anchor west side others rusty	replace with new 45' 69-DT3, remove 40' 69-DT-2
L5527-242	arm twisted and rotten	replace 69-tpost timber/ transfer insulators
L5527-250	old insulators	re-insulate 3 x 5/phase idlers and 5 x 6/phase de
L5527-251	u bolts showing wear	replace 3 x u-bolts and re-insulate 3 x 5/phase
L5527-253	minor rust on guys 2 poles sound hollow	replace with new 55' 138-DT-3, remove old 55' poles
L5527-255	rotten with small cracks	replace with new 40' 69-t-post-1, remove old 40' pole
L5527-263	arm and pole top weathered	replace with new 69-tpost-1 timber/ transfer insulators
L5527-265	arm rotten	replace 69-tpost-1 timber/ transfer insulators
L5527-266	arm rotten	replace 69-T-post-1 timber/ transfer insulators
L5527-278	arm tilting down and rotting	replace 69-tpost-1 timber/ transfer insulators
L5527-279	loose storm guys	tighten both storm guys and install guy guards
L5527-281	cribbed. slight i bolt wear	replace 69-th-1 timber with 69-th2 timber, reinsulate 2 x 5/phase and transfer post insulator
L5527-287	arm rotting and twisting from pole	replace 69-tpost-1 timber/ transfer insulators
L5527-293	arm rotten and cracked	replace 69-tpost-1 timber/ transfer insulators
L5527-296	slack guys on east side. idler timbers rotting	re-insulate 3 x 5/phase idlers, 6 x 5/phase de's, replace long and short idler arms, tighten 3 guys on east side, install 8 guy guards
L5527-297	1 broken guy west side	re-insulate 3 x 5/phase idlers, 6 x 5/phase de's, replace long and short idler arms, tighten 1 guys on east side, install 8 guy guards

Str #	Comments	Recommendations
L5527-298	arm cracked wth rot	replace 69-tpost-1 timber/ transfer insulators
L5527-311	split bolt twisted arm rotting	replace 69-T-post-1 timber/ transfer insulators
L5527-316	cracks and rot in arm	replace 69-T-post-1 timber/ transfer insulators
L5527-317	ants in butt of pole, pole hollow	replace 40' 69-tpost-1, remove 40' pole/ transfer insulators
L5527-321	pole hollow arm rotten	replace with 40' 69-tpost-1, remove old 40' pole
L5527-322	ants in pole rotten arm	replace with new 40' 69-Tpost-1, remove old 40' pole
L5527-326	hollow, ants and rotten	replace with new 40' 60-tpost-1, transfer insulators, remove 40' pole
L5527-338	arm showing slight rot	replace 69-T-post-1 timber/ transfer insulators
L5527-340	pole hollow. arms showing rot	replace with new 45' 138-DA-3, remove 45' poles
L5527-342	pole hollow	replace with new 40' 69-tpost-1/ transfer insulators
L5527-344	arm cracked with rot	replace 69-T-post-1 timber/ transfer insulators
L5527-345	pole rejected bad insect damage	replace with new 45' 69-tpost-1, transfer insulators
L5527-352	wood pecker hole at pole top below insulator, pole also hollow	replace 45' 69-tpost-1, transfer insulators
L5527-353	4 large wood pecker holes one at top is bad	replace 55' 69-tpost-1, transfer insulators
L5527-354	hollow rejected pole and bad arm	replace 45' 69-tpost-1, transfer insulators
L5527-355	all 3 poles riddled with wood pecker holes	replace with new 45' 69-DT-3
L5527-356	old insulators	re-insulate 3 x 5/phase idlers and 6 x 5/phase de
L5527-357	rejected pole	replace 45' 69-tpost-1, transfer insulators
L5527-360	ants in pole bases	replace 69-th1 timber with 69-th-2 timber, re-insulate 3 x 5/phase
L5527-365	has wood pecker holes in 3 poles	replace with new 45' 138-DT-3
L5527-367	very hollow reject poles	replace 50' 69-tpost-1, transfer insulators
L5527-372	pole hollowed out at middle	replace 45' 69-tpost-1, transfer insulators
L5527-374	arm starting to rot with a bit of a twist 2yr	replace 69-tpost -1 timber/transfer insulators
L5527-375	brown insulators, ibolts worn	replace 69-th-1 timbers with 69-th2 timbers, re-insulate 3 x 5/phase
L5527-377	arm cracks looks like rot	replace 69-tpost-1 timber/ transfer insulators
L5527-384	lightning strike at top of pole	replace 55' 69-tpost-1, transfer insulators

REDACTED (CONFIDENTIAL INFORMATION REMOVED)

Str #	Comments	Recommendations
L5527-386	porcelain brown insulators and eye bolt wear	replace 69-th1 timber with 69-th-2 timber/ re-insulate 3 x 5/phase
L5527-390	armor rod fraying	replace 2/0 armour rod, install 5527 on both sides
L5527-392	2 conductor armor rods unraveling	replace 2 armour rods
L5527-399	crossarm has a crack and some rot	replace 69-tpost-1 timber/ transfer insulators
L5527-401	arm showing weathering	replace 69-tpost-1 timber/ transfer insulators
L5527-402	arm cracked	replace 69-tpost-1 timber/ transfer insulators
L5527-414	Pole Hollow	replace 45' 69-tpost-1/ transfer insulators
L5527-415	2 large holes in pole top	replace 40' 69-tpost-1
L5527-417	old insulators	re-insulate 3 x 5/phase
L5527-420	Pole leaning about 10 degrees	install 2 storm guys and 2 x 5' log anchors with 2 guy guards
L5527-426	rejected pole	replace 40' 69 t-post-1
L5527-429	rejected pole	replace 40' 69-tpost-1/ transfer insulators
L5527-431	arm rotten	replace 69-tpost-1 timber/ transfer insulators
L5527-432	arm rotting	replace 69-tpost-1 timber/ transfer insulators
L5527-433	ants in base reject pole	replace 45' 69-tpost-1/ transfer insulators
L5527-434	arm and pole are rotten	replace 45' 69-tpost-1/ transfer insulators
L5527-435	arm rotten and cracked	replace 69-tpost-1 timber/ transfer insulators
L5527-438	conductor has burns, i bolts very worn 20% remains	replace 69-th-1 timber with 69-th2 timber, transfer insulators
L5527-446	crossarm in poor condition	replace 69-tpost-1 timber/ transfer insulators
L5527-448	arm rot and wood pecker holes	replace 55' 69-tpost-1/ transfer insulators
L5527-449	arm looks like rot	replace 69-tpost-1 timber/ transfer insulators
L5527-450	arm twisting from pole	replace 69-tpost-1 timber/ transfer insulators
L5527-458	rot in arm	replace 69-tpost-1 timber/ transfer insulators
L5527-461	replace arm	replace 69-tpost-1 timber/ transfer insulators
L5527-462	replace arm	replace 69-tpost-1 timber/ transfer insulators
L5527-463	minor rot on right side of arm	replace 69-tpost-1 timber/ transfer insulators
L5527-467	wood pecker holes in poles	replace 50' 69-tpost-1/ transfer insulators

Str #	Comments	Recommendations
L5527-468	loud buzz hard to localize	replace with 50' 69-DA-3, remove 45' 69-DT-2, remove burndy connectors and install 2/0- 2/0 ampacts (doubled), install 5527 on both sides
L5527-471	arm in bad shape	replace 69-tpost-1 timber/ transfer insulators
L5527-474	arm in bad shape	replace 69-tpost-1 timber/ transfer insulators
L5527-478	arm in bad shape	replace 69-tpost-1 timber/ transfer insulators
L5527-481	center jumper seems close to guy has some pitting	replace with 45' 69-DA-3, remove 69-DT-2
L5527-482	arm rotten	replace 69-tpost-1 timber/ transfer insulators
L5527-485	arm starting to rot	replace 69-tpost-1 timber/ transfer insulators
L5527-488	arm looks bad	replace 69-tpost-1 timber/ transfer insulators
L5527-490	shell breaking from pole, arm rot and twisting from pole	replace 45' 69-tpost-1/ transfer insulators
L5527-493	broken strand in conductor by splice	repair conductor/ broken strand by splice
L5527-507	pole hit by lightning, 2 bad splices	replace 40' 69-tpost-1 / transfer insulators, replace 2 splices
L5527-508	arm starting to rot	replace 69-tpost-1 timber/ transfer insulators
L5527-515	arm twisted	replace 69-tpost-1 timber/ transfer insulators
L5527-516	1 storm guy slack	tighten 1 storm guy/ install 2 guy guards
L5527-519	should replace arm	replace 69-tpost-1 timber/ transfer insulators
L5527-522	ants in pole, hollow base	replace 50' 69-tpost-1
L5527-523	rotten pole, arm has cracks	replace 40' 69-tpost-1
L5527-524	pole rotten, arm twisting	replace 69-tpost-1 timber/ transfer insulators
L5527-532	top of pole in bad shape	replace 45' 69-tpost-1
L5527-533	hollow pole	replace with 45' 69-tpost-1
L5527-535	pole top rot	replace with 45' 69-tpost-1
L5527-537	pole hollow	replace with 45' 69-tpost-1
L5527-544	very slack guy	tighten guy, reinsulate 1 post insulator (tie top), install 6 guy guards
L5527-547	arm cracked with rot	replace 69-tpost-1 timber/ transfer insulators
L5527-548	arm and pole rot	replace with new 45' 69-tpost-1/ transfer insulators
L5527-550	pole rotten, missing id	replace with new 45' 69-tpost-1, install 55 on both sides

Request IR-34:

Reference CI# 49814, 2017/2018 Steel Tower Life Extension

(a) On page 2 of 4 (p. 494 of N-1), NSPI states that the protective coating costs are around $50,000 per lattice steel tower. Please justify the $1,462,000 cost of the project for 19 lattices or $76,952 per steel tower.

(b) Provide documentation that confirms these structures are showing signs of corrosion and must be replaced in 2017.

Response IR-34:

(a) The $50,000 estimate referred to on page 494 is for a typical tower in recent steel tower life extension programs (less than 100 feet, two circuits, grey coating). This estimate is valid for 16 of the 19 towers in this project. The three larger towers that require red and white coatings (per Transport Canada regulations) account for approximately 38% of the total project cost. These three towers are estimated at $171,651 per tower, and the other 16 are estimated at $52,816 per tower.

(b) The corrosion on these towers was originally identified during the transmission inspection program. The tower coating contractor also identified these towers as candidates for re-coating due to corrosion. These claims are being verified by a third party to ensure that the towers in this scope of work should be re-coated in 2017. Please refer to Attachment 1 dated October 25, 2016, which provides a third party assessment of a steel tower in the 2017 scope of work, indicating that the tower should be re-coated in the next 1-2 years.

VARCON INC. consulting engineers

Dartmouth NS, Fredericton NB, Barrie ON, Edmonton AB, Calgary AB, Burnaby BC. www.varcon.net

October 25, 2016

Attention: Grant Fraser, Project Manager; **Nova Scotia Power**

Subject: L6033-030 Site Investigation

Dear Mr. Fraser:

As per your request, Varcon Inc. has visited the site to further investigate various structure issues documented during the asset inspection programs. Varcon Inc. visited the site on October 18, 2016 and visually inspected the structure paint.

Below is a summary of our findings.

- The square bolts throughout the tower connections are corroded.
- The structure members above 12.0m are corroded.
- There is a bent sub horizontal member on the tower at 3.0m on the west face.

Based on our findings, review of the information and knowledge of lattice structures we summarize our findings with the following recommendations (timeframe).

- The square bolts used throughout the tower should be replaced with galvanized 5/8" ø A325 structural bolts. (1-2 years)
- The tower members should be cleaned and properly prepped prior to a zinc rich paint being applied. (1-2 years)
- The bent tower member should be replaced with similar size and grade material. (1-2 years)

We trust the forgoing is satisfactory. If you have any questions or comments, please contact the undersigned.

Sean Hayman, P.Eng., PhD., MScE.
Director of Engineering
sean.hayman@varcon.net

REGISTERED PROFESSIONAL ENGINEER
DATE Oct. 28,2016
F. J. Weatherby
9836
PROVINCE OF NOVA SCOTIA

Appendix A: **Photos**

Ph 1 – Corroded tower members (1 of 3).

Ph 2 – Corroded tower members (2 of 3).

Ph 3 – Corroded tower members (3 of 3).

Ph 4 – Corroded bolts (typ.)..

Ph 5 – Bent tower member.

Request IR-35:

Reference CI# 49790, L5505 Replacements and Upgrades

(a) Provide documentation from NSPI's inspection program that identifies the ground clearance violations stated on page 1 of 3 (p. 610 of N-1).

(b) Please identify the number of L5505's structures, timber arms and other assets which will not be replaced under this project.

(c) Provide analysis that shows replacement of these assets is more cost effective than rebuilding the entire line.

Response IR-35:

(a) The minimum ground clearance for a 69kV Transmission Line is 5.2 meters. If any point in a given span is less than 5.2 meters, that span is in violation and needs to be addressed. The following structures have been identified to be raised to rectify a ground clearance violation.

Line, Str #	Min Ground Clearance (m)	Recommendations
L5505,011	5.1	GC violation=5.1m taken 10m from 11 toward 10, remove 35' 69-th1, install 40' 69-th2, install 5505 on both sides
L5505,012	4.7	GC violation=4.7m taken 28m from 12 toward 13. replace with 45' 138-Ah-3 (with 10' spacing), remove 2 x 35' and 1 x 40' poles
L5505,018	5	GC violation=5.0m taken 42m from 18 toward 19, replace with 50' 69-th2, remove 45' 69-th1
L5505,020	5	GC violation=5.0m taken 53m from 20 toward 19, remove 35' 69-DT-2, install 40' 69-DT-3, install 2 on both sides
L5505,026	3.5	GC violation=3.5m taken 10m from 26 toward 27, remove 30', 35' and 40' poles and 69-DA-3, install 40', 45' and 50' 69-DA-3, maintain 25' spacing, use 138kv stand-offs to carry jumpers
L5505,041	5	GC violation=5.0m taken 10m from 41 towards 42, remove 40' 69-th1, install 45' 69-th2

Line, Str #	Min Ground Clearance (m)	Recommendations
L5505,042	4.9	GC violation=4.9m taken 71m from 42 toward 43, remove 45' 69-th1, install 50' 69-th2
L5505,048	4.5	GC violation=4.5m, remove 40' 69-th1, install 45' 69-th2
L5505,057	4.7	GC violation=4.7m taken 45m from 57 toward 56, remove 45' 69-th1, install 50' 69-th2
L5505,071	4.4	GC violations=4.4m taken 45m from 71 toward 70, replace 35' 69-th1, install 40' 69-th2
L5505,073	4.4	GC violation=4.4m taken 90m from 75 toward 74, replace 40' 69-th1, install 45' 69-th2
L5505,076	4.7	GC violation=4.7m taken 45m from 76 toward 75, remove 40' 69-th1, install 45' 69-th2
L5505,077	4.9	GC violation=4.9m taken 30m from 77 toward 76, remove 45 and 40' 69-th1, install 45' and 50' 69-th2
L5505,081	4.8	GC violation=4.8m taken 30m from 81 toward 82, remove 40' 69-th1, install 45' 69-th2
L5505,083	4.5	GC violation=4.5m taken 13m from 83 toward 84, remove 40' 69-da-3, install 45' 69-DA-3

(b) There are a total of 87 structures on L-5505. NS Power will be working on 70 structures in total. The following is a breakdown of how many structures need timbers and/or poles replaced on this line.

- A total of 64 structures will have timber arm replacements, leaving 23 structures not requiring timber arm replacements.
- A total of 33 structures will have pole replacements, leaving 54 structures not requiring pole replacements

(c) Engineering experience indicates an estimated $300,000 per kilometer for the construction of a new 69 kV transmission line. This results in a cost of $3.3 million to build a line to replace L5505. The cost of the L5505 replacements and upgrades proposed in this project is $1.2 million. In addition, the construction of a new transmission line would require significant lead time before construction begins in order to complete the new line design and secure the necessary right-of-way easements. During the design and construction of the new transmission line, the existing transmission line would remain in-service to maintain service reliability and would require regular maintenance which would add to the overall costs.

