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December 12, 2019

Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, NL A1A 5B2

Attention: Ms. Cheryl Blundon
Director of Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: Investigation and Hearing into Supply Issues and Power Outages on the Island Interconnected System - Phase Two - The Liberty Consulting Group Eighth Quarterly Monitoring Report on the Integration of Power Supply Facilities to the Island Interconnected System - Further Information - Updated Version of the Overhead Transmission Lines Emergency Response Plan

On November 21, 2019, the Board of Commissioners of Public Utilities ("Board") requested that Newfoundland and Labrador Hydro ("Hydro") provide further information as a result of the findings in The Liberty Consulting Group's ("Liberty") Eighth Quarterly Monitoring Report on the Integration of Power supply Facilities to the Island Interconnected System ("Liberty Report").

One item of information requested by the Board in its November 21, 2019 correspondence was the overview of the Phase II Overhead Transmission Lines Emergency Response Plan ("Emergency Response Plan"), which Nalcor had agreed to provide to Liberty by the end of November 2019. In error, the copy of the Emergency Response Plan included as Attachment 2 to Hydro's response on November 29, 2019 was a draft version and is not the most up to date version of that document. Included with this letter, as Attachment 1, is the most current version of the Emergency Response Plan dated November 29, 2019. Hydro apologises for the error.

Should you have any questions, please contact the undersigned.

Yours truly,

Newfoundland and Labrador Hydro

Shirley A. Walsh
Senior Legal Counsel, Regulatory
SAW/sk

cc: **Newfoundland Power**
Mr. Gerard M. Hayes

Consumer Advocate
Mr. Dennis M. Browne, Q.C, Browne Fitzgerald Morgan & Avis

Industrial Customer Group
Mr. Paul L. Coxworthy, Stewart McKelvey
Mr. Denis J. Fleming, Cox & Palmer

Mr. Danny Dumaresque

ecc: **Board of Commissioners of Public Utilities**
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Grand RiverKeeper® Labrador Inc.
Ms. Roberta Frampton Benfiel
Ms. Prunelle Thibault-Bédard
Mr. Philip Raphals, The Helios Centre

Teck Resources Limited
Mr. Shawn Kinsella

Attachment 1

Summary of Emergency Restoration Planning
Labrador-Island Link – Overland Transmission

Summary of Emergency Restoration Planning

Labrador-Island Link – Overland Transmission

November 29, 2019

Revision: R4

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1 ABBREVIATIONS AND ACRONYMS

AC	Alternating Current
CERP	Corporate Emergency Response Plan
Company	Nalcor Energy
DC	Direct Current
ECC	Emergency Control Centre
EFLA	Engineering & Consulting Company based in Iceland
EOC	Emergency Operations Center
ERP	Emergency Restoration Plan
ERS	Emergency Restoration Structure
HSE	Health, Safety and Environment
HIW	High Intensity Winds
HVac	High Voltage alternate current
HVdc	High Voltage direct current
ICC	Incident Command Centre
ICS	Incident Command System
LCP	Lower Churchill Project
LITL	Labrador Island Link
LITL	Labrador Island Transmission Link
LMS	Learning Management System
LRM	Long Range Mountains
NL	Newfoundland & Labrador
NLSO	Newfoundland & Labrador System Operator
PPE	Personnel Protective Equipment
RTM	Real-Time Monitoring
RoW	Right of Way
SPOC	Single Point of Contact
SOP	Soliders Pond
SWAPs	Safe Work Activity Plans

2 EXECUTIVE SUMMARY

The Labrador-Island Transmission Link is an important transmission line for the provincial energy grid due to its power carrying capacity and that it is used to deliver a large portion of the winter peak energy and demand to the Island Interconnected System. With a critical asset such as the Labrador Island Transmission Link (LITL), Nalcor Energy has committed to an extensive program to ensure the reliability of the Link as well as ensuring a broad range of options to efficiently restore power as the result of an unlikely structural failure along the transmission line.

In 2017 Nalcor Energy engaged EFLA Engineering Consultants Inc. to assess common practices with respect to overhead lines emergency response planning. EFLA has completed seven assessment documents addressing several areas of developing an emergency restoration plan. The seven reports are as follows:

1. Event Preparation & Risk Mitigation
2. Risk Assessment
3. Crew Compliment & Training
4. Emergency Line Conductor Selection
5. Emergency Restoration Solutions
6. Transport, Material, Storage Logistics
7. Emergency Restoration Plan

Numerous documents and actions were produced from EFLA's work providing the guiding principles in which our Emergency Response Planning efforts have been based upon. Nalcor Engineering has developed multiple detailed engineering solutions that could be used as an interim solution to facilitate line re-energization as quick as possible. This upfront engineering will save on response time and enable the operations team to select from a variety of solutions depending on the failure scenario. Engineering alternatives for the restoration of power include:

1. Wood pole Solution,
2. Composite Insulators,
3. Emergency Restoration Structure,
4. Swivel Base Adapter,
5. Tower Modifications, and
6. Beam Gantry.

Preparing for the unknown is a daunting and difficult task. However, Nalcor Energy is continuously working to improve its operational readiness and preparedness in the event of an emergency situation. The steps taken to improve readiness include:

- Functional operational crews stationed in Labrador and on the Island,
- A full complement of equipment and tools to assist the operational crews in day-to-day operations as well as in the event of an emergency,
- An assortment of mock exercises for the purpose of practicing and refining operational procedures, compiling lessons learned and creating actions to address any gaps in Nalcor's procedures and processes, and
- Initiating agreements with third parties and contractors to provide assistance in the event of an incident that is beyond the capabilities of the in-house crews.

While there has been a large amount of work completed thus far to prepare Nalcor Energy to respond in the event of a failure incident, there is a commitment to continuous improvement. Future planning for Emergency Restoration Plan (ERP) activities includes:

- Additional mock exercises,
- Procurement of adequate line crew equipment,
- Completion of a LiDAR survey and the resulting development of an as-built PLS-CADD model,
- Procurement of the alternative engineered solutions,
- Further investigations into helicopter assisted work, and
- Development and implementation of a real-time monitoring program.

3 PURPOSE /SCOPE

From an overland transmission perspective, the Labrador Island Link (LITL) is an important transmission line for the provincial energy grid due to its power carrying capacity that it is used to deliver a large portion of the winter peak energy and demand to the Island Interconnected System. For this reason, it is key that Nalcor has a detailed emergency response plan/ approach for the LITL. As with all lines within the grid, in the unlikely event of catastrophic and multiple line failures, Nalcor will take direction from the Newfoundland & Labrador System Operator (NLSO) on which lines would be re-energized first. This document considers the thoughts and plans from an engineering and operational perspective on the LITL alone.

This document serves a summary document of Nalcor's efforts from an emergency response perspective for LITL to date. It will;

- Summarize internal/consultant recommendations,
- Highlight progressed engineering work on selected recommendations with respect to emergency response,
- Highlight the operational team's philosophy and consideration for LITL with respect to material management, logistics and operational team compliment,
- Summarize emergency response exercises completed to date including lessons learned that have been identified and actioned, and

- Outline future plans for both the operations and engineering team with respect to emergency response planning.

4 BACKGROUND

The overhead transmission line runs from the Muskrat Falls converter station to Soldiers Pond converter station. It is a 900 MW, ± 350 kV Direct Current (DC), bipolar line, with a single conductor per pole, and galvanized lattice steel towers. There are 11 different tower types on the LITL, consisting of both guyed and self-support structures. See *Table 1: Tower Types* for more details.

Table 1: Tower Types

Tower Type	Structure Type	Insulator Assembly Type	Deflection Angle Limit (degree)
A1, A2, A3, A4	Guyed	Suspension	0-1
B1	Guyed	Suspension	0-3
B2	Self-Support	Suspension	0-3
C1, C2	Self-Support	Dead End	0-30
D1, D2	Self-Support	Dead End	0-45
E1	Self-Support	Dead End	45-90

Ninety percent of all towers on the LITL are suspension towers, types A1, A2, A3, A4, B1, and B2 respectfully. *Figure 1: Suspension Towers* displays the six suspension tower types, while *Figure 2: Distribution of Tower Type on LITL* breaks down the tower distribution on the LITL.

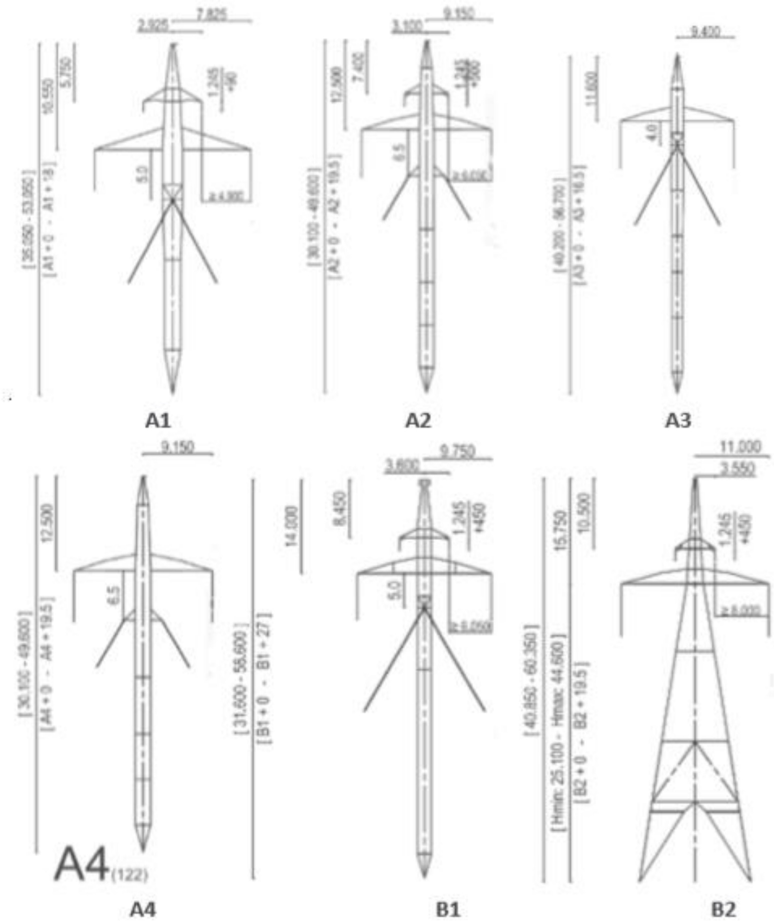

Figure 1: Suspension Towers [1]

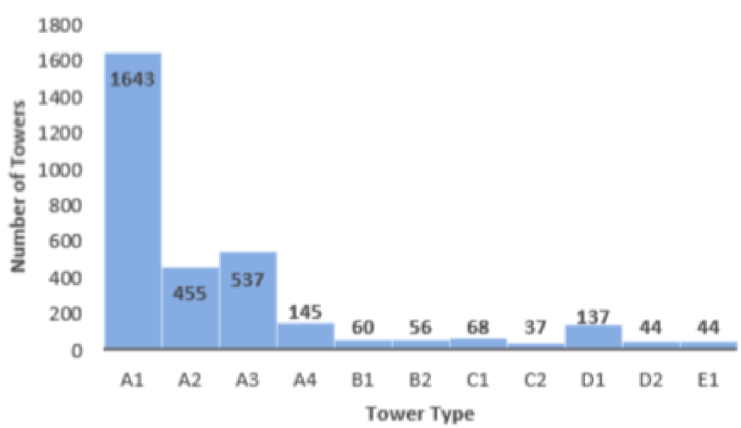

Figure 2: Distribution of Tower Type on LITL [1]

The line passes through 11 different climatic loading zones. The zones include 10 min average maximum wind speeds ranging from 105 to 180 km/h. There are two types of icing conditions experienced along the line: rime ice (in-cloud icing) and glaze ice (from freezing rain). Rime icing occurs at higher elevations and is opaque and less dense than glaze ice. Rime ice radial thickness ranges from 115 to 135 mm along the line, and glaze ice radial thickness ranges from 50 to 75 mm. See *Figure 3: Line Route in Labrador showing Loading Zones* and *Figure 4: Line Route in Newfoundland showing Loading Zones* for a map of the route and loading zones. *Table 2: Loading Zone Information* summarizes the loading conditions of each zone.