Request IR-36:

Reference CI# 49782, L5027B Replacements and Upgrades

(a) Provide documentation from NSPI's inspection program that identifies the ground clearance violations stated on page 1 of 3 (p. 613 of N-1).

(b) Please identify the number of L5027B's structures, timber arms and others assets which will not be replaced under this project.

(c) Provide analysis that shows replacement of these assets is more cost effective than rebuilding the entire line.

Response IR-36:

(a) CI 49782 is required to replace deteriorated assets on L5027B, not to address ground clearance violations.

(b) There are a total of 619 structures on this line. NS Power will be working on 103 structures in total. The following is a breakdown of the 619 of structures and their required timbers, insulators or pole replacements.

- A total of 82 structures will have timber replacements, leaving 537 structures not requiring timber replacements.

- A total of 91 structures will have insulator replacements, leaving 528 structures not requiring insulator replacements.

- A total of 19 structures will have pole replacements, leaving 600 structures not requiring pole replacement.

(c) Engineering experience indicated an estimated $300,000 per kilometer for the construction of a new 69 kV transmission line. This results in a cost of $16.7 million to build a line to replace L5027B (the B section of the line is 55.8km). The cost of the L5027B replacements and upgrades proposed in this project is $1.1 million. In addition, the construction of a new transmission line would require significant lead time before construction begins in order to complete the new line design and secure the necessary right-of-way easements. During the design and construction of the new transmission line, the existing transmission line would remain in-service to maintain service reliability and would require regular maintenance which would add to the overall costs.

Request IR-37:

Reference CI# 49775, L5004 Replacements and Upgrades

(a) Provide documentation from NSPI's inspection program that identifies the ground clearance violations stated on page 1 of 3 of the project (p. 619 of N-1).

(b) Please identify the number of L5004's structures, timber arms and others assets which will not be replaced under this project.

(c) Provide analysis that shows replacement of these assets is more cost effective than rebuilding the entire line.

Response IR-37:

(a) The minimum ground clearance for a 69 kV Transmission Line is 5.2 meters. If any point in a given span is less than 5.2 meters, that span is in violation and needs to be addressed. The following recommendations have been made to rectify ground clearance violations.

Line, Str #	Min Ground Clearance (m)	Recommendations
L5004-054B	5.1	GC=5.1m (5.2m) address gc violation
L5004-068	5	Replace with 50' 69-th-2, gc violation=5.0m 70m from 68 toward 69, remove 45' 69-TH-2
L5004-069	5.1	Replace with 45' 69-th2, GC=5.1, remove 45' poles
L5004-083	4.7	Replace 50' 69-th-2, GC=4.7m (violation) between str 83-84 midspan, remove 40' poles

(b) There are a total of 88 structures on this line. NS Power will be working on 34 structures in total. The following is a breakdown of how many structures need timbers, insulators and/or poles replaced on this line.

- A total of 27 structures will have timber replacements, leaving 61 structures not requiring timber replacements.
- A total of 28 structures will have insulator replacements, leaving 60 structures not requiring insulator replacements.
- A total of 25 structures will have pole replacements, leaving 63 structures not requiring pole replacement.

(c) Engineering experience indicates an estimated $300,000 per kilometer for the construction of a new 69 kV transmission line. This results in a cost of $3.9 million to build a line to replace L50004. The cost of the L5004 replacements and upgrades proposed in this project is $1.0 million. In addition, the construction of a new transmission line would require significant lead time before construction begins in order to complete the new line design and secure the necessary right-of-way easements. During the design and construction of the new transmission line, the existing transmission line would remain in-service to maintain service reliability and would require regular maintenance which would add to the overall costs.

Request IR-38:

Reference CI#49821, Mersey River Hydro Spare Transformer

(a) Please provide a copy of NS Power's Power Transformer Spares Inventory Study denoted on page 1 of 8 (p. 637 of N-1).

(b) Page 2 of 9 of Attachment 1 (p. 646 of N-1) states "consider reclaiming the oil". Please indicated whether NSPI considered reclaiming the oil to mitigate the issues denoted in the report.

Response IR-38:

(a) Please refer to Confidential Attachment 1.

(b) Reclaiming the oil would not improve the paper insulation deterioration present in this transformer. Please refer to page 3 of 9 of CI 49821 Attachment 1 under "Furan Analysis Remarks," (pdf page 647 of 1100 in the 2017 ACE Plan).

SBA IR-38 Attachment 1
has been removed due to confidentiality.

Request IR-39:

Reference CI# 49878, 2017 Substation Insulator Replacement Program

(a) Please provide instances in the last 5 years where a transmission element failed due to faulty insulators

(b) Refer to page 1 of 3 (p. 654 of N-1). Provide studies and or other documentation that confirm "The insulators are well known in the industry for being prone to failure."

(c) Identify similar older programs aimed at identifying and removing these insulators. Why NSPI did not pursue replacing these insulators at that time?

Response IR-39:

(a) Please refer to the table below for interruptions caused by an insulator failure in the last five years.

Line/Sub	Station or Line	Date
93V	Station	03/01/2011
L-5561	Line	11/04/2011
L-5571	Line	12/06/2011
L-5011	Line	21/07/2011
L-7002	Line	14/10/2011
L-7002	Line	31/12/2011
L-5502	Line	01/01/2012
L-5549	Line	08/03/2012
L-7002	Line	10/05/2012
L-5500	Line	19/05/2012
L-6004	Line	30/12/2012
L-5033	Line	09/02/2013

Line/Sub	Station or Line	Date
L-6004	Line	17/02/2013
57C	Station	02/06/2013
L-7011	Line	08/07/2013
L-7011	Line	20/07/2013
L-5011	Line	09/08/2013
L-5560	Line	21/11/2013
L-7011	Line	23/11/2013
L-5014	Line	27/11/2013
L-5559/5579	Line	05/01/2014
L-6002	Line	08/01/2014
L-5561	Line	10/01/2014
L-5561	Line	10/01/2014
L-7003	Line	19/01/2014
L-7018	Line	22/02/2014
L-7012	Line	29/07/2014
L-5564	Line	06/09/2014
L-5042	Line	16/01/2015
83V	Station	01/03/2015
L-5547	Line	13/03/2015
1N	Station	21/04/2015
L-7002	Line	13/07/2015
L-5546	Line	23/10/2015
L-5014	Line	04/02/2016
L-6511	Line	08/04/2016
L-5546	Line	28/05/2016
L-6015	Line	25/06/2016
L-6537	Line	16/08/2016
30W	Station	05/09/2016
L-5573	Line	11/10/2016
L-5573	Line	11/10/2016
L-5573	Line	13/10/2016
L-8002	Line	27/11/2016
L-6516	Line	27/11/2016

(b) Please refer to Attachment 1 for an IEEE article on the Cement Growth Failure of Porcelain Suspension Insulators.

(c) A similar project for Substation Insulator Replacement was included in the 2016 ACE Plan (CI 48151, included as Less than $250K). The removal of these types of insulators has been completed in many previous transmission line replacement and upgrade projects.

[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

$$\nabla \times \tilde{H} = \tilde{J} \quad \text{(A-1)}$$

$$\nabla \cdot \tilde{B} = 0 \quad \text{(A-2)}$$

$$\tilde{B} = \mu \tilde{H} \quad \text{(A-3)}$$

$$\ldots \frac{\partial \tilde{B}}{\partial t} \quad \text{(A-4)}$$

$$\ldots + \tilde{v} \times \tilde{B}) \quad \text{(A-5)}$$

...eliminate $\tilde{E}$ in (A-4):

$$\ldots \times (\tilde{v} \times \tilde{B}) = -\frac{\partial \tilde{B}}{\partial t} \quad \text{(A-6)}$$

...he curl of (A-1) into (A-6) yields:

$$\ldots \tilde{B}) - \nabla \times (\tilde{v} \times \tilde{B}) = -\frac{\partial \tilde{B}}{\partial t} \quad \text{(A-7)}$$

...dentity:

$$\ldots = \nabla(\nabla \cdot \tilde{B}) - \nabla^2 \tilde{B} \quad \text{(A-8)}$$

...ENDIX B: FORMULAE

$$\ldots \begin{array}{c|c} [D\,B_m(y+t/2)] & [0] \\ \hline [0] & [D\,B_m(y+t/2)] \end{array} \quad \text{(B-1)}$$

(block sizes N × N)

...2)] is a diagonal NxN matrix whose

$$\ldots \;\underline{\Delta}\; \beta_{mn}\, e^{-\beta_{mn}(y+t/2)} \quad \text{(B-2)}$$

$$[G\,F_m] \;\underline{\Delta}\; \begin{bmatrix} [G_m] & [F_m] \\ [\hat{G}_m] & [\hat{F}_m] \end{bmatrix} \quad \text{(B-3)}$$

$$[F\,G_m] \;\underline{\Delta}\; \begin{bmatrix} [F_m] & [G_m] \\ [\hat{F}_m] & [\hat{G}_m] \end{bmatrix} \quad \text{(B-4)}$$

(block sizes N × L)

The formulae of the n-ℓth elements of the submatrices are:

$$(G_m)_{n\ell} \;\underline{\Delta}\; \frac{z_{n\ell}\, e^{-\Gamma_{m\ell} t/2}}{\beta_{mn} + \Gamma_{m\ell}} \quad \text{(B-5)}$$

$$(F_m)_{n\ell} \;\underline{\Delta}\; \frac{z_{n\ell}\, e^{\Gamma_{m\ell} t/2}}{\beta_{mn} - \Gamma_{m\ell}} \quad \text{(B-6)}$$

$$(\hat{G}_m)_{n\ell} \;\underline{\Delta}\; -\frac{z^*_{n\ell}\, e^{-\Gamma_{m\ell} t/2}}{\beta_{mn} + \Gamma_{m\ell}} \quad \text{(B-7)}$$

$$(\hat{F}_m)_{n\ell} \;\underline{\Delta}\; -\frac{z^*_{n\ell}\, e^{\Gamma_{m\ell} t/2}}{\beta_{mn} - \Gamma_{m\ell}} \quad \text{(B-8)}$$

$$[S_{m1}] \;\underline{\Delta}\; \int_{-h/2}^{h/2} [DD\,R_m(y)]^{*T} [ARCL]^{*T} [DG\,B_m(y+t/2)]\,dy \quad \text{(B-9)}$$

$$[S_{m2}] \;\underline{\Delta}\; \int_{-h/2}^{h/2} [DD\,R_m(y)]^{*T} [ARCL]^{*T} [DG\,B_m(-y+t/2)]\,dy \quad \text{(B-10)}$$

$$[S_{m3}] \;\underline{\Delta}\; \int_{-h/2}^{h/2} [DD\,R_m(y)]^{*T} [ARCL]^{*T} [DG\,B_m(-y+h)]\,dy \quad \text{(B-11)}$$

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/m²
- $\tilde{u}_x, \tilde{u}_y, \tilde{u}_z$ = direction vectors in x,y,z
- $\tilde{v}$ = velocity m/s

Algebraic Vectors

- $\underline{A}_m, \underline{A}_{sm}, \underline{A}_{rm}$ = vector of Fourier Series coefficients
- $\underline{b}_m$ = vector of Fourier Series base
- $\underline{D}_m$ = vector of weights of eddy-current modes

Scalars

- d = guideway width
- h = suspension height
- t = guideway thickness
- L = Fourier base length
- W = Fourier base width

Greek Symbols

- α_m = see eq.(15)
- β_{mn} = eq.(38)
- γ_n = eq.(16)
- Γ_{ml} = eq.(24)

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.

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.

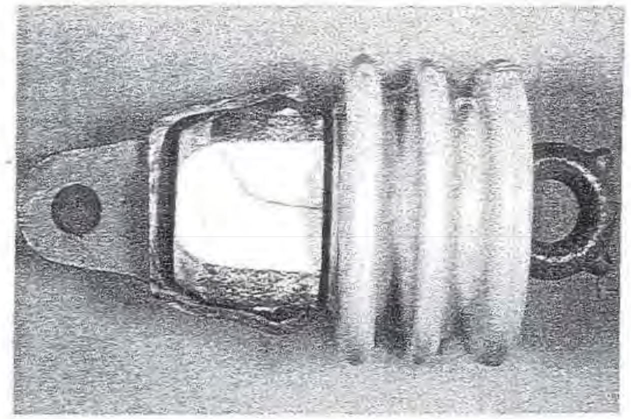


Fig. 1. Radial crack concealed in the head of an insulator.

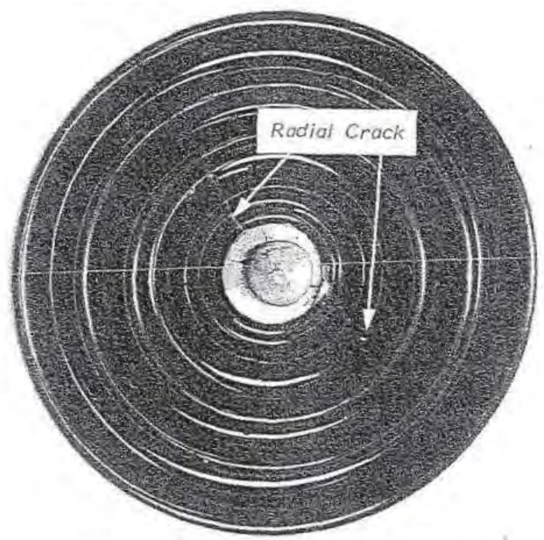


Fig. 2. Radial crack visible in the shell of a suspension insulator.

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.

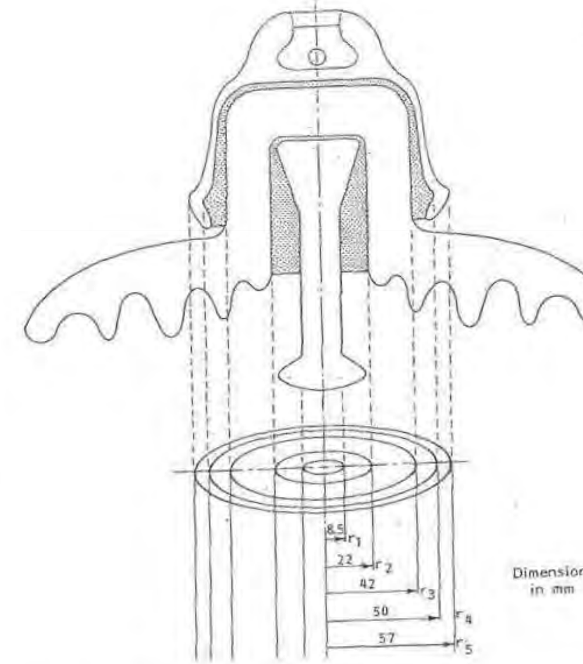


Fig. 3. Cylindrical approximation of the 5-3/4 x 10 in suspension insulator.

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 $\times 10^6$	7-8.5	10-12	3	30
THERMAL COEFFICIENT OF EXPANSION $\times 10^{-6}/°C$	5	7	9	12
FLEXURE STRENGTH psi $\times 10^3$	10-12.5	18.5-22	—	—
POISSON'S RATIO	0.3	0.3	0.2	0.3

Five boundary conditions on the radial stress and four boundary conditions on the circumferential strain yield nine differential equations. The solution applying the physical properties of the insulator components listed in Table 1 gives the dependence of circumferential stress at the porcelain boundary, r_2 in Fig. 3, on cement expansion. Temperature is factored into the model as a separable variable. The results are shown in Figs. 4 and 5 for quartz and alumina porcelains. The departure of circumferential stress from a straight line relationship at elevated temperatures is due to thermal expansion of the cap being greater than cement expansion. The values of flexure strength shown are for American porcelains reported in EPRI RP 425-1 [7]. Flexural strengths have higher values than tensile strengths because, in the case of flexing, the maximum tensile stress covers only a small cross-sectional area. The probability of weaknesses within this small area is lower than over the whole cross-sectional area. In the case of cement expansion and thermal stresses which have their maximum values over small areas near the interfaces, the same reasoning applies.