Figure 3: Line Route in Labrador showing Loading Zones

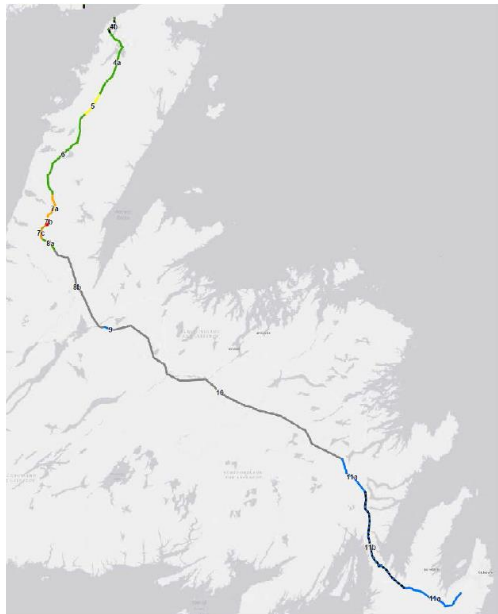

Figure 4: Line Route in Newfoundland showing Loading Zones

Table 2: Loading Zone Information

Zone #	Description	Location	Length (m)	Radial Ice Load (mm)	Wind Speed (km/h)	Inland or Costal	Max Elevation Above Sea Level (m)
1	Average Zone 1	Labrador	262.5	50_G	105	Inland	560
2a	Labrador High Alpine	Labrador	12.3	115_R	135	Inland	430
2b	Labrador Extreme Alpine	Labrador	62.9	135_R	135	Inland	460
2c	Average Zone 2	Labrador	22.4	115_R	135	Inland	350
3a	Average Zone 2	Labrador	12.4	50_G	120	Inland	270
3b	Average Zone 2	Labrador	12.3	50_G	120	Coastal	220
4b	Average Zone 2	Newfoundland	12.5	50_G	120	Coastal	40
4a	Average Zone 2	Newfoundland	56.4	50_G	120	Inland	300
5	HOSJ High Alspine	Newfoundland	18.9	115_R	150	Inland	500
6	Average Zone 2	Newfoundland	72.6	50_G	120	Inland	480
7a	LRM High Alpine	Newfoundland	21.1	115_R	180	Inland	590
7b	LRM Extreme Alpine	Newfoundland	7.1	135_R	180	Inland	630
7c	LRM High Alpine	Newfoundland	12.8	115_R	180	Inland	600
8a	Average Zone 2	Newfoundland	12.9	50_G	120	Inland	550
8b	Average Zone 1	Newfoundland	74.9	50_G	105	Inland	490
9	Alpine	Newfoundland	5.8	75_G	130	Inland	430
10	Average Zone 1	Newfoundland	221	50_G	105	Inland	360
11a	Eastern Zone	Newfoundland	89.4	75_G	130	Inland	280
11b	Eastern Zone	Newfoundland	88.8	75_G	130	Coastal	210

R = Rime Ice
G = Glaze Ice

More detailed information on the line design criteria, the tower design criteria, and the basis of design can be found in the following documents respectively: ILK-SN-CD-6200-TL-DC-0001-01, ILK-SN-CD-6200-TL-DC-0006-01, and LCP-PT-ED-0000-EN-RP-0001-01.

5 EMERGENCY RESTORATION EVALUATION & RECOMMENDATIONS

In 2017, Nalcor Energy engaged EFLA Engineering Consultants Inc. to assess common practices with respect to overhead lines emergency response planning. EFLA has completed seven assessment documents addressing several areas of developing an emergency restoration plan. The seven reports are as follows:

5.1 Event Preparation & Risk Mitigation,
5.2 Risk Assessment,
5.3 Crew Compliment & Training,
5.4 Emergency Line Conductor Selection,

5.5 Emergency Restoration Solutions,
5.6 Transport, Material, Storage Logistics, and
5.7 Emergency Restoration Plan.

EFLA used information from multiple international utilities along with their own knowledge to support their recommendations. Their reports and major conclusions have been summarized below.

5.1 EVENT PREPARATION & RISK MITIGATION [2]

Adopting a proactive approach to the operation of the High Voltage direct current (HVdc) LITL is necessary in order to ensure that the line operates as expected. Several risk mitigation measures can be implemented that will assist in the operation and maintenance of the line as well as effective implementation of the Emergency Restoration Plan. The key to the quick and efficient restoration of the line is being prepared. This can be achieved by early warning of impending failure/poor weather conditions, sufficient human resources to deal with the emergency, transportation for materials and personnel, equipment and material on hand to affect the necessary repairs, and information and operational changes that can be implemented to limit the financial and reliability impacts of a fault.

This EFLA document covers event preparation and risk mitigation measures that can be leveraged and they are grouped according to:

- Human resources,
- Transportation,
- Equipment, materials, and work Procedures,
- Information, and
- Operation and Maintenance.

The report contains more than 60 risk mitigation measures that can be implemented for the LITL. The recommendations revolve around the preparedness for an event, real-time monitoring, inspection and maintenance, use of robotics, the importance of work procedures, equipment, tools, and training.

The risk mitigation measures were mapped according to their influence/impact as a preventative measure, readiness to respond to outages, preparation activity, restoration time, and communication. This will help mitigating the duration of an event.

Several risk reduction measures have been proposed such as the development of detailed work procedures, maintenance and inspection plans, correct storage of materials, and the gathering and management of information. When implemented, the proposed measures will improve the operation and restoration ability of the line as well as the implementation of the ERP.

The work procedures will be extremely important considering that the restoration work is proposed to continue 24-hrs per day using shifts. The restoration work will also entail the use of helicopters to speed up the processes. Both these proposals will require detailed work procedures coupled with training of the workforce to ensure that the activities are conducted safely.

5.2 RISK ASSESSMENT [3]

A risk assessment of the LITL overhead transmission line was conducted as part of the ERP to assist in identifying major risks to the LITL as well as establishing possibly preventative measures that can be employed.

The report captures the results of the risk assessment workshop attended by representatives from Nalcor, Newfoundland & Labrador (NL) Hydro and The Lower Churchill Project. The aim of the workshop was to add to the risks already identified by EFLA consulting engineers and to grade the severity of each hazard item using the expertise from the attendees. A total of 40 hazards were identified. The most significant risks for the LITL were established as:

- Forest Fires,
- In-cloud icing, with and without wind,
- High Intensity Winds (HIW) such as Tornadoes, Downburst, Hurricanes, and
- Corrosive soils/bogs.

The document also covers some potential areas for the failures listed above as well as the seasons that they can be expected. The outcomes of the risk assessment were utilized to design the emergency restoration plan for the LITL.

The risk assessment evaluation used in this report followed a five-step approach. The five steps used to evaluate the ricks included: clarifying the overall risk assessment process, identifying potential hazards, analyzing each hazard, assigning the probability of occurrence, and evaluating using a risk matrix. The resulting matrix can be found in *Table 3: EFLA's Table 21: Risk Assessment of the 40 Identified Risks*.