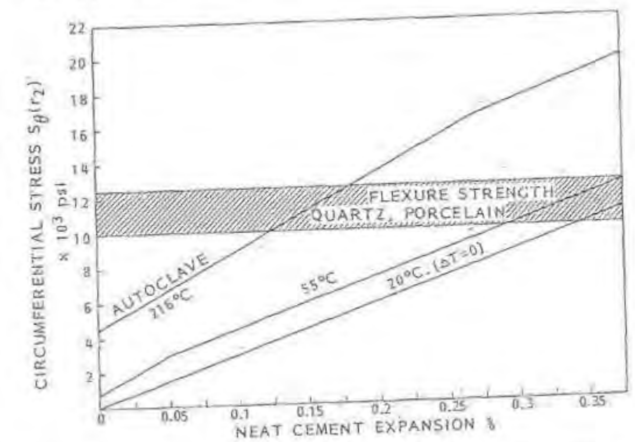


Fig. 4. Circumferential stress S_θ (r_2) in quartz porcelain for cement expansion in per cent.

The calculations show that temperature alone will not fracture quartz or alumina porcelain shells in the 15 000 lb insulator design. However, cement expansion assisted by temperature, will give rise to high enough stresses to produce radial fracture in quartz or alumina porcelain shells. For quartz porcelain, an expansion above 0.3 per cent at 55°C is predicted to cause fracture. For shells of alumina porcelain, cement expansion above 0.5 per cent is needed at 55°C for fracture in the same design of insulator.

At higher temperatures, for example at the ASTM C151 autoclave expansion test temperature of 216°C [8], insulators with quartz shells will fracture if the cement expansion is above 0.13 per cent and above 0.33 per cent for alumina shells.

Although the range for flexure strength shown in Figs. 4 and 5 are for sound porcelain, flaws acquired in manufacturing will greatly reduce the cement expansion necessary for fracture.

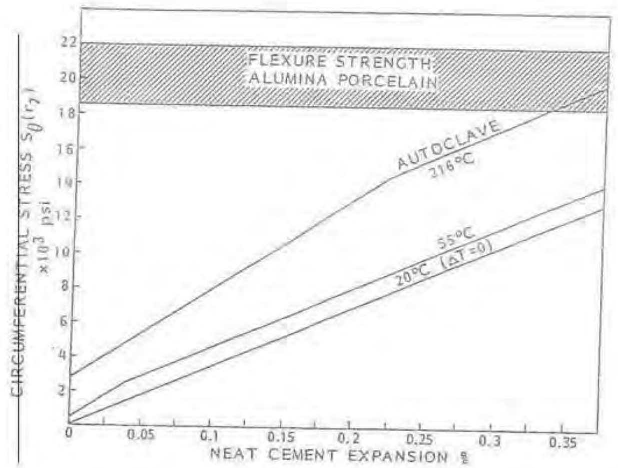


Fig. 5. Circumferential stress Sθ (r_2) in alumina porcelain for cement expansion in per cent.

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.

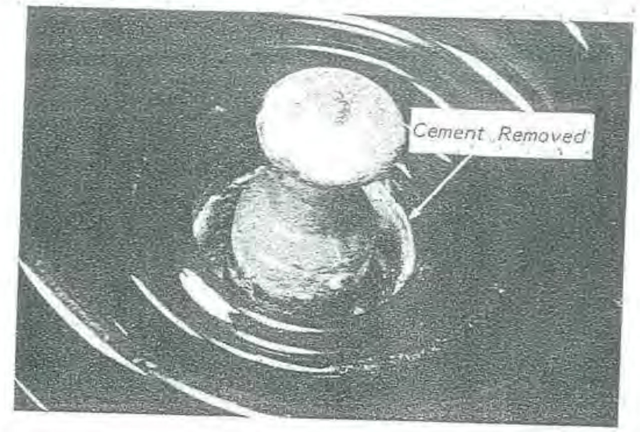


Fig. 6 Insulator pin cement removed for Thermal tests.

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.

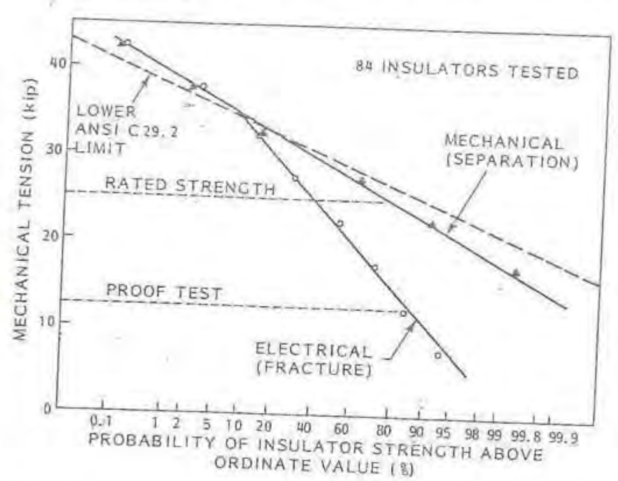


Fig. 7. Distribution of M&E strength for 25 000 lb insulators removed from the field.

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.

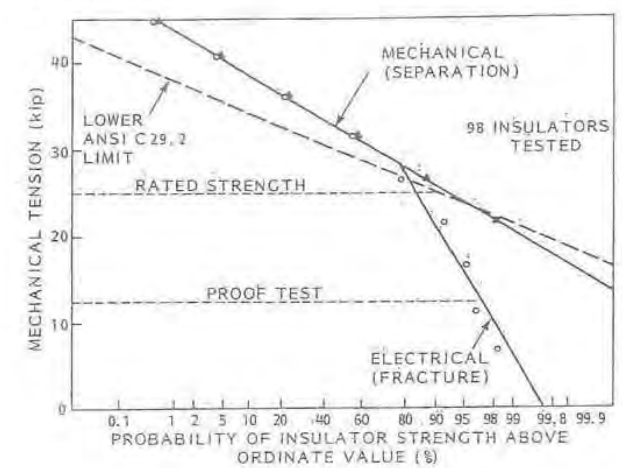


Fig. 8 Distribution of M&E strength of unused 25 000 lb insulators manufactured in 1965.

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.

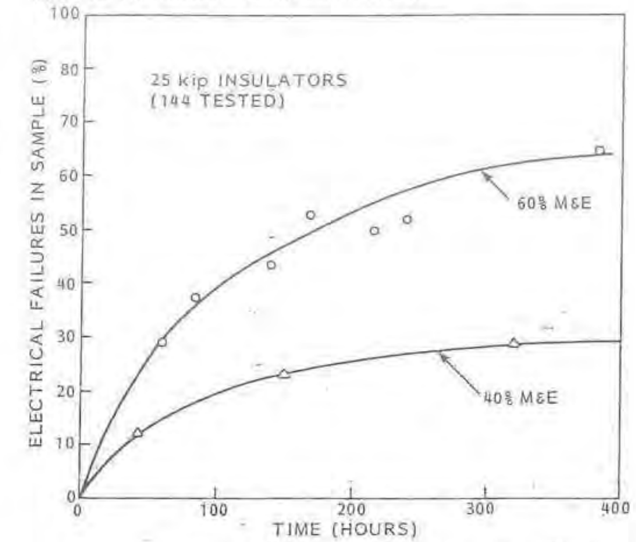


Fig. 9. Time-load test on unused 25 000 lb insulators manufactured in 1965.

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).

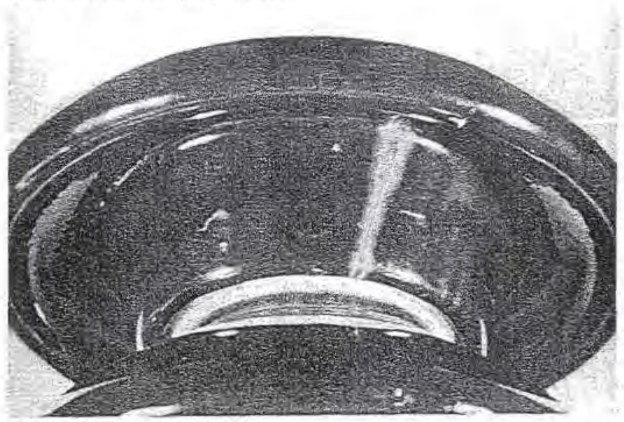


Fig. 10. Aged apparatus cap-and-pin insulator subjected to cement autoclave expansion test.

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.

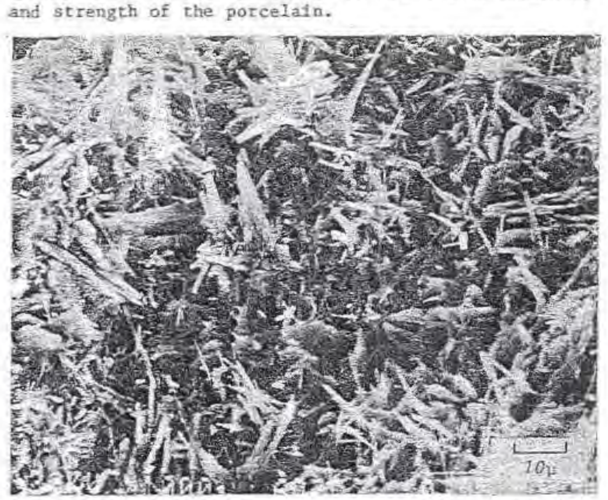


Fig. 11 Scanning electron microscope photograph of tricalcium sulphoaluminate crystals in an insulator cement at 1000 X.

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 gypsum?

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 break-

down 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

H. J. Fakheri (SM) T. C. Shuter (M) J. M. Schneider (NM) C. H. 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.

83 WM 147-6 A paper recommended and approved by the IEEE Transmission and Distribution Committee of the IEEE Power Engineering Society for presentation at the IEEE/PES 1983 Winter Meeting, New York, New York, January 30–February 4, 1983. Manuscript submitted September 3, 1982; made available for printing November 30, 1982.

The purpose of the tests was to determine the self-extinction times of large secondary arc currents in circuits with varying degrees of SPS compensation. The test data which was obtained can be generalized to systems with either simple or no SPS compensation. The paper also analyzes the secondary arc voltage and current waveforms, introduces an arc model and applies the model in a computer simulation of one of the test circuits.

TEST DESCRIPTION

Single line to ground faults were applied to the Kammer-Marysville 765 kV line at the Marysville Station (Figure 1). The line was energized from

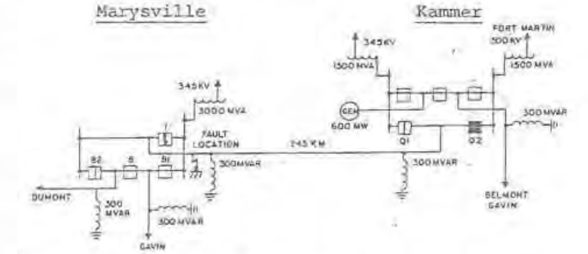


Figure 1: – One Line Diagram of the Test Line
▪ – Breaker used for SPS Operations
◫ – Open Breaker
⊟ – Closed Breaker

Kammer and open ended at Marysville. Therefore, magnetic coupling from load currents was not involved. This is a 243 km, horizontal, three phase, single circuit line [4]. Source strength at Kammer is approximately 20,000 MVA. The line circuit breakers used for the SPS operations are two cycle air blast type, with 640 ohm closing resistors and no opening resistors.

Prior to each test, the arc extinction time was not known. Therefore, the possibility of reinitiating the fault was eliminated by opening the healthy phases rather than attempting to reclose on the faulted phase. The time lag between the faulted phase opening and unfaulted phases opening was up to two seconds.

The line charging current is 86% compensated by a 300 MVAR reactor bank at each end of the line. A neutral reactor was added to each reactor bank to reduce the contribution to secondary arc current by interphase capacitive and inductive coupling. Optimum SPS compensation required neutral reactors of 800 ohms at Kammer and 300 ohms at Marysville [4]. For testing purposes, the neutral reactors were provided with taps of 400 and 200 ohms at Kammer and 150 ohms at Marysville. In addition, the reactor bank at Kammer Station has a special neutral switching scheme to compensate for the difference in interphase capacitance due to the untransposed nature of the line. The steady state 60 Hz component of secondary arc current (I_1) is limited to less than 20 A rms by the specified SPS compensation scheme [2].

The SPS compensation scheme on the line was modified throughout the tests in order that variations in the secondary arc could be obtained. At Marysville, the neutral reactor was shorted to ground for all the

Request IR-40:

Reference CI# 48507, Replace 69kV cables between 2S and 83S

(a) Please provide documentation that confirms the existing cables are showing signs of deterioration.

(b) How will the cable outage affect the operation of the Victoria Junctions Gas Turbines? Is there a reliability impact to NSPI's system due to the outage of these turbines at a specific time of the year and how will this be mitigated?

Response IR-40:

(a) These cables have exceeded the expected useful life by 10 years and are showing signs of deterioration. NS Power does not have specific recent documentation on the condition of these cables, but visual inspections are completed by NS Power technical staff on a monthly basis and have confirmed the cables are showing signs of deterioration. The photos below show damage to the outer jacket of the cable from the cable tray and deterioration of the jacket due to extended exposure to the environment. The electrical testing that would be required to confirm the insulation properties of the cables is a destructive test which these cables could not withstand.

(b) Any outage to a gas turbine at Victoria Junction (VJ1), including annual routine maintenance, must be coordinated with appropriate system conditions. VJ Unit #1 and VJ Unit #2 are on separate switchgear and buses, so an outage to one unit will not affect the other unit. The VJ units are used to support Sydney Area voltage during transmission outages, supply 10-minute operating reserve to the system, and provide backup service to the Sydney Area 69 kV system in the event of loss of one of the Victoria Junction 138/69 kV transformers. NS Power's Integrated Outage Coordination system ensures that reliability requirements are met during such work.

Request IR-41:

Reference CI# 49833, 2017 Oil Containment Program

(a) How did NPSI select the 30 sites out of the 76 with known sensitive areas for possible oil contamination? What criteria were used to prioritize these 30 sites and what will NSPI do with the 46 remaining sites?

(b) What is the age of the affected substation transformers? What is their useful life?

(c) Is the retrofitting cost the same for all affected transformers? If not, please explain why?

Response IR-41:

(a) The selection of the 30 sites from the 76 sites with known environmental sensitivities was based upon further evaluation of each site by the NS Power's Environmental Services department, which is responsible for assessing the potential impact and cost of oil release clean-ups. The sites were evaluated on the basis of risk to local habitats and the likelihood of an oil release to sensitive environmental habitat. High risk sites were prioritized above others. NS Power will continue to evaluate the risk of oil contamination from substation operation at the remaining 46 sites.

(b) Please refer to the table below for the in-service year of the transformers. These transformers have an average expected useful life range of 50-60 years.

Transformer	In Service Year / Age
43V-T61	1969 / 47 years
43V-T62	1992 / 24 years
129H-T61	1988 / 28 years
120H-T61	1985 / 31 years

It should be noted the oil containment is a separate asset from the transformer and does not affect the expected useful life of the transformer. The oil containment being installed provides environment protection should the transformer release oil. If one of the above transformers was to fail and a replacement installed on the existing transformer pad the oil containment system would provide environmental protection for the new transformer.

(c) No. Two main factors differentiate the cost of retrofitting a transformer: the transformer's volume and physical layout. The transformer's volume is the main factor determining the size and amount of material required for the retrofit. Costs due to the transformer's physical layout are dependent on the amount of additional retrofit required to move, protect, or re-design connections from the transformer to external systems.

Request IR-42:

Reference CI# 49806, Padmount Replacement Program

(a) Please provide the age of the 80 padmount transformers identified for replacement.

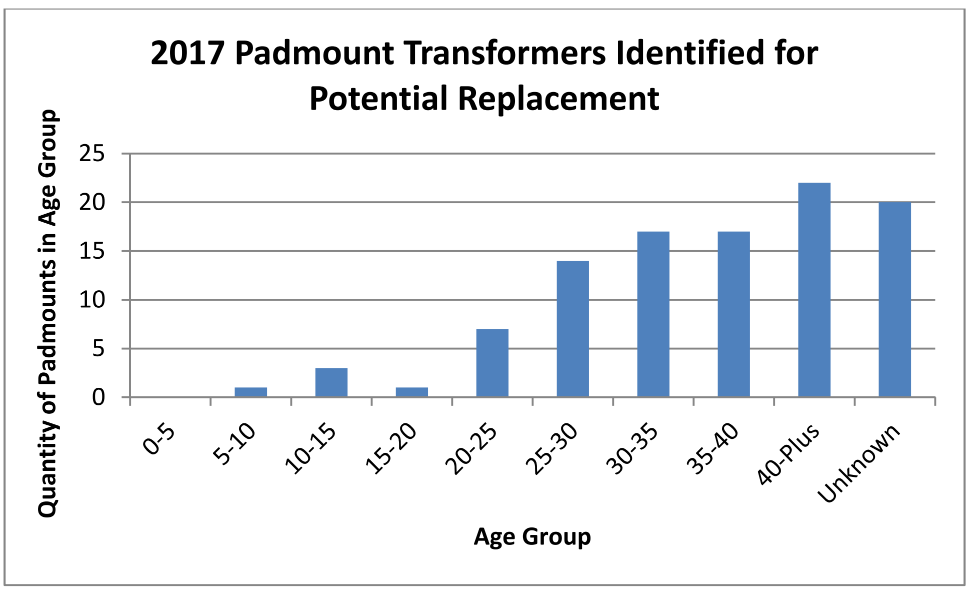
(b) How does NSPI determine what padmount transformers to replace proactively?

Response IR-42:

(a) The 80 padmount transformers that will be targeted for replacement are currently being prioritized based on the 102 padmount transformers that were identified during recent inspections for potential replacement. The table and chart below provide the age profile of the 102 transformers identified during recent inspections. A manufacture year is deemed "Unknown" if it is deteriorated to the point that it is no longer legible or if it is not listed on the padmount transformer nameplate.

Year	Age (Years)	Quantity
2010	7	1
2006	11	1
2004	13	1
2003	14	1
1997	20	1
1996	21	1
1995	22	1
1994	23	1
1992	25	4
1991	26	3
1990	27	2
1989	28	6
1987	30	3
1986	31	9
1985	32	1
1984	33	4

Year	Age (Years)	Quantity
1983	34	1
1982	35	2
1981	36	1
1980	37	2
1979	38	2
1978	39	8
1977	40	4
1976	41	4
1975	42	3
1974	43	8
1973	44	6
1971	46	1
Unknown	Unknown	20



(b) Please refer to NSUARB IR-70 part (c).

Request IR-43:

Reference CI# 41350, 16W-301G Hebron Rebuild Phase 2

(a) Identify the work done under phase 1.

(b) Please explain the following statement "Some of the existing spans are beyond current standard for span lengths." What is the standard length and what is the length of the existing structures?

(c) NPSI states that replacements are required based on "inspections of the targeted devices and assessment based on age, condition and risk of failure". Please provide documentation that concludes to the above statement.

(d) How will NSPI supply the 745 customers during the outage needed to reconduct the line?

Response IR-43:

(a) Phase 1 provided for the upgrade of 3.5 km of conductor on primary feeder 16W-301 from the 16W Hebron substation to the first recloser, R311-058, on Highway 1. The existing #4 Cu conductor was upgraded to 336 ASC. The table below provides a summary of all replacements.

Device	Quantity Installed	Quantity Removed
Primary Conductor (m)	10,324	10,560
Neutral Conductor (m)	3,549	3,632
Poles	15	23
Insulators	202	189
Cutouts	12	15
Pole-Top Transformers	17	22

(b) The existing, average span length is approximately 64.6 meters, with multiple spans over 75 meters. The current standard for average span length for joint-use lines in rural areas is 60 meters, and in urban areas 40 meters, with a maximum of 75 meters and 50 meters respectively.

(c) The line was assessed by feeder inspectors, a power-line technician, a T&D capital planner and a T&D capital engineer to generate the scope of work for this project, refer to Attachment 1. The assessment determined that the following replacements are required:

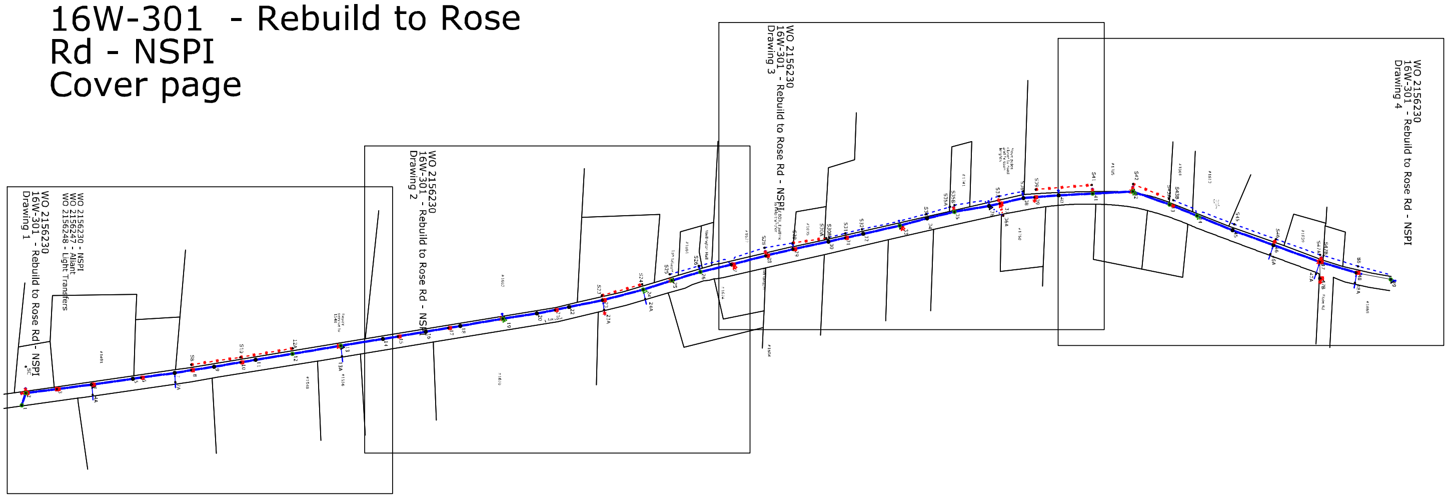
Device	Installs	Removals
Primary Conductor (m)	12,668	12,605
Neutral Conductor (m)	4,223	4,201
Poles	70	53
Insulators	219	180
Cut Outs	11	7
Pole Top Transformers	14	16
Recloser	1	1

From 2013 to October 2016, customers on the targeted feeder section have experienced a SAIFI of 3.0 and a SAIDI of 6.5 as a result of deteriorated equipment, including the following devices:

Device	Events
Pole	2
Primary Conductor	2
Secondary Conductor	6
Neutral Conductor	3
Service Wire	1
Lead	5
Connecting Devices	6
Pin Insulator	1
Polemount Transformer	6
Cut Out	12
Fuse Link	3
Lightning Arrester	1
Total	**48**

(d) An outage for the 745 customers is not planned for this project. The existing sections of targeted line that are located off-road will remain energized while the new line is constructed along the roadside. The new conductor for the existing sections that are located roadside will be constructed on temporary stand-off insulators, as the existing conductor can no longer be worked on under live conditions. This method prevents the need for outages to the 745 customers. Brief individual customer outages will be required to transfer each pole-top transformer on the targeted section of line to the new conductor. The existing conductor will be de-energized and removed after all construction is complete and load has been transferred to the new conductor.

WO 2156230
16W-301 - Rebuild to Rose Rd - NSPI
Cover page



NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 1

Description	Quantity	Job Notes
Install - RURAL-3PH-SDE-4/0-336AL: Framing-Rural SDE-4/0-336al	1	
Install - AMP-336MCM-336MCM-AL/CU: Ampact - 336 MCM to 336 MCM Al or Cu	3	
Remove - RURAL-3PH-SDE-#4-2/0AL: Framing-Rural SDE-#4-2/0al	1	

Station: 2

Description	Quantity	Job Notes
Install - TXFR-SERVICE: Transfer service	2	
Install - RURAL-3PH-SDE-4/0-336AL: Framing-Rural SDE-4/0-336al	3	
Install - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	1	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	2	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	54.6	
Install - GUY-DOWN: Guy - Down	4	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	2	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	18.2	
Remove - PRIM-COND-GIS-#2ACSR: Primary conductor # 2 ACSR	54.6	
Remove - RURAL-3PH-SDE-#4-2/0AL: Framing-Rural SDE-#4-2/0al	2	
Remove - NEUT-COND-GIS-#4AASC: neutral conductor #4 AASC	18.2	
Remove - GUY-DOWN: Guy - Down	2	
Remove - POLE-35'-CL4-T-D: Pole 35' Cl 4 Treated Dead	1	
Remove - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	1	

Station: 3

Description	Quantity	Job Notes
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	133.89	
Install - 3PH_RECLOSER<=#2GENERIC: 3ph Recloser (Generic) <=#2 Primary	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	44.63	
Install - STIRRUP-336: Stirrup - 336	6	
Install - RURAL-3PH-DDE-4/0-336AL: Framing-Rural DDE-4/0-336al	1	
Install - 3PH_RECLOSER>#2_MAT: 3ph Recloser Material >#2 Primary (Excludes Recloser, Rack, Dead End Clamps & Leads)	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230 **Planner: HILTON, ANDREW**
Estimate Version: 1 **Estimate Status: NEW**

Station: 3

Description	Quantity	Job Notes
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - 3PH_RECLOSER<=#2GENERIC: 3ph Recloser (Generic) <=#2 Primary	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	44.63	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	133.89	

Station: 4

Description	Quantity	Job Notes
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - STIRRUP-336: Stirrup - 336	1	
Install - TRANSFORMCUTOUT27KV1PHMAT: Transformer Cutout 27kV 1ph - Material	1	
Install - TRANSFORMERCUTOUT27KV1PH: Transformer Cutout 27kV 1ph	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	150.84	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	1	
Install - 1PH-MAT-10KVA-7200: 1ph Transformer Material 10kva 7200	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Install - TXFR-SERVICE: Transfer service	1	
Install - POLE-45'-CL3-T-L: Pole 45' Cl 3 Treated Live	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	50.28	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - 10KVA-7200-120/240: Transformer 10kva-7200-120/240	1	
Install - MATLOOP-TRANSFER-ALIANT: Material for Transfer loop (Aliant)	2	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	150.84	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	50.28	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230 **Planner: HILTON, ANDREW**
Estimate Version: 1 **Estimate Status: NEW**

Station: 4

Description	Quantity	Job Notes
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	

Station: 5

Description	Quantity	Job Notes
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	58.95	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	176.85	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	58.95	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	176.85	

Station: 6

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	11.55	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	34.65	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	11.55	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	34.65	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	

Station: 7

Description	Quantity	Job Notes
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	48.59	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230 **Planner: HILTON, ANDREW**
Estimate Version: 1 **Estimate Status: NEW**

Station: 7

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	145.77	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	145.77	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	48.59	

Station: 8

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	23.57	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	70.71	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	70.71	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	23.57	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	1	

Station: 9

Description	Quantity	Job Notes
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	33.1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	99.3	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	99.3	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	33.1	

Station: 10

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: **2156230**
Estimate Version: **1**

Planner: HILTON, ANDREW
Estimate Status: NEW

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	38.15	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	114.45	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	38.15	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	114.45	

Station: **11**

Description	Quantity	Job Notes
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	65.49	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	21.83	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	21.83	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	65.49	

Station: **12**

Description	Quantity	Job Notes
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	159.36	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - XFR-SEC-DE-L: Transfer Secondary Dead end Live	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	53.12	
Install - GUY-DOWN: Guy - Down	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230 **Planner:** HILTON, ANDREW
Estimate Version: 1 **Estimate Status:** NEW

Station: 12

Description	Quantity	Job Notes
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	53.12	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	159.36	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	

Station: 13

Description	Quantity	Job Notes
Install - 1PH-MAT-25KVA-7200: 1ph Transformer Material 25kva 7200	1	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	209.37	
Install - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Install - GUY-DOWN: Guy - Down	1	
Install - AMP-4/0-1/0-AL/CU: Ampact - 4/0 to 1/0 Al or Cu	2	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	69.79	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	1	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	3	
Install - TRANSFORMCUTOUT27KV1PHMAT: Transformer Cutout 27kV 1ph - Material	1	
Install - TRANSFORMERCUTOUT27KV1PH: Transformer Cutout 27kV 1ph	1	
Install - SER-REPAIR-RESAG: Repair/Resag Service	1	
Install - STIRRUP-336: Stirrup - 336	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	69.79	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	209.37	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	

Station: 14

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230 **Planner: HILTON, ANDREW**
Estimate Version: 1 **Estimate Status: NEW**

Description	Quantity	Job Notes
Install - POLE-45'-CL3-T-L: Pole 45' Cl 3 Treated Live	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	182.22	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	60.74	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	60.74	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	182.22	

Station: 15

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	64.41	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	21.47	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	21.47	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	64.41	

Station: 16

Description	Quantity	Job Notes
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	40.43	
Install - POLE-45'-CL3-T-L: Pole 45' Cl 3 Treated Live	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	121.29	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	40.43	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	121.29	

NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 16

Description	Quantity	Job Notes

Station: 17

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	32.34	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	97.02	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	32.34	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	97.02	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	

Station: 18

Description	Quantity	Job Notes
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	17.48	
Install - POLE-45'-CL3-T-L: Pole 45' Cl 3 Treated Live	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	52.44	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	17.48	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	52.44	

Station: 19

Description	Quantity	Job Notes
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	184.08	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	2	
Install - TXFR-SERVICE: Transfer service	2	

NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 19

Description	Quantity	Job Notes
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	1	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - GUY-EPOXYROD: Guy - Epoxyrod extension	1	
Install - CUTOUT-15KV: Cutout 15kV	1	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	3	
Install - GUY-DOWN: Guy - Down	1	
Install - STIRRUP-336: Stirrup - 336	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	61.36	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Remove - CUTOUT-15KV: Cutout 15kV	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	184.08	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	61.36	

Station: 20

Description	Quantity	Job Notes
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	49.05	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	147.15	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	49.05	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	147.15	

Station: 21

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 21

Description	Quantity	Job Notes
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	26.14	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	78.42	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	78.42	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	26.14	

Station: 22

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	20.72	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	62.16	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	20.72	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	62.16	

Station: 23

Description	Quantity	Job Notes
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	146.79	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	48.93	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - RURAL-3PH-ALLEY-ARM: Framing-Rural 3ph alley arm	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	48.93	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230 **Planner: HILTON, ANDREW**
Estimate Version: 1 **Estimate Status: NEW**

Station: 23

Description	Quantity	Job Notes
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	1	
Remove - RURAL-3PH-ALLEY-ARM: Framing-Rural 3ph alley arm	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	146.79	

Station: 24

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	59.33	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	2	
Install - STIRRUP-336: Stirrup - 336	1	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	177.99	
Install - TXFR-SERVICE: Transfer service	2	
Install - AMP-4/0-1/0-AL/CU: Ampact - 4/0 to 1/0 Al or Cu	1	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	59.33	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	177.99	
Remove - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	

Station: 25

Description	Quantity	Job Notes
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	42.8	
Install - TXFR-SERVICE: Transfer service	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	4	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	2	
Install - CUTOUT-15KV: Cutout 15kV	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230 | **Planner: HILTON, ANDREW**

Estimate Version: 1 | **Estimate Status: NEW**

Station: 25

Description	Quantity	Job Notes
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - NEUT-JUMPER: Neutral jumper (including flying tap)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	128.4	
Install - GUY-DOWN: Guy - Down	1	
Install - STIRRUP-336: Stirrup - 336	1	
Remove - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	42.8	
Remove - CUTOUT-15KV: Cutout 15kV	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	128.4	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	

Station: 26

Description	Quantity	Job Notes
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	127.32	
Install - TXFR-SERVICE: Transfer service	2	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	42.44	
Install - GUY-DOWN: Guy - Down	2	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	2	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	2	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	4	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	2	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Remove - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	127.32	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 26

Description	Quantity	Job Notes
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	42.44	