Table 3: EFLA's Table 21: Risk Assessment of the 40 Identified Risks

Num.	Hazard	Incident level Minor 1	Moderate 2	Major 3	Severe 4	Catastrophic 5
Nature						
1	Freezing rain, with/without wind	5	3	3	2	1
2	In-cloud icing , with/without wind	5	4	3	3	1
3	Wet snow icing, with/without wind	4	3	2	2	1
4	Extreme wind storm (low pressure)	2	3	3	2	1
5	HIW wind (Tornadoes, Downburst, Hurricanes...)	2	3	3	3	1
6	Low temperature	1	1	1	1	1
7	High temperature (with high solar radiation & no wind)	1	1	1	1	1
8	Flooding (heavy rain, snow melting, ocean)	1	1	2	1	1
9	River erosion and flooding	1	1	2	1	1
10	Land-, mud-, rock slide	1	1	2	1	1
11	Erosion of foundations, sinkhole, ..	1	1	2	1	1
12	Ground subsidence	1	1	2	1	1
13	Loss of permafrost	1	1	1	1	1
14	Frost/Ice heave	1	2	1	1	1
15	Snow avalance	1	1	1	1	1
16	Snow creep	1	2	1	1	1
17	Extreme snow depth	3	1	1	1	1
18	Earthquake/Tsunami	1	1	1	1	1
19	Lightning	5	4	1	1	1
20	Salt pollution	5	4	1	1	1
21	Forest fire	5	5	3	3	3
22	Geomagnetically induced currents (GIC)	1	1	1	1	1
23	Volcanic Eruptions	1	1	1	1	1
24	Corrossive soil/bogs	1	3	3	3	1
Dynamic						
25	Galloping - flashover, wear of hardware & conductor	1	4	3	2	1
26	Vibration	1	4	2	1	1
27	Ice drop	2	3	1	1	1
Human or animal action or vegetation						
28	Vandalism or sabotage	1	3	2	2	1
29	Theft of minor to moderate quantities	1	1	1	1	1
30	Terror action	1	2	2	2	1
31	Ground vehicle impact with tower (car, farming machinery, s	1	3	3	2	1
32	Airborne vehicle impact with tower/conductor (drone, light	2	4	2	1	1
33	Nearby man-made hazards (clearance to nearby lines, powe	2	2	2	1	1
34	Animal leading to outage	1	2	1	1	1
35	Vegetation growth	1	1	1	1	1
36	Stray current	1	1	2	1	1
Design, production and construction						
37	Insufficient/unforeseen shortcoming in design (faulty desig	2	3	2	2	1
38	Insufficient/unforeseen shortcoming in manufacturing (man	2	3	2	2	1
39	Insufficient/unforeseen shortcoming in construction (e.g. Fa	1	1	2	2	1
40	Insufficient/unforeseen maintenance	1	2	2	1	1

coloured numbers represent the hazards probability

5.3 CREW COMPLIMENT & TRAINING [4]

This EFLA document covers the recommendations for the line crews including the number of people, skills and training requirements. Due to the remoteness of the LITL and the body of water separating the line sections, it was determined that the line should be maintained by two-line crews.

The first crew will be in Happy Valley-Goose Bay and would cover the 400 km of the overhead transmission lines on Labrador and the second crew for the 700 km on the island. It is recommended that these crew members be always ready in the case of emergencies and can act in a timely fashion on maintenance, inspection, and restoration activities. Note, while each crew has a designated region, they will work as a team for whatever area in which work is required.

Personal attributes of crew members:

- Be committed to safety,
- Strong manual dexterity, hand-eye coordination, and attentive to detail,
- Ability to work in all weather conditions, confined spaces, isolation,
- Ability to work construction in a physically demanding environment including; climbing in towers, handling heavy equipment,
- Self-disciplined, motivated, organized, and a team player,
- Ability to work in a fast-paced environment with tight deadlines and repetitive tasks, and
- Adapt easily to changes.

The specific training recommendations were defined in detail in the report, this training is needed in addition to the normal introductory and other training programs run by Nalcor to enable it to comply with the legal requirements and the requirements indicated in the Canada Occupational Health and Safety Regulations.

The training can be split into the following categories:

- Basic Safety on Construction Sites,
- Survival skills,
- Rescue,
- Transportation,
- Procurement and Logistics,
- Powerline Design,
- Helicopter Construction and Maintenance,
- Line Construction & Rigging, and
- Live Line maintenance.

It is recommended that yearly training exercises be conducted by the restoration team to familiarise themselves with the procedures. The training should include the assembly and erection of an Emergency Restoration Structure (ERS) tower as well as a lattice tower and cross arm as well as the changing of a cross-arm on a tower.

The power line technician must be trained in basic maintenance and repair activities for the line thereby enabling them to participate in the repair efforts for incident level 0-3 as indicated in the Emergency Restoration plan document.

An area should be created where a tower can be installed and practice exercises can be conducted together with a foundation, guy installation, and tower dressing activities.

Retention of the highly-trained staff is key to their effectiveness and a comprehensive human resource plan must be developed and implemented.

5.4 EMERGENCY LINE CONDUCTOR SELECTION [5]

EFLA examined a number of criteria as listed below along with loads obtained in the PLS-CADD criteria files supplied by Nalcor Energy to obtain the new loads for the emergency conductor and Temporary towers. This conductor is envisioned to be used on a wood pole bypass solution with the idea to get the line operational as quickly as possible.

The emergency conductor must satisfy the following criteria:

- Low weight,
- High tensile capacity,
- Robust,
- Capable of carrying the full load current without loss of strength,
- Good self-damping characteristics,
- Sufficiently large diameter to withstand the environmental requirements,
- Easy to install, i.e. standard stringing equipment,
- No special tools required for installation,
- Conventional installation practices,
- Familiar technology, and
- Standard Hardware.

The temporary line would be constructed with a smaller conductor than normally utilized on the mainline as electrical losses are not a concern due to the short periods that the line will operate.

The critical factor (low weight) is that the conductor can be transported to the site in suitable drum sizes during an outage. The helicopter lifting capacity is generally around 1000 kg, which implies that a 400 m drum would require a maximum conductor mass of 2.3 kg/m with an 80 kg drum mass.

EFLA recommended the most suitable conductor that would provide sufficient strength with a low weight for a by-pass line is the Grackle AACSR. This conductor would create lower loading on the temporary restoration towers than the standard ACSR conductor used on the HVdc line currently.

5.5 EMERGENCY RESTORATION SOLUTIONS [1]

The purpose of this EFLA document was to provide possible emergency restoration solutions available for restoration of the LITL. It is important to realise that there is no single solution that can be utilised for the restoration of the line and that a toolbox of solutions is required that can be deployed for various failure types and conditions. The options presented range from solutions that can be deployed for rapid restoration to bypass solutions utilising ready-made restoration structures. Tools and methods for restoration of the towers using minimal tools and equipment are also included.