Station: 27

Description	Quantity	Job Notes
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	45.93	
Install - MATSTRAND-DE-6M-CATV: Material For Transfer 6M (1/4") Strand DE (CATV)	1	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	2	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - STRAND-DDE-6M-CATV: Transfer 6M (1/4") Strand DE (CATV)	1	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	137.79	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	2	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	4	
Remove - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	1	
Remove - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	45.93	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	137.79	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	1	

Station: 28

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	50.67	
Install - GUY-DOWN: Guy - Down	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230 **Planner: HILTON, ANDREW**
Estimate Version: 1 **Estimate Status: NEW**

Station: 28

Description	Quantity	Job Notes
Install - XFR-NEUT-DE-L: Transfer Neutral Dead end Live	1	
Install - NEUT-JUMPER: Neutral jumper (including flying tap)	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	152.01	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	1	
Install - XFR-PRIM-DE-L: Transfer Primary Dead end Live	1	
Install - STIRRUP-336: Stirrup - 336	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - 1PH-TAKE-OFF-#4-4/0AL: Framing-1ph take off #4-4/0al urban, Rural & SP	1	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - CUTOUT-15KV-1PH-MAT: Cutout 15KV 1PH Material	1	
Install - CUTOUT-15KV: Cutout 15kV	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	50.67	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Remove - GUY-DOWN: Guy - Down	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	152.01	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - 1PH-TAKE-OFF-#4-4/0AL: Framing-1ph take off #4-4/0al urban, Rural & SP	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	

Station: 29

Description	Quantity	Job Notes
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	119.28	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1
Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 29

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	39.76	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	3	
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	2	
Install - TXFR-SERVICE: Transfer service	2	
Install - GUY-DOWN: Guy - Down	2	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	2	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	39.76	
Remove - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	119.28	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	1	
Remove - RURAL-3PH-LIGHT-CORNER: Framing-Rural, Light Corner 1-5 deg, 3ph	1	

Station: 30

Description	Quantity	Job Notes
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	1	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	51	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 30

Description	Quantity	Job Notes
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	51	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	153	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	51	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	153	

Station: 31

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	24.3	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	72.9	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	72.9	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	24.3	
Remove - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	

Station: 32

Description	Quantity	Job Notes
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	79.47	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	26.49	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	26.49	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	79.47	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 32

Description	Quantity	Job Notes

Station: 33

Description	Quantity	Job Notes
Install - STRAIGHTEN_RESET_STUB: Straighten and stub pole	1	
Install - ANC-PISA-REGULAR: Anchor - Pisa - Regular Duty	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	53.14	
Install - TXFR-SERVICE: Transfer service	1	
Install - STIRRUP-336: Stirrup - 336	1	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - TRANSFORMERCUTOUT27KV1PH: Transformer Cutout 27kV 1ph	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	159.42	
Install - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Install - TRANSFORMCUTOUT27KV1PHMAT: Transformer Cutout 27kV 1ph - Material	1	
Install - GUY-DOWN: Guy - Down	1	
Install - 1PH-MAT-25KVA-7200: 1ph Transformer Material 25kva 7200	1	
Install - AMP-4/0-1/0-AL/CU: Ampact - 4/0 to 1/0 Al or Cu	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	1	
Remove - 10KVA-7200-120/240: Transformer 10kva-7200-120/240	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	53.14	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	159.42	

Station: 34

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	120.9	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	40.3	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 34

Description	Quantity	Job Notes
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	40.3	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	120.9	

Station: 35

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	120.21	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	2	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - ANC-PISA-REGULAR: Anchor - Pisa - Regular Duty	3	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - GUY-EPOXYROD: Guy - Epoxyrod extension	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	40.07	
Install - GUY-DOWN: Guy - Down	2	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	3	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	40.07	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	120.21	
Remove - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	1	
Remove - GUY-DOWN: Guy - Down	1	
Remove - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	1	

Station: 36

Description	Quantity	Job Notes
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	2	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 36

Description	Quantity	Job Notes
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	2	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	50.06	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - AMP-2/0-1/0-AL/CU: Ampact - 2/0 to 1/0 Al or Cu	2	
Install - STIRRUP-336: Stirrup - 336	1	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	150.18	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Install - GUY-DOWN: Guy - Down	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	150.18	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	50.06	

Station: 37

Description	Quantity	Job Notes
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	15.37	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	46.11	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Remove - 10KVA-7200-120/240: Transformer 10kva-7200-120/240	1	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	46.11	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	15.37	
Remove - GUY-DOWN: Guy - Down	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230 **Planner: HILTON, ANDREW**
Estimate Version: 1 **Estimate Status: NEW**

Station: 38

Description	Quantity	Job Notes
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - GUY-DOWN: Guy - Down	3	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	2	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	3	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	34.76	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	104.28	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	104.28	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	34.76	

Station: 39

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	46.56	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	15.52	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	15.52	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	46.56	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - GUY-DOWN: Guy - Down	1	

Station: 40

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230 **Planner: HILTON, ANDREW**
Estimate Version: 1 **Estimate Status: NEW**

Description	Quantity	Job Notes
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	34.77	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - GUY-DOWN: Guy - Down	2	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	4	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	104.31	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	104.31	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	34.77	

Station: **41**

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	48.49	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	145.47	
Install - GUY-DOWN: Guy - Down	2	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	1	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	2	
Install - TXFR-SERVICE: Transfer service	1	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	145.47	
Remove - GUY-DOWN: Guy - Down	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	48.49	

Station: **42**

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	171.63	
Install - TXFR-SERVICE: Transfer service	1	
Install - GUY-DOWN: Guy - Down	2	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 42

Description	Quantity	Job Notes
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	2	
Install - ANC-PISA-REGULAR: Anchor - Pisa - Regular Duty	1	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	1	
Install - CUTOUT-15KV: Cutout 15kV	1	
Install - STIRRUP-336: Stirrup - 336	1	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	57.21	
Remove - GUY-DOWN: Guy - Down	1	
Remove - CUTOUT-15KV: Cutout 15kV	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	171.63	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	57.21	

Station: 43

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	166.62	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	55.54	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	3	
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	2	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	55.54	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - TXFR-SERVICE: Transfer service	1	
Remove - ANC-PISA-REGULAR: Anchor - Pisa - Regular Duty	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	166.62	
Remove - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Remove - GUY-DOWN: Guy - Down	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	55.54	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 44

Description	Quantity	Job Notes
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	4	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	2	
Install - PRIM-RISER-L: Primary riser	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	126.84	
Install - TXFR-SERVICE: Transfer service	2	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	42.28	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	3	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - AMP-2/0-1/0-AL/CU: Ampact - 2/0 to 1/0 Al or Cu	2	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	42.28	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	126.84	
Remove - SECONDARY-SDE>=4/0AL: Framing-Secondary single dead end >=4/0al	2	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	

Station: 45

Description	Quantity	Job Notes
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	54.51	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	163.53	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	54.51	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	163.53	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	

Station: 46

Description	Quantity	Job Notes

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 46

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	61.88	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	185.64	
Install - STRAIGHTEN_RESET_POLE: Straighten and reset pole	1	
Remove - ANC-PISA-REGULAR: Anchor - Pisa - Regular Duty	1	
Remove - GUY-DOWN: Guy - Down	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	61.88	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	185.64	

Station: 47

Description	Quantity	Job Notes
Install - TXFR-SERVICE: Transfer service	1	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - 3PH-TAKE-OFF-#4-4/0AL: Framing-3ph take off #4-4/0al urban and Rural	1	
Install - CUTOUT-15KV: Cutout 15kV	3	
Install - ANC-PLATE: Anchor - Plate	1	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - XFR-NEUT-DE-L: Transfer Neutral Dead end Live	1	
Install - STRAND-CNR-CATV: Transfer Strand Corner (CATV)	1	
Install - GUY-DOWN: Guy - Down	1	
Install - STIRRUP-336: Stirrup - 336	3	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	2	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - POLE-45'-CL3-T-L: Pole 45' Cl 3 Treated Live	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	70.4	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	211.2	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	2	
Install - XFR-PRIM-DE-L: Transfer Primary Dead end Live	3	
Install - MATSTRAND-CNR-CATV: Material For Transfer Strand Corner (CATV)	1	
Remove - GUY-DOWN: Guy - Down	1	

NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 47

Description	Quantity	Job Notes
Remove - CUTOUT-15KV: Cutout 15kV	3	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	70.4	
Remove - 3PH-TAKE-OFF-#4-4/0AL: Framing-3ph take off #4-4/0al urban and Rural	1	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	211.2	
Remove - CATV-GUY-DOWN: [CATV] Guy - Down	1	

Station: 48

Description	Quantity	Job Notes
Install - GUY-EPOXYROD: Guy - Epoxyrod extension	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	163.29	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	2	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	54.43	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	1	
Install - RURAL-3PH-DDE-#4-2/0AL: Framing-Rural DDE-#4-2/0al	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - TXFR-SERVICE: Transfer service	1	
Remove - NEUT-COND-GIS-#6CU: neutral conductor # 6 Cu	54.43	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	163.29	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 48

Description	Quantity	Job Notes

Station: 49

Description	Quantity	Job Notes
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - TRANSFORMERCUTOUT27KV1PH: Transformer Cutout 27kV 1ph	1	
Install - TXFR-SERVICE: Transfer service	1	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - TRANSFORMCUTOUT27KV1PHMAT: Transformer Cutout 27kV 1ph - Material	1	
Install - AMP-2/0-1/0-AL/CU: Ampact - 2/0 to 1/0 Al or Cu	1	
Install - GUY-DOWN: Guy - Down	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	3	
Install - 1PH-MAT-25KVA-7200: 1ph Transformer Material 25kva 7200	1	
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Install - STIRRUP-336: Stirrup - 336	1	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	

Station: 88

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	105.54	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	105.54	

Station: 12A

Description	Quantity	Job Notes
Remove - SEC-COND-GIS-#4AASC: Secondary conductor #4 AASC	75.47	

Station: 13A

Description	Quantity	Job Notes
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	

NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 13A

Description	Quantity	Job Notes
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	15.06	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	15.06	
Install - GUY-DOWN: Guy - Down	1	

Station: 23A

Description	Quantity	Job Notes
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	13.84	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - GUY-DOWN: Guy - Down	1	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	13.84	
Remove - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Remove - GUY-DOWN: Guy - Down	1	
Remove - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	13.84	

Station: 24A

Description	Quantity	Job Notes
Install - GUY-DOWN: Guy - Down	1	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	13.68	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	13.68	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Remove - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	13.68	

Station: 36A

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Description	Quantity	Job Notes
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	3	
Install - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	24.33	
Install - TXFR-SERVICE: Transfer service	2	
Remove - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	18.01	

Station: **46A**

Description	Quantity	Job Notes
Install - GUY-DOWN: Guy - Down	1	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	13.53	

Station: **47A**

Description	Quantity	Job Notes
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	17.92	
Install - GUY-DOWN: Guy - Down	1	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	17.92	

Station: **47B**

Description	Quantity	Job Notes
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - XFR-NEUT-DE-L: Transfer Neutral Dead end Live	1	
Install - XFR-NEUT-TAN-CU-L: Transfer Neutral tangent Cu conductor Live	1	
Install - MAT-XFR-NEUT-TAN-CU-L: Material For Transfer Neutral tangent Cu conductor Live	1	
Install - RURAL-3PH-DDE-#4-2/0AL: Framing-Rural DDE-#4-2/0al	1	
Install - XFR-PRIM-DE-L: Transfer Primary Dead end Live	6	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - GUY-DOWN: Guy - Down	2	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230 **Planner:** HILTON, ANDREW
Estimate Version: 1 **Estimate Status:** NEW

Station: 47B

Description	Quantity	Job Notes
Remove - RURAL-3PH-DDE-#4-2/0AL: Framing-Rural DDE-#4-2/0al	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	

Station: 48A

Description	Quantity	Job Notes
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - GUY-DOWN: Guy - Down	1	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	14.28	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	14.28	

Station: 4A

Description	Quantity	Job Notes
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	14.44	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - GUY-DOWN: Guy - Down	1	

Station: 7A

Description	Quantity	Job Notes
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	13.11	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	13.11	
Install - GUY-DOWN: Guy - Down	1	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1
Planner: HILTON, ANDREW
Estimate Status: NEW

Station: S10

Description	Quantity	Job Notes
Remove - SEC-COND-GIS-#4AASC: Secondary conductor #4 AASC	70.88	

Station: S24

Description	Quantity	Job Notes
Remove - SEC-COND-GIS-#4AASC: Secondary conductor #4 AASC	59.5	

Station: S26

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	186.94	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	186.94	

Station: S28

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	111.22	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	111.22	

Station: S29

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	80.88	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	129.34	

Station: S31

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	48.21	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	24.39	

Station: S32

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	56.76	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	56.76	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: **S34**

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	79.65	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	79.65	

Station: **S35B**

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	106.88	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	106.88	

Station: **S37**

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	116.24	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	116.24	

Station: **S41**

Description	Quantity	Job Notes
Remove - SEC-COND-GIS-#4CU: Remove Secondary conductor #4 Cu	160.38	

Station: **S43A**

Description	Quantity	Job Notes
Remove - SEC-COND-GIS-#4CU: Remove Secondary conductor #4 Cu	55.06	

Station: **S43B**

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	86.86	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	86.86	

Station: **S45**

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	115.34	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	115.34	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2156230
Estimate Version: 1

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: **S46**

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	126.22	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	126.22	

Station: **S47A**

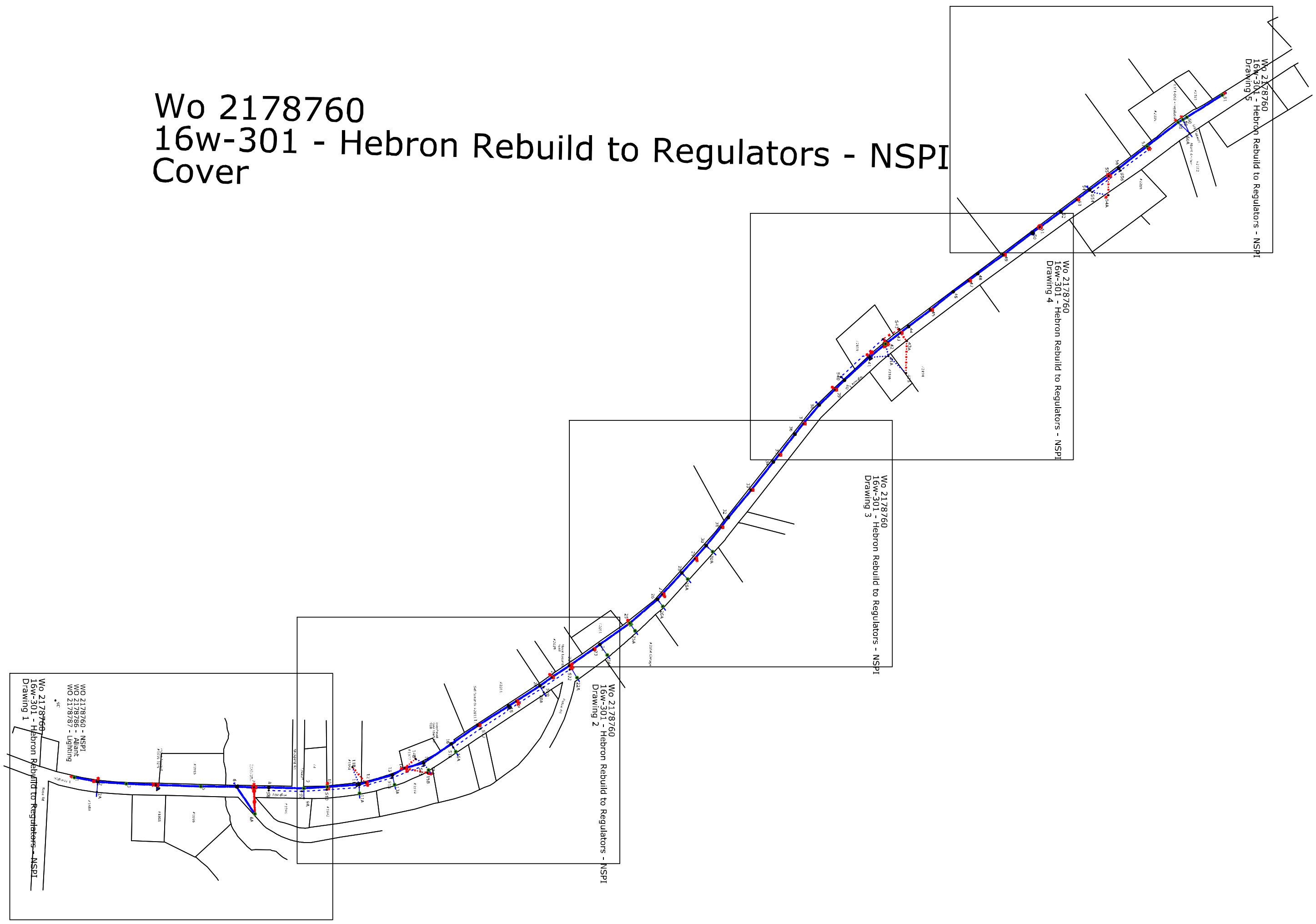
Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	133.42	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	133.42	

Station: **S47B**

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	102.36	
Remove - SEC-COND-GIS-#2CU: Secondary conductor #2 Cu	102.36	

Station: **SC**

Description	Quantity	Job Notes
Install - FLAGGERS: CU to Capture External Flagging Costs	1	
Install - BACKHOE: CU to Capture Backhoe Costs	1	


Wo 2178760
16w-301 - Hebron Rebuild to Regulators - NSPI
Cover
Wo 2178760
16w-301 - Hebron Rebuild to Regulators - NSPI
Drawing 1
Wo 2178760
16w-301 - Hebron Rebuild to Regulators - NSPI
Drawing 2
Wo 2178760
16w-301 - Hebron Rebuild to Regulators - NSPI
Drawing 3
Wo 2178760
16w-301 - Hebron Rebuild to Regulators - NSPI
Drawing 4
Wo 2178760
16w-301 - Hebron Rebuild to Regulators - NSPI
Drawing 5
WO 2178760 - NSPI
WO 2178786 - Aliant
WO 2178787 - Lighting

NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 1

Description	Quantity	Job Notes
Install - AMP-336MCM-336MCM-AL/CU: Ampact - 336 MCM to 336 MCM Al or Cu	3	
Install - NEUTRAL-SDE<=2/0: Framing-Neutral single dead end <=2/0	1	
Install - RURAL-3PH-SDE-4/0-336AL: Framing-Rural SDE-4/0-336al	1	
Install - AMP-4/0-4/0-AL/CU: Ampact - 4/0 to 4/0 Al or Cu	1	
Remove - RURAL-3PH-SDE-#4-2/0AL: Framing-Rural SDE-#4-2/0al	1	
Remove - GUY-DOWN: Guy - Down	1	
Remove - NEUTRAL-SDE<=2/0: Framing-Neutral single dead end <=2/0	1	

Station: 2

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	39.38	
Install - TXFR-SERVICE: Transfer service	1	
Install - REPAIR/RESAG-SEC: Repair/Resag Secondary	2	
Install - STRAND-CNR-CATV: Transfer Strand Corner (CATV)	1	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - XFR-SEC-DE-L: Transfer Secondary Dead end Live	2	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	2	
Install - MATSTRAND-CNR-CATV: Material For Transfer Strand Corner (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	118.14	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Install - AL-SLEEVE-2/0-STR-ACSR: Al Sleeve - 2/0 str ACSR	2	
Remove - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	39.38	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - GUY-DOWN: Guy - Down	1	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 2

Description	Quantity	Job Notes
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	78.76	
Remove - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	

Station: 3

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	141.78	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	47.26	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	47.26	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	94.52	

Station: 4

Description	Quantity	Job Notes
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - TRANSFORMERCUTOUT27KV1PH: Transformer Cutout 27kV 1ph	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	2	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	147.72	
Install - TXFR-SERVICE: Transfer service	3	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	49.24	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	2	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - 50KVA-7200-120/240: Transformer 50kva-7200-120/240	1	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	3	
Install - STIRRUP-336: Stirrup - 336	1	
Install - 1PH-MAT-50KVA-7200: 1ph Transformer Material 50kva 7200	1	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	3	
Install - AMP-4/0-4/0-AL/CU: Ampact - 4/0 to 4/0 Al or Cu	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	9	
Install - TRANSFORMCUTOUT27KV1PHMAT: Transformer Cutout 27kV 1ph - Material	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	98.48	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4
Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 4

Description	Quantity	Job Notes
Remove - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	49.24	

Station: 5

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	222.57	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	74.19	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	74.19	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	148.38	

Station: 6

Description	Quantity	Job Notes
Install - ANC-PLATE: Anchor - Plate	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - CUTOUT-15KV: Cutout 15kV	3	
Install - POLE-50'-CL2-U-L: Pole 50' Cl 2 Untreated Live	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	59.13	
Install - CUTOUT-15KV-3PH-MAT: Cutout 15KV 3PH Material	1	
Install - 3PH-TAKE-OFF-#4-2/0AL: Framing-3ph take off #4-2/0al urban and Rural	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	177.39	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	59.13	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	118.26	

Station: 7

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	86.7	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 7

Description	Quantity	Job Notes
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	28.9	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	57.8	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	28.9	
Remove - 3PH-TAKE-OFF-#4-4/0AL: Framing-3ph take off #4-4/0al urban and Rural	1	
Remove - CUTOUT-15KV: Cutout 15kV	3	
Remove - GUY-DOWN: Guy - Down	1	

Station: 8

Description	Quantity	Job Notes
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	24.42	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	73.26	
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - GUY-DOWN: Guy - Down	1	
Install - POLE-45'-CL3-T-L: Pole 45' Cl 3 Treated Live	1	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	2	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	48.84	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	24.42	

Station: 9

Description	Quantity	Job Notes

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 9

Description	Quantity	Job Notes
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	173.58	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	2	
Install - PRIM-RISER-L: Primary riser	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	57.86	
Install - TXFR-SERVICE: Transfer service	2	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	4	
Install - STRAIGHTEN_RESET_POLE: Straighten and reset pole	1	
Install - XFR-NEUT-DE-L: Transfer Neutral Dead end Live	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	115.72	
Remove - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	1	
Remove - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	57.86	

Station: 10

Description	Quantity	Job Notes
Install - ANC-PLATE: Anchor - Plate	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	39.02	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	2	
Install - GUY-DOWN: Guy - Down	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	117.06	
Remove - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Remove - RURAL-3PH-LIGHT-CORNER: Framing-Rural, Light Corner 1-5 deg, 3ph	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 10

Description	Quantity	Job Notes
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	1	
Remove - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	1	
Remove - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	39.02	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	78.04	
Remove - GUY-DOWN: Guy - Down	1	

Station: 11

Description	Quantity	Job Notes
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - STIRRUP-336: Stirrup - 336	1	
Install - 50KVA-7200-120/240: Transformer 50kva-7200-120/240	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	1	
Install - 1PH-MAT-50KVA-7200: 1ph Transformer Material 50kva 7200	1	
Install - AMP-4/0-4/0-AL/CU: Ampact - 4/0 to 4/0 Al or Cu	1	
Install - AMP-4/0-2/0-AL/CU: Ampact - 4/0 to 2/0 Al or Cu	2	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - TRANSFORMCUTOUT27KV1PHMAT: Transformer Cutout 27kV 1ph - Material	1	
Install - TRANSFORMERCUTOUT27KV1PH: Transformer Cutout 27kV 1ph	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	52.82	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	158.46	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	52.82	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	105.64	

Station: 12

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	32.73	

NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 12

Description	Quantity	Job Notes
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	10.91	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - GUY-DOWN: Guy - Down	1	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	21.82	
Remove - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	10.91	

Station: 13

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	46.07	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	138.21	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	46.07	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	92.14	

Station: 14

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	69.84	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	23.28	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760 **Planner: HILTON, ANDREW**
Estimate Version: 4 **Estimate Status: NEW**

Station: 14

Description	Quantity	Job Notes
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	23.28	
Remove - GUY-DOWN: Guy - Down	1	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	46.56	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	

Station: 15

Description	Quantity	Job Notes
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	32.71	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	4	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	4	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	98.13	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	65.42	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	32.71	

Station: 16

Description	Quantity	Job Notes
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	2	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 16

Description	Quantity	Job Notes
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	55.57	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	166.71	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	2	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	55.57	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	2	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	111.14	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	55.57	

Station: 17

Description	Quantity	Job Notes
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	162.12	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - POLE-45'-CL3-T-L: Pole 45' Cl 3 Treated Live	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	54.04	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	108.08	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	54.04	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	1	

Station: 18

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	59.53	

NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 18

Description	Quantity	Job Notes
Install - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	3	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	4	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - AMP-2/0-1/0-AL/CU: Ampact - 2/0 to 1/0 Al or Cu	2	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Install - 1PH-MAT-25KVA-7200: 1ph Transformer Material 25kva 7200	1	
Install - TRANSFORMCUTOUT27KV1PHMAT: Transformer Cutout 27kV 1ph - Material	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - TRANSFORMERCUTOUT27KV1PH: Transformer Cutout 27kV 1ph	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - TXFR-SERVICE: Transfer service	2	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	178.59	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	2	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	59.53	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	119.06	

Station: 19

Description	Quantity	Job Notes
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	14.62	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	43.86	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 19

Description	Quantity	Job Notes
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	1	
Remove - RURAL-3PH-LIGHT-CORNER: Framing-Rural, Light Corner 1-5 deg, 3ph	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	14.62	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - 10KVA-7200-120/240: Transformer 10kva-7200-120/240	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	29.24	

Station: 20

Description	Quantity	Job Notes
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	141.42	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	47.14	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	47.14	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	94.28	

Station: 21

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	23.92	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	71.76	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - POLE-35'-CL5-T-L: Pole 35' Cl 5 Treated Live	1	
Remove - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	47.84	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 21

Description	Quantity	Job Notes
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	23.92	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - GUY-DOWN: Guy - Down	2	
Remove - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	1	

Station: 22

Description	Quantity	Job Notes
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	3	
Install - TXFR-SERVICE: Transfer service	1	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	4	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	35.51	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	106.53	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - POLE-45'-CL3-T-L: Pole 45' Cl 3 Treated Live	1	
Install - SER-REPAIR-RESAG: Repair/Resag Service	1	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	71.02	
Remove - RURAL-3PH-LIGHT-CORNER: Framing-Rural, Light Corner 1-5 deg, 3ph	1	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	35.51	
Remove - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	
Remove - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Remove - GUY-DOWN: Guy - Down	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 23

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	47.23	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	141.69	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	47.23	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	94.46	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	

Station: 24

Description	Quantity	Job Notes
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	41.04	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	13.68	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	13.68	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	27.36	

Station: 25

Description	Quantity	Job Notes
Install - TXFR-SERVICE: Transfer service	2	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - CUTOUT-15KV: Cutout 15kV	1	
Install - STIRRUP-336: Stirrup - 336	1	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	182.25	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	60.75	

NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 25

Description	Quantity	Job Notes
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	1	
Remove - GUY-DOWN: Guy - Down	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	121.5	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	60.75	
Remove - ANC-PLATE: Anchor - Plate	1	
Remove - CUTOUT-15KV: Cutout 15kV	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	

Station: 26

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	181.11	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	60.37	
Install - NEUTRAL-SDE<=2/0: Framing-Neutral single dead end <=2/0	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	60.37	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	120.74	

Station: 27

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	11.48	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	34.44	
Remove - ANC-PLATE: Anchor - Plate	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	11.48	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Remove - GUY-DOWN: Guy - Down	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 27

Description	Quantity	Job Notes
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	22.96	

Station: 28

Description	Quantity	Job Notes
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	144	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	48	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	96	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	48	

Station: 29

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	31.97	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	95.91	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	31.97	
Remove - GUY-DOWN: Guy - Down	1	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	63.94	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	

Station: 30

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	28.44	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 30

Description	Quantity	Job Notes
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	85.32	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	56.88	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	28.44	

Station: 31

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	117.39	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	39.13	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	39.13	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	78.26	

Station: 32

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	60.09	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	20.03	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	20.03	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	40.06	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4
Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 32

Description	Quantity	Job Notes

Station: 33

Description	Quantity	Job Notes
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	177.9	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	59.3	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	59.3	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	118.6	

Station: 34

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	58.99	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	176.97	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	117.98	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	58.99	

Station: 35

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4
Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 35

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	15.13	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	45.39	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	15.13	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	30.26	

Station: 36

Description	Quantity	Job Notes
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	43.06	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	129.18	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	43.06	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	86.12	

Station: 37

Description	Quantity	Job Notes
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	66.66	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	22.22	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	22.22	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	44.44	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 37

Description	Quantity	Job Notes
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	

Station: 38

Description	Quantity	Job Notes
Install - GUY-DOWN: Guy - Down	2	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	40.51	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	121.53	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	2	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	40.51	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	81.02	

Station: 39

Description	Quantity	Job Notes
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	36.18	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	108.54	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	72.36	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	36.18	
Remove - GUY-DOWN: Guy - Down	1	
Remove - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	1	

Station: 40

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Description	Quantity	Job Notes
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - GUY-DOWN: Guy - Down	3	
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	3	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	2	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	22.45	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	67.35	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	44.9	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	22.45	

Station: 41

Description	Quantity	Job Notes
Install - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Install - 1PH-MAT-25KVA-7200: 1ph Transformer Material 25kva 7200	1	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	2	
Install - TRANSFORMERCUTOUT27KV1PH: Transformer Cutout 27kV 1ph	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	168.6	
Install - TXFR-SERVICE: Transfer service	2	
Install - TRANSFORMCUTOUT27KV1PHMAT: Transformer Cutout 27kV 1ph - Material	1	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	4	
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - PRIM-RISER-L: Primary riser	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	56.2	
Install - STIRRUP-336: Stirrup - 336	1	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	2	

NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2178760
Estimate Version: 4
Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 41

Description	Quantity	Job Notes
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	3	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - SER-REPAIR-RESAG: Repair/Resag Service	1	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	2	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Remove - ANC-PLATE: Anchor - Plate	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	56.2	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	112.4	
Remove - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Remove - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Remove - GUY-DOWN: Guy - Down	1	

Station: 42

Description	Quantity	Job Notes
Install - PRIM-RISER-L: Primary riser	3	
Install - 10KVA-7200-120/240: Transformer 10kva-7200-120/240	3	
Install - TXFR-SERVICE: Transfer service	1	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	4	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	2	
Install - SERVICE-PREFORM-WRAP-1/0: Service Preformed Wrap 1/0 ACSR/AASC	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	102.87	
Install - RURAL-3PH-ANGLE: Framing-Rural,Angle 6-20 deg, 3ph	1	
Install - GUY-DOWN: Guy - Down	4	
Install - 3PH-MAT-10KVA-7200: 3ph Transformer Material 10kva 7200	1	
Install - TRANSFORMCUTOUT27KV3PHMAT: Transformer Cutouts 27kV 3ph -	1	

NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 42

Description	Quantity	Job Notes
Material		
Install - AMP-4/0-#4-AL/CU: Ampact - 4/0 to #4 Al or Cu	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	34.29	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - STIRRUP-336: Stirrup - 336	3	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	3	
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - AMP-250MCM-4/0-AL/CU: Ampact - 250 MCM to 4/0 Al or Cu	2	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	2	
Install - TRANSFORMERCUTOUT27KV3PH: Transformer Cutouts 27kV 3ph	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	34.29	
Remove - 3PH-MAT-25KVA-7200: 3ph Transformer Material 25kva 7200	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - TRANSFORMCUTOUT27KV3PHMAT: Transformer Cutouts 27kV 3ph - Material	1	
Remove - TRANSFORMERCUTOUT27KV3PH: Transformer Cutouts 27kV 3ph	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	68.58	
Remove - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Remove - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	3	
Remove - GUY-DOWN: Guy - Down	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	

Station: 43

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	92.22	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	30.74	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	30.74	

NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 43

Description	Quantity	Job Notes
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	61.48	

Station: 44

Description	Quantity	Job Notes
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	17.22	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	51.66	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	34.44	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	17.22	