Anchoring of the guys can be a major problem in the LITL, especially during the winter months when the area could be covered with vast amounts of snow. The soil conditions vary along the LITL from bogs to rock and hence options must be available for all conditions. The document covers various alternatives that can be implemented to match the soil conditions however the strengths may not match those of the current anchors due to the founding material and speed at which they can be deployed. For these instances, multiple anchors will be required.

Given the importance of the LITL coupled with the remoteness of the line, it is essential that Nalcor Energy is prepared to deal with a failure of the line to limit the consequences of the outage. The risk of a line failure or outage is always present, however, the consequence of that outage can be altered by implementing suitable mitigation measures as well as having a thorough restoration plan to reduce the consequences.

Nalcor Energy has committed to developing a restoration system that has the ability to restore one HVdc Pole as quickly as possible.

The restoration alternatives proposed in the document consider this commitment as well as other alternatives.

The main criteria for ERS structure:

- Fast to install and restore supply on at least one HVdc Pole,
- Reliable solution. Need to be able to remain in position until weather conditions are favorable to restore the original line, and
- A commitment to personal safety shall be followed while the installation takes place.

Other aspects of importance are:

- Can be used in various situations,
- Can easily and effectively be transported in all weather and site condition,
- Reasonably simple to install,
- Efficiently stored for quick material retrieval, and
- Reliable and with sufficient strength.

Key questions that this document aims to clarify:

- What types of ERS are most suitable for the LITL?
- What special tools and equipment are required for the restoration?

The document focused mainly on the failure of suspension towers as they represent 90 % of the towers on the line. The dead-end towers are generally designed with higher reliability than the suspension tower and the failure of a dead-end tower will most certainly lead to the failure of suspension towers. Methods to restore a dead-end tower are also proposed in the document.

Failures that damage one or more structure of the LITL can stem from a number of causes. It can range from an isolated failure, to cascading failure, to failures in more than one location. The site conditions can vary from being easily accessible to being inaccessible by land transport. Due to this variability, it is important to acknowledge that there is not a single approach for an emergency restoration structure that fulfills all conditions, therefore, there is a need for having a toolbox of solutions, where the best suitable method would need to be selected for each case. The main alternatives to get the lines back into operation can be classified into:

- Rapid restoration of supply,
- Using failed structure as part of the solution,
- Erect new standard tower in the same location as the failed tower,
- Erect fast restoration tower in existing tower place, as part of the permanent solution,
- Erect temporary structure(s) in existing track, and
- Erect temporary structure(s) in a by-pass.

The questions that arise for the structures are what type is most suitable for each case and suitable for the equipment available at the site and the training of the linesmen. The main structures are:

- Normal tower,
- Ready-made ERS,
- Specially and custom made ERS for the LITL,
- Modified, fast restoration version of the normal tower, and
- Wood poles or composite poles.

The most important questions to consider in selecting a restoration method are:

- How can restoration work be carried out safely?
- How can outage be minimized?
- How long an outage will be required for the final restoration?
- How can the time for final restoration be controlled?
- What is the operational reliability before the final restoration has been made?
- What is the total cost of restoration and outage?

It is clear from the analysis above that a toolkit of solutions must be developed. It is essential that the solutions selected by Nalcor from the EFLA reports are developed, documented, and tested. The necessary training must be conducted on the systems that are selected. The design documentation must be available for all of the systems during emergencies for reference purposes. It is important to note that the most appropriate solutions for restoration may differ depending on the location of the fault and site condition.

5.6 TRANSPORT, MATERIAL, STORAGE LOGISTICS AND COMMUNICATION [6]

The purpose of this EFLA report was to document the thinking with respect to the restoration methods for the LITL line, the transport methods and access routes based on the environmental conditions, as well as the potential material storage methods and locations. The aim is to determine the appropriate storage locations for materials, transport mediums to be used during restoration, and communication requirements during an emergency on the LITL.

The material storage, as well as the repair methods and line accessibility, are all intertwined. The most suitable alternative differs for Labrador and the Island. For the Island section, during the most adverse weather conditions, materials can be transported along the national highway when these materials are required in fault locations close to the highway. This distance from a government-maintained road to the restoration site should be no more than 40 km based on the analysis done on the line route.

A laydown area can then be utilised and the materials can be assembled and transported short distances by helicopter to the restoration site. All staff will be transported to the site by helicopter. If conditions are favourable, the materials and staff can be transported with normal vehicles. Should the conditions be unfavourable for flying, both materials and equipment can be transported via track vehicles to the site. Ice or snow roads may need to be created depending on weather conditions.

The Labrador section of the line presents greater challenges with respect to material storage and transportation to the site due to the remoteness of the line location. The road separates from the line to a maximum distance of 100 km and helicopter availability is limited to those lines nearest Goose Bay as the primary option. If helicopters are requested from Pasadena, they would need to travel 280 km straight-line distance to Forteau which will not normally be done as the pilots will try to keep any water body crossing to a minimum. This could result in a flying distance of around 305 km before the helicopter reaches Labrador.

Transportation will be conducted by normal tractor and trailer or track vehicles depending on the environmental conditions. For materials accessed from the middle store location, the track vehicles would have to access the storage location first and then assist in the removal of the snow to access the materials during unfavourable weather conditions. Helicopters can then be utilised to transfer the materials and equipment to the restoration site. If the weather is unfavourable for helicopters to fly, the track vehicles can be utilised.

The transportation of the materials to the site will impact heavily on the restoration times. For both the Island and Labrador, helicopters and 4x4 vehicles with extended cabs will be utilised to extract employees from the worksite in the event of poor weather conditions developing. All tools and materials will be left at the worksite. The materials and tools will, therefore, need to be packaged in secure lockable containers that are light enough to be carried to the worksite by helicopter.

To ensure that there are multiple means to access the site during failures, especially severe incidents, it is essential that the road infrastructure remains. The level of maintenance can be varied depending on the road type and design. It is recommended that the bridges be kept in place but closed with a temporary barrier such as a gate. Maintaining the bridges will facilitate inspection and maintenance of the line while keeping the effort to access the site during a failure to a minimum.

Failure to keep the existing infrastructure will increase the risk for successful restoration of the line as well as create problems for the inspection and maintenance staff during their routine activities. Removing the road infrastructure will require that all line inspections and maintenance be conducted using helicopters which can be unpredictable due to rapidly changing weather conditions. Severe incidents require many large vehicles and workers to access the site, this will be difficult without road infrastructure and will increase greatly the response time for a failure. The access roads should be assessed over the next few years to determine the level of maintenance required. Ideally, the roads should be maintained in a condition suitable for access.

Communication on site will be conducted primarily by cellular network with Satellite being the backup/alternative on the island.

5.7 EMERGENCY RESTORATION PLAN [7]

The Emergency Restoration Plan provided by EFLA is a culmination of all documents previously detailed above. The objective of the Emergency Response Plan for the Labrador Island Transmission Link is to ensure that the high-risk failures are identified and that appropriate high-level actions are documented to deal with the failure(s) thereby reducing the consequence of the failure and hence the overall risk for the line.

The ERP document itself was split into two parts, part one includes the information that the restoration team should be trained on upfront to assist in smooth execution of the plan. Part two of the document has a high-level emergency restoration plan covering the roles and responsibilities of the team members.

The scope of the restoration plan covers the restoration of power flow on the HVdc Labrador Island Transmission Link between Muskrat Falls and Soldiers Pond as well as the electrode lines on Labrador and the Island. The plan focuses on the resources and processes for the restoration of one pole of the HVdc link. The submarine cable and its connections, substations, earth electrode sites, and the control centre are not covered as part of this ERP.

A typical emergency response plan consists of three sections; namely: Incident Command Centre (ICC), the Restoration Management (Incident Response Centre) and Energy Control Center. The restoration plan is a high-level document focused primarily on the activities of ICC and the incident response centre.

The goals for the ERP plan are:

- Restoration methods should be mapped to assist with restoration efforts,
- Minimal environmental damage during the repairs (zero environmental findings),
- Identify special equipment requirements,
- Effective control of the restoration process while maintaining financial control,
- Ensure effective communication during the outage / failure repairs,
- Repair Solutions available for all types of major outages,
- Identify skills and training requirements for line crews,
- Establish the training requirements for the restoration team members and repair crews to ensure readiness to respond, and
- Identify risk mitigation methods that can be implemented on the line.

The ERP for the LITL was developed by utilising the expertise of EFLA consulting engineers, consultation with industry experts in other utilities, as well as, the experts within Nalcor Energy. The greatest knowledge, with respect to what is possible and effective with line maintenance and repair, is held by the maintenance staff working on the transmission lines in the area. A risk workshop was held in Newfoundland where relevant knowledge was gained from Nalcor Energy employees. A literature and questionnaire survey was conducted to establish utility trends with respect to ERP. Input from several technical references, as well as the Nicolette Commission report, were utilized to assist in the development of this ERP.

Questionnaires were issued to contractors available in Newfoundland to establish their competencies and equipment availability the results of which were incorporated in the ERP Plan.

The main factors that will largely influence the successful implementation of the ERP are the human resources, equipment and materials availability, effective communication within the restoration team members, and reporting. These aspects are covered on a high level in the ERP document.

5.8 NEXT STEPS ANALYSIS/RANKING & PLAN

Ninety-nine general recommendations have been generated from EFLA's original analysis. Each of these recommendations has been listed and categorized into an implementation schedule which can be found in *Appendix A: Next Steps Registry*. An analysis with both Nalcor and NL Hydro executive was completed to place scope owners on each recommendation as well as a ranking with respect to which activities were deemed high priorities.

This analysis was completed to ensure that Nalcor places a logical focus on items in the short term that were achievable and of the most value from an engineering and operations perspective. The items that have been identified as a "high" priority have been adopted in Nalcor's short term plan and form the basis of the following activities. Details of each are as follow, but in general, the next steps include:

- Identification of the proper crews, material plans, tools, and logistical requirements from an operational perspective,
- The design of alternative emergency solutions for pole restoration structures based on emerging technologies, experience, and lessons learned from other utilities, providing a practical solutions for the LITL itself,
- Procure equipment required for chosen designed solutions for emergence restoration structures,
- Conduct mock exercises to aid in the efficient and effective response to line failures, and
- To use these lessons learned to continue to develop and execute exercises with increasing complexity.

6 EMERGENCY RESTORATION TEAM

Nalcor Energy's emergency restoration team's organization follows the guidelines of the Incident Command System (ICS) and is consistent with Nalcor's CERP. The ICS is a standardized approach to the command control and coordination of emergency response providing a common hierarchy within which responders from multiple agencies can be effective. There are five primary management functions of the ICS, they are:

1. Command – The Incident Commander is responsible for all incident or event activity.
2. Operations – The Operations Section is responsible for directing the tactical actions to meet incident objectives.

3. Planning – The Planning Section is responsible for the collection, evaluation, and display of incident information, maintaining the status of resources and preparing the Incident Action Plan and incident related documentation.
4. Logistics – The Logistics Section is responsible for providing adequate services and support to meet all incident or event needs.
5. Finance/Administration – the Finance/Administration Section is responsible for keeping track of the incident related costs, personnel and equipment records and administering procurement contracts associated with the incident or event.

The Incident Command Post is the location at which the primary command functions are performed and is where the Incident Commander would be located. The Post is located at Soldier's Pond in conference room 1 already furnished with general office supplies, such as office furniture and printer access. In addition, utilizing the established binders created for the roles, responsibilities, and information package for the following key restoration/response members:

- Incident Commander,
- Deputy Incident Commander,
- Safety Representative,
- Data Recorder, and
- Logistical Representative.

Nalcor Operations is continually updating the Emergency Response process and procedure binders that reside in the Incident Command Post and ensuring the personnel that would be expected to fulfill the roles listed above are aware of their responsibilities via training and mock exercises.

7 ENGINEERING PLANNING

Proper engineering considerations based on LITL's physical characteristics and design is crucial in aiding the team's ability to respond effectively in the event of an emergency. The following are on-going engineering planning considerations that will help properly highlight the line exposure areas, the lines performance, and some tools that will aid in proper design and analysis.

7.1 LITL ZONE CLASSIFICATION & RESTORATION TIME ESTIMATION

Table 4: Details on Conditions Based on LITL Section outlines an engineering study that identifies the general high exposure areas based on difficult to access areas and comments on the zones general meteorological loading. This analysis outlines, for the operations team, the areas which require more focus and planning from an emergency response perspective on a macro scale. The next phase of the ERP planning, in 2020, is to detail these zones into tower sections further and match alternative engineering solutions to each area.