Station: 45

Description	Quantity	Job Notes
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - MATSTRAND-CNR-CATV: Material For Transfer Strand Corner (CATV)	1	
Install - STRAND-CNR-CATV: Transfer Strand Corner (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	136.89	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	45.63	
Remove - RURAL-3PH-LIGHT-CORNER: Framing-Rural, Light Corner 1-5 deg, 3ph	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	45.63	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	91.26	

Station: 46

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 46

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	143.79	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	47.93	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	95.86	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	47.93	

Station: 47

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	31.4	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	94.2	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	31.4	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	62.8	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	

Station: 48

Description	Quantity	Job Notes
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - POLE-45'-CL3-T-L: Pole 45' Cl 3 Treated Live	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	56.43	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	18.81	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	18.81	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4
Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 48

Description	Quantity	Job Notes
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	37.62	

Station: 49

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	158.55	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	52.85	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	52.85	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	105.7	

Station: 50

Description	Quantity	Job Notes
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - CAPACITORS3X100,7200V: Capacitors 3 X 100, 7200V	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	178.8	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - CUTOUT-15KV: Cutout 15kV	3	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	59.6	
Install - CUTOUT-15KV-3PH-MAT: Cutout 15KV 3PH Material	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	119.2	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	59.6	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 50

Description	Quantity	Job Notes

Station: 51

Description	Quantity	Job Notes
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	47.07	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	15.69	
Remove - CAPACITORS3X100,7200V: Capacitors 3 X 100, 7200V	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	15.69	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	31.38	

Station: 52

Description	Quantity	Job Notes
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	43.53	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	130.59	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	87.06	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	43.53	

Station: 53

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	33.19	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	99.57	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	66.38	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 53

Description	Quantity	Job Notes
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	33.19	

Station: 54

Description	Quantity	Job Notes
Install - GUY-DOWN: Guy - Down	2	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	26.53	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	2	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	79.59	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	26.53	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	53.06	

Station: 55

Description	Quantity	Job Notes
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	117.03	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	39.01	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	2	
Remove - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	39.01	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - 10KVA-7200-120/240: Transformer 10kva-7200-120/240	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	78.02	

Station: 56

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Description	Quantity	Job Notes
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - MATSTRAND-TAN-CATV: Material For Transfer Strand Tangent (CATV)	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - POLE-40'-CL4-T-L: Pole 40' Cl 4 Treated Live	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	20.81	
Install - SECONDARY-TANGENT/CORNER: Framing-Secondary tangent/corner	2	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	62.43	
Install - STRAND-TAN-CATV: Transfer Strand Tangent (CATV)	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	41.62	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	20.81	

Station: 57

Description	Quantity	Job Notes
Install - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - TRANSFORMCUTOUT27KV1PHMAT: Transformer Cutout 27kV 1ph - Material	1	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - PRIM-RISER-L: Primary riser	1	
Install - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	2	
Install - GUY-DOWN: Guy - Down	2	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	6	
Install - STIRRUP-336: Stirrup - 336	1	
Install - TRANSFORMERCUTOUT27KV1PH: Transformer Cutout 27kV 1ph	1	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	2	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	3	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	177.96	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	3	
Install - 1PH-MAT-25KVA-7200: 1ph Transformer Material 25kva 7200	1	
Install - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Install - GUY-TRANSFER: Guy - Transfer (all types)	3	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	59.32	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 57

Description	Quantity	Job Notes
Install - PREFORM-WRAP-2/0-AL: Preform Wrap 2/0 Al	2	
Install - CRIMPIT-#2-2/0TO#2-2/0: Crimpit - #2-2/0 to #2-2/0 Al or Cu (504-82 or HT-4)	7	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	118.64	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	59.32	
Remove - 25KVA-7200-120/240: Transformer 25kva-7200-120/240	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	

Station: 58

Description	Quantity	Job Notes
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	64.74	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	194.22	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	129.48	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - GUY-DOWN: Guy - Down	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	64.74	

Station: 59

Description	Quantity	Job Notes
Install - STIRRUP-336: Stirrup - 336	6	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	9.21	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	6	
Install - PRIM-RISER-L: Primary riser	6	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	27.63	
Install - INLINEINSULATOR4/0-556AL: Inline suspension insulator 4/0-556al	3	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	9.21	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	18.42	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - GUY-DOWN: Guy - Down	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4
Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 59

Description	Quantity	Job Notes

Station: 60

Description	Quantity	Job Notes
Install - PRIM-RISER-L: Primary riser	1	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	7.82	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	23.46	
Install - STIRRUP-336: Stirrup - 336	1	
Install - AMP-2/0-2/0-AL/CU: Ampact - 2/0 to 2/0 Al or Cu	1	
Install - PREFORM-WRAP-#2-AL: Preform Wrap #2 Al	1	
Install - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Install - XFR-NEUT-DE-L: Transfer Neutral Dead end Live	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	7.82	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	15.64	

Station: 61

Description	Quantity	Job Notes
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	2	
Install - NEUT-COND-4/0AASC-L: Neutral conductor 4/0 AASC - Live	68.97	
Install - PRIM-COND-336ASC-L: Primary conductor 336 ASC - Live	206.91	
Install - TXFR-SERVICE: Transfer service	1	
Install - CRIMPIT-#2-1/0TO#6-#2: Crimpit - #2-1/0 to #6-#2 Al or Cu (508-82 or HT-8)	1	
Install - GUY-EPOXYROD: Guy - Epoxyrod extension	1	
Install - XFR-NEUT-DE-L: Transfer Neutral Dead end Live	1	
Install - RURAL-3PH-DDE-4/0-336AL: Framing-Rural DDE-4/0-336al	1	
Install - XFR-PRIM-DE-L: Transfer Primary Dead end Live	3	
Install - GUY-DOWN: Guy - Down	3	
Remove - NEUTRAL-TANGENT/CORNER: Framing-Neutral tangent/corner	1	
Remove - NEUT-COND-GIS-#4CU: neutral conductor #4 Cu	68.97	
Remove - PRIM-COND-GIS-#4CU: Primary conductor #4 Cu	137.94	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 61

Description	Quantity	Job Notes
Remove - GUY-DOWN: Guy - Down	1	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	

Station: 70

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	80.9	
Remove - SEC-COND-GIS-#4AASC: Secondary conductor #4 AASC	144.78	

Station: 11A

Description	Quantity	Job Notes
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	14.64	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - GUY-DOWN: Guy - Down	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	14.64	

Station: 11B

Description	Quantity	Job Notes
Install - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	30.81	
Remove - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	33.58	

Station: 13A

Description	Quantity	Job Notes
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	16.45	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	16.45	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760 **Planner: HILTON, ANDREW**
Estimate Version: 4 **Estimate Status: NEW**

Station: 13A

Description	Quantity	Job Notes
Install - GUY-DOWN: Guy - Down	1	

Station: 14B

Description	Quantity	Job Notes
Install - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	15	
Remove - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	23.73	

Station: 15A

Description	Quantity	Job Notes
Install - LOOP-TRANSFER-CATV: Transfer loop (CATV)	2	
Install - GUY-DOWN: Guy - Down	1	
Install - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	14.26	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	14.26	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	2	
Install - SER-REPAIR-RESAG: Repair/Resag Service	1	
Install - TXFR-SERVICE: Transfer service	1	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	2	
Install - MATLOOP-TRANSFER-CATV: Material For Transfer loop (CATV)	2	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	14.26	

Station: 15B

Description	Quantity	Job Notes
Remove - SECONDARY-SDE<=2/0: Framing-Secondary single dead end <=2/0	2	
Remove - ANC-LOG-5FT: Anchor - Log - 5 Ft. (rod/washer only)	2	
Remove - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	39	
Remove - GUY-DOWN: Guy - Down	2	
Remove - POLE-35'-CL4-T-L: Pole 35' Cl 4 Treated Live	1	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 16A

Description	Quantity	Job Notes
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	14.84	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - GUY-DOWN: Guy - Down	1	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	14.84	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	

Station: 20A

Description	Quantity	Job Notes
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	12.54	
Install - GUY-DOWN: Guy - Down	1	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	12.54	

Station: 22A

Description	Quantity	Job Notes
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	23.45	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	23.45	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - GUY-DOWN: Guy - Down	1	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	

Station: 24A

Description	Quantity	Job Notes

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 24A

Description	Quantity	Job Notes
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - GUY-DOWN: Guy - Down	1	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	21.29	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	21.29	

Station: 25A

Description	Quantity	Job Notes
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - GUY-DOWN: Guy - Down	1	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	15.29	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	15.29	

Station: 26A

Description	Quantity	Job Notes
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - GUY-DOWN: Guy - Down	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	14.51	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	14.51	

Station: 28A

Description	Quantity	Job Notes

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 28A

Description	Quantity	Job Notes
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - GUY-DOWN: Guy - Down	1	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	14.14	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	14.14	

Station: 2A

Description	Quantity	Job Notes
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	16.64	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	16.64	
Install - GUY-DOWN: Guy - Down	1	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	

Station: 30A

Description	Quantity	Job Notes
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	14.6	
Install - CATV-GUY-DOWN: [CATV] Guy - Down	1	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	14.6	
Install - GUY-DOWN: Guy - Down	1	

Station: 41A

Description	Quantity	Job Notes

NOVA SCOTIA POWER
An Emera Company

Staking Report

Work Order: 2178760
Estimate Version: 4
Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 41A

Description	Quantity	Job Notes
Install - SERVICE-PREFORM-WRAP-1/0: Service Preformed Wrap 1/0 ACSR/ AASC	2	
Install - TXFR-SERVICE: Transfer service	1	
Install - INSULINK-1/0-1/0: Insulink - 1/0 to 1/0 Al or Cu	4	
Install - SERVICE-PREFORM-WRAP-#2: Service Preformed Wrap #2 ACSR/AASC	1	
Install - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	92.6	
Install - SECONDARY-DDE<=2/0: Framing-Secondary double dead end <=2/0	1	
Remove - SER-SEC-1PH-#2: Service secondary, #2AASC triplex	40.38	
Remove - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	31.69	

Station: 42B

Description	Quantity	Job Notes
Install - LINKIT-#2-#2: Linkit - #2 to #2 Al or Cu	1	
Install - INSULINK-1/0-#2: Insulink - 1/0 to #2 Al or Cu	2	

Station: 43A

Description	Quantity	Job Notes
Remove - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	70.29	

Station: 54A

Description	Quantity	Job Notes
Install - LINKIT-#2-#2: Linkit - #2 to #2 Al or Cu	1	
Install - INSULINK-1/0-1/0: Insulink - 1/0 to 1/0 Al or Cu	2	
Remove - GUY-DOWN: Guy - Down	1	
Remove - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	31.7	

Station: 60A

Description	Quantity	Job Notes
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	50.6	
Install - GUY-EPOXYROD: Guy - Epoxyrod extension	1	
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	2	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4

Planner: HILTON, ANDREW
Estimate Status: NEW

Station: 6A

Description	Quantity	Job Notes
Install - NEUT-COND-#2AASC-L: Neutral conductor #2 AASC - Live	54.13	
Install - PRIM-COND-#2AASC-L: Primary conductor #2 AASC - Live	162.39	
Install - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Install - XFR-NEUT-DE-L: Transfer Neutral Dead end Live	1	
Install - XFR-PRIM-DE-L: Transfer Primary Dead end Live	3	
Install - RURAL-3PH-DDE-#4-2/0AL: Framing-Rural DDE-#4-2/0al	1	
Remove - NEUTRAL-DDE<=2/0: Framing-Neutral double dead end <=2/0	1	
Remove - PRIM-COND-GIS-#2CU: Primary conductor #2 Cu	131.88	
Remove - NEUT-COND-GIS-#2CU: neutral conductor #2 Cu	43.96	
Remove - RURAL-3PH-TANGENT: Framing-Rural Tangent Pole, 3 ph	1	

Station: 9A

Description	Quantity	Job Notes
Install - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Install - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	16.34	
Install - CATV-GUY-OHEAD-INSTALL: [CATV] Guy - Overhead INSTALL GUY ONLY	16.34	
Install - CATV-GUY-OHEAD-FRAMING: [CATV] Guy - Overhead FRAMING AND LABOUR	1	
Remove - GUY-OHEAD-FRAMING: Guy Overhead Framing and Labour	1	
Remove - GUY-OHEAD-INSTALL: GUY-OHEAD - INSTALL OF GUY WIRE ONLY	16.34	

Station: S10

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	194.56	
Remove - SEC-COND-GIS-#4AASC: Secondary conductor #4 AASC	138.23	

Station: S13

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	224.98	
Remove - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	56.16	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760
Estimate Version: 4
Planner: HILTON, ANDREW
Estimate Status: NEW

Station: S16

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	110	

Station: S17

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	123.1	

Station: S20

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	134.08	

Station: S22

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	104.4	

Station: S40

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	122.62	

Station: S54

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	117.4	
Install - SER-SEC-1PH-1/0: Service secondary, 1/0AASC triplex	27.16	

Station: S56

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	123.32	

Station: S8

Description	Quantity	Job Notes
Install - SEC-COND-POLY-2/0AASC-L: Secondary poly conductor 2/0 AASC - Live	109.94	

Staking Report

NOVA SCOTIA POWER
An Emera Company

Work Order: 2178760 **Planner: HILTON, ANDREW**
Estimate Version: 4 **Estimate Status: NEW**

Station: SC

Description	Quantity	Job Notes
Install - BACKHOE: CU to Capture Backhoe Costs	1	
Install - FLAGGERS: CU to Capture External Flagging Costs	1	

Request IR-44:

Reference CI# 49836, 11S-411 11S-302 Rebuild Coxheath Road Phase 2

(a) Identify the work done under phase 1.

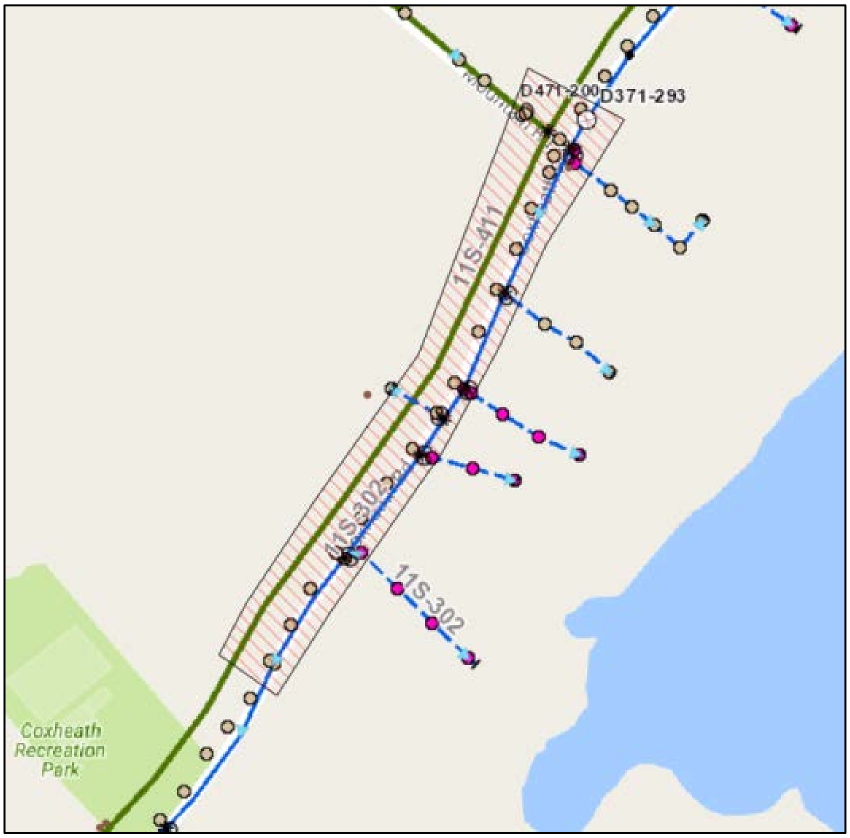
(b) Please explain how only 500 customers were affected by the outage of both circuits when a fault can affect up to 4,300 customers. See statements on page 1 of 4 (p. 678 of N-1) of the project justification.

(c) Provide a list of the outage events for 2016 on both circuits and the length of each event.