Table 4: Details on Conditions Based on LITL Section

Structure	Access	Comments
1 – 401	Good[1] – Mainly Accessible off Route 510	Average Meteorological Loading Zone
402 – 1282	Remote[2] – Interior of Labrador	Average and Alpine Meteorological Loading Zones
1283 – 1366	Remote – Island Northern Peninsula, Winter Access Zone	Average Meteorological Loading Zone. Construction in this section used winter access only.
1367 – 1685	Fair[3] – Northern Peninsula, Forestry trails and constructed access	Average and Alpine Meteorological Loading Zones
1685 – 2014	Remote – Long Range Mountain, constructed access only	Average and Alpine Meteorological Loading Zones
2015 – 2147	Good – Taylors Brook to Birchy Lake, Forestry trails and constructed access	Average and Alpine Meteorological Loading Zones
2148 – 2235	Remote – Dawe's Pond, Forestry trails and constructed access	Average Meteorological Loading Zone
2236 – 2415	Fair – Badger to Bay D'Espoir highway, existing and constructed access	Average Meteorological Loading Zone
2416 – 2649	Remote – Interior of Newfoundland, Terra Nova Combination of Forestry, existing and constructed access	Average Meteorological Loading Zone
2650 – 3223	Good – Avalon, Close Proximity to Trans-Canada Highway	Average and Eastern Meteorological Loading Zones

[1] Good - within 20 minutes from paved Government serviced road
[2] Remote – Beyond 60 Minutes from paved government serviced road
[3] Fair – 20 to 60 minutes from paved government serviced road

In 2019, the team underwent an estimation exercise of the expected "time to energization" period by location to forecast an estimated time to restore power. *Table 5: Estimated Restoration Time by Tower Failure* was created and refined by Nalcor Energy from the collective experience of the engineering and operations divisions post construction. It provides an estimated timeline for the restoration of power following a transmission line failure. A strategic analysis will commence in 2020 to evaluate the estimated number of towers that could fail in heavier loaded sections. Due to the design capacity of LITL, it is less probable that large segments of towers will fail. A proper engineering analysis of failure scenarios per region will identify the estimated number of tower failures, which can then be utilized to refine response time.

Table 5: Estimated Restoration Time by Tower Failure *

Description of Failure							
Number of towers	**Approx. length (km)**	**Dead Ends Down?**	**Area/Location**	**Anchors and Foundations are Sound?**	**Guy wire reusability percentage**	**Temporary or Permanent Solution**	**Total Days**
<3	1	No	All	Yes	100%	Temporary Wood Pole	**1 to 3 weeks**
>3	1, 7	No	All	yes	100%	Temporary Wood Pole (Mono-pole)	**2 to 6 weeks**
21	7	No	Terra Nova/Long Range/Labrador	Yes	50%	Permanent Steel (Bi-pole)	**5 to 7 weeks**
22	8	No	Avalon	Yes	50%	Permanent Steel (Bi-pole)	**5 weeks**

- Assuming unlimited resources, snow clearing, and construction at night.
- Assuming structures are located anywhere from 15 to 80 km of snow covered road to main road.
- Assuming 4-5 pieces of the following equipment (nodwells, loaders, dump trucks, plows, and excavators), with 10 excavators and 3 dozers for snow clearing.
- Assuming that time utilized to prep guy wires (measuring/cutting) could be completed concurrently with clearing of site. Several trucks loaded, external contractor utilized for shipping and loading.
- Assuming four assembly crews only (1 excavator per crew) 8 to 10 people.
- Assuming installation can begin approx. 3 days after assembly begins. Assuming no helicopter or crane assistance. Assuming good weather for the raising of towers. (4-5 linesmen)
- 1 Crew (from contractor) & stringing in daylight in addition to assembly crews

7.2 ENGINEERING TOOLS (LIDAR, REAL-TIME MONITORING AND ASSET MANAGEMENT)

Best practice engineering and asset management are crucial to properly understanding the life of LITL and to appropriately adapt and engineer solutions as required in the event of an emergency. Nalcor currently utilizes an as-built computer model of the LITL based on data received during construction. To further verify the current models, Nalcor Energy is committed to acquiring as-built LiDAR and ortho-photography for LITL in 2020. The imagery obtained will greatly aid in understanding the as-built condition of not only the line itself (conductor sag, clearance tower locations) but also the access road network built along the RoW. From an engineering perspective, this data is vital to facilitate quick design options for alternative engineering solutions. LiDAR imagery is a powerful tool as well for aiding in flood prediction for tower boxes and future general operations work as well.

Nalcor will use this collected data, along with design data, to develop a geospatial database that is connected and carrying maintenance records and inspection observations. This database will aid Nalcor's team to understand the condition and past performance of LITL in each area throughout the province. This should adequately capture any areas of failed dampers, corona rings, tower members, etc. Accurately capturing and trending the data will aid the team in understanding areas prone to specific weather patterns and loading.

Nalcor has a history of using Real-Time Monitoring (RTM) stations in aiding design loading analysis but also in evaluating meteorological conditions that lines are subjected to. In 2018 and 2019, the team has extensively researched RTM equipment used throughout the world by different utilities and will look to leverage these findings to expand its network in the future. There are many commercially available devices that monitor key conditions on the line such as ice loading, wind loading, galloping, and aeolian vibrations. These devices can be installed directly on the line or on test spans.

Nalcor has attended a workshop discussing real-time monitoring in the industry and is meeting with suppliers to understand which solution would work best for the line. Nalcor currently maintains three test spans throughout Alpine regions of LITL and will look to upgrade and expand this network in detail throughout 2020/2021. These stations were used throughout the design phase of LITL's development and require upgrades and expansions. RTM Stations used in conjunction with weather prediction models will aid in emergency response readiness from the operations side and will also help the engineering team in understanding the weather/loading conditions.

8 ENGINEERING DESIGN ALTERNATIVES

Nalcor Engineering has developed and is continuing to develop, multiple detailed engineering solutions that could be used as an interim solution to facilitate line re-energization as quick as possible. This upfront engineering will save on response time and enable the operations team to select from a variety of solutions depending on the failure scenario. The engineering alternatives described below consider the size and abilities of local contractors and line crews within the province. Nalcor has commenced work on the following solutions outlined in sections 8.1 to 8.6 below.

8.1 WOOD POLE SOLUTION

In the event of a failure of multiple tangent towers on the line, a wood pole bypass line is an option to install power quickly before restoration of the permanent line can be complete. The wood pole bypass is a temporary line that would restore power.

A generic line design consisting of a combination of tangent, angle, and dead-end two-pole wood structures has been designed. This wood pole bypass line is designed to withstand any of the loading found along the complete length of the line and will work in most situations. The design is limited by both the short height and span lengths of wood poles, and may not work in areas of significant elevation change or across large bodies of water.