(d) Regarding page 1 of 4 (p. 678 of N-1) of the project justification, justify the following statement: "Rebuilding this line will improve reliability by improving the ability of crews to work on the circuits, and by improving outage response time".

Response IR-44:

(a) Phase 1 provided for the replacement of 17 poles. The existing, deteriorated, 45-foot poles were replaced with 50-foot poles in order to provide the appropriate spacing between two circuits, in compliance with current NS Power standards. Additional replacements included insulators and transformers. Replacements were done along Coxheath Road from Mountain Road to the Coxheath Recreational Park, as shown in the following image.



(b) At page 678 of the 2017 ACE Plan, CI 49836 provides the following:

> In 2014 and 2015, there were 20 outage events on both circuits, impacting more than 500 customers per event.

This refers to the number of outages that affected 500 or more customers, which have occurred on either feeder. The exact location of the fault and the ability to sectionalize determined the number of customers impacted in each event. Outages to both circuits, in full, affect approximately 4,300 total customers, as summarised in the following table.

11S-302/11S-411 Combined Outage Events			
Date	Duration (min)	Customers Interrupted	Feeder
08/03/2014	24.00	2923	11S-411
08/03/2014	24.00	1237	11S-302
05/06/2014	11.00	2923	11S-411
05/06/2014	11.00	1236	11S-302
26/06/2014	56.42	2924	11S-411
26/06/2014	56.17	1235	11S-302
23/08/2015	235.02	2804	11S-411
23/08/2015	198.96	1239	11S-302

(c) Please refer to the following tables. There were no events as of November 2016 that impacted both feeders, in full, as experienced in 2014 and 2015.

11S-302		
Date	Duration (min)	Customers Interrupted
03/01/2016	129	15
03/04/2016	126	12
30/04/2016	20	20
06/05/2016	83	15
16/08/2016	80	8
10/10/2016	141	34
11/10/2016	3466	10
11/10/2016	1083	16
11/10/2016	963	127
21/11/2016	140	97

11S-411		
Date	Duration (min)	Customers Interrupted
29/01/2016	2530	5
29/01/2016	2960	97
17/02/2016	129	6
02/03/2016	86	136
03/03/2016	227	66
10/03/2016	68	1028
10/03/2016	145	1842
01/04/2016	219	136
12/04/2016	51	106
13/04/2016	77	106
13/04/2016	42	106

11S-411		
Date	**Duration (min)**	**Customers Interrupted**
20/04/2016	93	106
02/07/2016	138	8
14/07/2016	89	5
24/07/2016	172	34
26/07/2016	16	1674
10/08/2016	103	136
17/08/2016	47	7
20/08/2016	194	15
20/08/2016	320	150
10/09/2016	121	10
10/10/2016	1586	1034
10/10/2016	2318	1873
11/10/2016	881	581
12/10/2016	1099	7
12/10/2016	1338	9
12/10/2016	1295	9
12/10/2016	23	137
17/10/2016	439	6
25/10/2016	148	9
27/11/2016	306	64

(d) The original construction (circa 1972) of the existing circuits does not meet current NS Power standards, and does not provide sufficient clearances for crews during construction or repairs. As a result, additional time is required during construction or repair in order to install cover-up and/or temporarily extend energized conductor on to auxiliary arms, or alternatively, the circuits can be de-energized, resulting in customer outages. The scope of work for this project provides for the replacement of deteriorated poles, insulators, cut-outs and transformers, and for an increase in pole height, which will improve our ability to conduct work on both circuits under live conditions.

Request IR-45:

For CI 49861—IT PI System Upgrade, please refer to pages 1035 and 1041 of document N-1, the 2017 ACE Plan.

(a) Please define "virtual high-availability" system and why this is appropriate for this project.

(b) What are the "primary and secondary PI servers" and what is their function?

(c) What software and hardware alternatives were considered?

(d) Please provide all evidence and justification to show that the proposed project is the "least cost technically acceptable option" per the CEJC.

Response IR-45:

(a) One of the goals of this upgrade is to enhance reliability and provide redundancy related to our operating data historian system, PI. PI is a critical data system feeding Engineering and Operating functions. The information available via PI facilitates real-time trouble-shooting, data trending, as well as NS Power's growing Predictive Analytics Systems (PdP). The two existing servers are aged, standalone physical machines. In case of failure of either of these machines, a similar machine would need to be sourced, installed, and a physical restoration performed from backups. During these activities, no access to the information on these servers would be available to facilitate equipment monitoring and troubleshooting. The upgrade project would provide two cloned virtual servers, providing seamless redundancy in case of failure of the primary server.

(b) The primary server is the virtual production server that the users or application would normally connect to when utilizing information from PI. The secondary server is a clone of the primary server which is standing by in case of any technical problem with the primary.

(c) This project is an upgrade to NS Power's existing PI Software which will be implemented in NS Power's standard server configuration (Virtual Servers). Numerous existing tools and systems rely on PI and are deeply integrated into existing business process. Please refer to NSUARB IR-75 part (a) for additional information.

Hardware is being provided under an existing negotiated Master Service Agreement (MSA) which was subject to a Request For Proposal (RFP) in December 2015.

(d) NS Power has explored opportunities to determine that the proposed approach is the least cost technically acceptable option. Please refer to part (c). In addition:

- OSISoft has provided NS Power credit for existing licensing in its quotations for the upgraded product suite.
- The upgraded version of PI will reduce NS Power's cost per client as the latest version of PI can be accessed via the web, in lieu of the administrative effort and costs associated with licensing and software installed on individual user computers.
- NS Power has proposed utilizing a less costly local certified consultant, in lieu of the software provider, as supplier of speciality PI upgrade services. Selection of consultant will be subject to a competitive bidding process. Please refer to NSUARB IR-75 part (a) for additional information.

NS Power considers the PI system a critical business system, necessary for the safe and reliable operation of its assets.

Request IR-46:

For CI 46572—2017 RTU Replacement Program, please refer to page 1055 of document N-1, the 2017 ACE Plan.

(a) How many RTUs of what make and model are being replaced under the 2017 replacement program?

(b) Among the 87 obsolete RTUs, are they all the type of equipment listed in Attachment 1?

Response IR-46:

(a) The following RTUs are scheduled to be replaced under the 2017 RTU Replacement Program:

Make	Model	Quantity
Motorola	MDO-11	2
General Electric	Harris DART	1
General Electric	D20	1

(b) In addition to the Landis & Gyr and GE D20 examples in CI 46572 Attachment 1 of the 2017 ACE Plan, the GE Harris DART, Advanced Control Systems NTU-7510 and Motorola MDO-11 RTUs are also obsolete. Please refer to Attachment 1 for the notices of discontinuance for these products.

DART Notice of Discontinuance

Product Bulletin

Date: July 21st 2016 **Classification:** GE Information

NOTICE Effective January 1st 2019, while limited supply lasts, the manufacture and sale of the DART product family will end.

Product Discontinuance

Table 1 lists the part numbers and descriptions of the DART modules affected.

Table 1 DART Modules Being Discontinued

Part Number	Description
512-0001	WESDAC DART, 12V W/PLGTB
512-0002	WESDAC DART, 24V W/PLGTB
512-0003	WESDAC DART, 24V
512-0004	WESDAC DART, 12V
512-0005	WESDAC DART, 24/12V W/O PLGTBS
512-0006	WESDAC DART, 12/24V W/O PLGTBS
512-0007	WESDAC DART, 24/12V W/PLGTBS
512-0008	WESDAC DART, 12/24V W/PLGTBS
512-0010	WDC DART NVRAM 12V/12V SENSA
512-0100	WD DART SWITCH CNTRL 24V ST. (REQ. SBJ0047_04)
512-9000	WESDAC DART, COMMON PCBA
517-0185	WESTERM DART (3@5A, 3@7.6V) W/TBS
517-0186	WESTERM DART (6@5A, 6@7.6V) W/TBS
517-0187	WESTERM DART (9@5A, 3@7.6V) W/TBS
517-0188	WESTERM DART (3@5A, 3@7.6V) W/O TBS
517-0189	WESTERM DART (6@5A, 6@7.6V) W/O TBS
517-0190	WESTERM DART (9@5A, 3@7.6V) W/O TBS
517-0197	WESTERM DART (3@5A, 3@120V) W/TBS
517-0198	WESTERM DART (6@5A, 6@120V) W/TBS
517-0199	WESTERM DART (9@5A, 3@120V) W/TBS
517-0200	WESTERM DART (3@5A, 3@69V) W/TBS

Part Number	Description
517-0201	WESTERM DART (6@5A, 6@69V) W/TBS
517-0202	WESTERM DART (9@5A, 3@69V) W/TBS
517-0255	WESTERM DART (3@120V, 3@10V)
517-0256	WESTERM DART (6@120V, 6@10V)
517-0257	WESTERM DART (3@120V, 9@10V)
517-0264	WESTERM DART TYPE6 (SQ D LPS)
517-0265	WESTERM DART, FP
517-0308	WESTERM DART (3@1OV, 3@120V) W/TBS
517-0309	WESTERM DART (6@10V, 6@120V) W/TBS
517-0310	WESTERM DART (9@10V, 3@120V) W/TBS
517-0311	WESTERM DART (3@1A, 3@120V) W/TBS
517-0312	WESTERM DART (6@1A, 6@120V) W/TBS
517-0313	WESTERM DART (9@1A, 3@120V)
517-0314	WESTERM DART (3@5V, 3@120V) HIZ
517-0315	WESTERM DART (6@5V, 6@120V) HIZ
517-0316	WESTERM DART (9@5V, 3@120V) HIZ
517-0317	WESTERM DART, 3CT@5A/3VT@7.5V
517-0318	WESTERM DART (6@5A, 6@7.5V) HIZ
517-0319	WESTERM DART (9@5A, 3@7.5V) HIZ
517-0320	WESTERM DART (3@10V, 3@7.5V) HI-Z
517-0321	WESTERM DART (6@10V, 6@7.5V) HI-Z
517-0322	WESTERM DART (9@10V, 3@7.5V) HI-Z
517-0323	WESTERM DART, TECO TYPE 3
517-0324	WT DART (LILCO S&C)
517-0329	WESTERM DART, 3V/6I (110V/5A)
517-0419	WESTERM DART TY23(3C5A,3C220V)W/TBS
517-0420	WESTERM DART TY24(6C5A,6C220V)W/TBS
517-0421	WESTERM DART TY25(9C5A,3C220V)W/TBS
517-0422	WESTERM DART TY26 (3C1A,3C220V) W/TBS
517-0423	WESTERM DART TY27 (6C1A,6C220V) W/TBS
517-0424	WESTERM DART TY28 (9C1A,3C220V) W/TBS
540-0167	DART MODEM
540-0172	DART CHARGER TYPE 1
540-0177	DART CHARGER TYPE 2
540-0186	DART CHARGER TYPE 3, 12V
540-0190	DART CHARGER TYPE 3, 24V
540-0191	DART L.E.D. DISPLAY
540-0193	DART CONTROL EXPANSION W/TBS
540-0194	DART CONTROL EXPANSION
540-0218	DART CHARGER TY3, 12V W/O TBS
540-0245	DART TRANSIENT PROTECTION MODULE

Part Number	Description
540-0255	DART SWITCH CONTROL, EXTERNAL HMI
540-0400	DART TEMPERATURE INPUT
540-0401	DART DC ANALOG I/P, 15V
540-0402	DART DC ANALOG I/P, 30V
540-0403	DART DC ANALOG I/P, 1MA
540-0404	DART DC ANALOG I/P, 5MA
540-0405	DART DC ANALOG I/P, 20MA
540-0406	DART DC ANALOG I/P, 1.25MA
540-0407	DART DC ANALOG I/P, 5V
540-0409	DART DC ANALOG I/P 1.5MA
540-0410	DART DC ANALOG I/P, 60V
540-9000	COMMON ASSEMBLY DART DC ANALOG I/P
550-0052	DART CHARGER, TY1

Reason for Discontinuance

The manufacture of the DART CPU, Digital signal processor (DSP), and some memory chips used in the DART main board have ended with no alternate supply. The product will continue to ship as long as these components are available.

Last-time-Buy Requests

Users are encouraged to make a request for a last-time-buy while limited supply lasts. Last buy requests should be sent to the GE sales and commercial operations teams no later than December 1st 2018.

NOTICE **GE Grid Solutions reserves the right to modify the set last buy date at its sole discretion, depending upon the time period during which limited supplies are available.**

DART Replacement

The DART product can be replaced by GE Multilin's DGCM Field RTU product.

DART - Continued Product Support

Before December 31st 2018, while limited supply lasts, Returns and Repairs will continue to be processed – estimated repair services time-frame is 7 years.

After January 1st 2019, if DART product family devices under warranty cannot be repaired, GE will work with customers to explore alternate solutions.

Contact

Sales

Contact your local sales representative or email us at: sales.gegridsolutionsap@ge.com.

Technical Support: Returns and Repairs/Product Support

The GE Grid Solutions Technical Support is open from 9am-5pm Eastern Time zone during business days and 24 hours, seven days a week, in case of emergencies, for you to talk directly to a GE representative. In the U.S. and Canada, call toll-free: 1 800 547 8629. International customers, please call: +1 905 927 7070.

To log a technical support request, send an e-mail to: multilin.tech@ge.com.

Search Technical Support

The GE Grid Solutions Web site provides fast access to technical information, such as manuals, release notes and knowledge base topics.

- Visit us on the Web at:
  http://www.gegridsolutions.com
- Login to the technical support portal:
  http://sc.ge.com/*SASTechSupport

We trust that this information assures you that GE Grid Solutions is committed to the continued support of the D20 product line.

Copyright

Trademark Notice

Document Revision History

Version	Revision	Date	Author	Change Description
1.00	0	July 21, 2016	E. Stuhr	Created

TINGLEY, SARA

Subject: FW: NTU-7510 NERC CIP
Attachments: ACS Substation Product Delivery History_6-3-2016.pdf

From: Clint Cowan [mailto:clint.cowan@acspower.com]
Sent: Friday, September 09, 2016 14:34
To: PENNEY, ERIC; Joe Boike
Cc: Jim Edwards; Marian Cosereanu; Paulo Barbosa; Cindy Mayne
Subject: RE: NTU-7510 NERC CIP

Eric: That statement must have come from Joe when he generated the NTU document regarding NERC CIP. The NTU-7510 is three generations old that was retired from production in 2002. I can easily confirm we won't be making any firmware changes to product this old and long out of our guarantee of 10 years of support after production ceases. All of this generation of NTU-7500 went out of production in 2003/2004. Reference the attached ACS Substation Product Delivery History.

Best Regards,

Clint

M. Clint Cowan
Substation Systems Manager, Sales & Marketing

ACS

Advanced Control Systems
2755 Northwoods Parkway
Norcross, Georgia 30071
Direct Office Phone: +1 770 409 2971 | Cell: +1 404 353 6377

Clint.Cowan@acspower.com
www.acspower.com

Note new Email Address!

TINGLEY, SARA

From: Motorola AutoNotify-CSC075 <CSC075@motorolasolutions.com>
Sent: October 13, 2016 2:53 PM
To: PENNEY, ERIC
Subject: Case Number Update 25077900, MOL Authorization Request for New User eric.penney@nspower.ca

Hi Eric,
After speaking with our technical support team again, they have confirmed that this product (SCADA RTU model: DACSCAN MDO-11) is no longer manufactured or supported.

Regards,
CanadaUS

Request IR-47:

For CI 49880—Meter Shop Test Console Replacement, please refer to page 1094 of document N-1, the 2017 ACE Plan. Will the new test consoles still be used after NSPI's planned roll out of AMI metering infrastructure? If not, please justify the need for new test consoles.

Response IR-47:

Yes, the test consoles will still be used after the planned roll out of Advanced Meter Infrastructure (AMI). Both non-AMI and AMI meters can be tested with this equipment, and as such, these test consoles would be replaced whether the AMI project proceeds or not. The consoles will be used for acceptance testing of new meters, ongoing testing of customer disputes, programming and testing of any non-AMI meters (advanced commercial and industrial meters such as IONs), continued testing of municipal meters, and sample testing of deployed meters from the new AMI fleet to monitor their in-field performance.