Wood poles, hardware, and glass insulators have been procured for this design currently stored in Argentia and Muskrat Falls respectfully.

Figure 5: Wooden Pole Solution Used in 2018 Mock Exercise

8.2 COMPOSITE INSULATOR ASSEMBLIES

Composite Insulators have been designed and ordered for the wood pole solution. These assemblies will replace the existing hardware and glass insulator strings. Composite insulators are lighter than glass insulator strings and will make material transportation and constructability easier.

In addition to the wood pole structure assemblies, composite insulators have been ordered for the backstay assemblies. In the event that a conductor breaks during a line failure, this broken conductor will have to be anchored to prevent further damage and stabilize the intact section of the line. This would be completed with a backstay that would clamp on the broken conductor and be anchored into the ground. The clamp, hardware, and anchor material have been procured. The composite insulator is designed and ordered with an expected delivery of winter 2020 with an expected storage location of Forteau Point in Labrador and Central Newfoundland.

8.3 SWIVEL BASE ADAPTER

The original suspension towers are designed to be installed on a base plate with a guiding pin. Should the tower fail, there is a strong possibility that the pin will be damaged and the entire base plate will need to be replaced. Replacing the base plate will create problems with erecting the new tower onto the new base plate without the use of a crane or helicopter. A special base plate capable of pivoting is being designed, which would allow the tower to be raised and set on the locating pin using a derrick, winches, and guys. The tower can be assembled on the ground with the base of the tower attached to the swivel connection. The tower can then be raised into position using a derrick and the pivot connection. The pivot connection could either remain in place as part of the tower or be removed depending on the final design.

The design and work procedures for this solution are currently ongoing and should be complete Q4, 2019. This solution is expected to be manufactured and delivered in 2020.

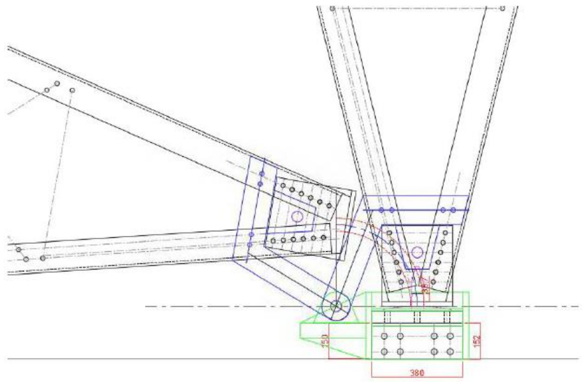

Figure 6: One of the Swivel Base Adapter Proposed Designs

8.4 BEAM GANTRY

The beam gantry will be utilized in combination with a crane to lift and support the conductors of a line that has fallen to ground over existing infrastructure such as roads, highways, and other powerlines. The solution will be utilized as a short-term measure to restore the supply as quickly as possible while alternative arrangements can be implemented. The gantry will be universal and capable of supporting all 230 kV and 315 kV High Voltage alternate current (HVac) phases or both the HVdc poles.

The design and work procedures for this solution are currently ongoing and should be complete Q4, 2019. This solution is expected to be manufactured and delivered in 2020.

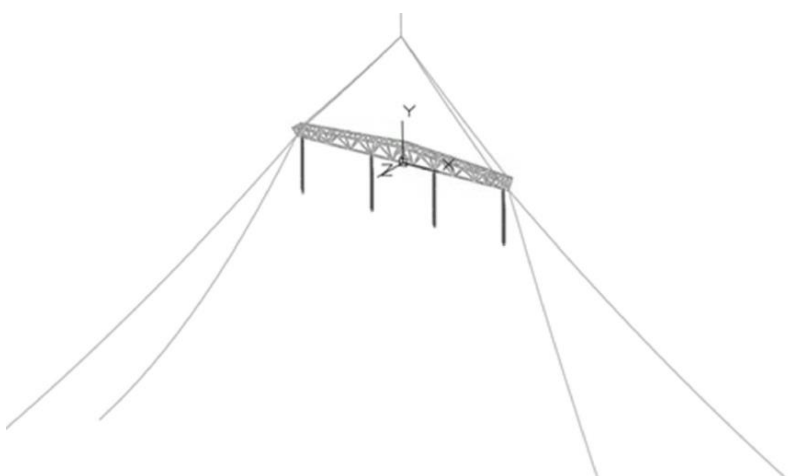

Figure 7: Beam Gantry Design

8.5 MODIFICATION TO HVDC TOWER

By modifying and adding tower members, an undamaged section of the existing tower from the failed line can be used to restore the line. This is done by reinforcing the tower and adding stand-off post insulators to the section of the tower under the existing crossarm. This option has the advantage of using not only existing tower sections but also existing anchors and foundations.

The design and work procedures for this solution are currently ongoing and should be complete Q4, 2019. This solution is expected to be manufactured and delivered in 2020.

8.6 ERS (FEED)

Emergency restoration structures (ERS) are structures designed to be installed quickly in the event of line failure. ERS towers are usually lightweight modular aluminum structures and associated with polymer insulators, hardware, and guying components. The lightweight modular components allow transportation to remote and hard to access sites, either manually or by helicopter. Unlike typical permanent transmission structures, an ERS design is not driven by optimization, but rather by flexibility, providing many different structural concepts.

There are several emergency restoration structures available in the market. These structures are generally supplied with the tools and equipment required for tower assembly and erection. The systems are largely similar and they have been designed to be installed with minimal equipment. Most of the towers and equipment can be airlifted to the required location.

The design of an ERS for the line will be initiated by the first quarter of 2020 with manufacturing and supply expected in 2020.

9 MATERIAL STORAGE & LOGISTICS

The materials must be stored in accordance with the manufacturers' recommendations so that their usability is assured during an emergency. Ideally, a closed environment is preferred. Loading and offloading equipment such as cranes and portable forklifts must be available at the storage locations to aid in loading materials onto the tractor and trailers. Open trailers are preferred for material transportation as this would facilitate the movement of the materials from the laydown area directly via helicopters if available.

9.1 MATERIAL STORAGE AREAS AND CAMPS

It has been determined that there will be storage areas required for both long-term and short-term/temporary solution materials. The long term storage solutions will require a location in Newfoundland as well as in Labrador; the locations are currently as follows:

- Soldiers Pond, Newfoundland (Argentia, Newfoundland currently), and
- Muskrat Falls, Labrador.

For the short-term/temporary solution storage locations, Labrador requires its own site, and Newfoundland requires a location on either side of the Long Range Mountains (LRM) since the LRM is the most heavily loaded area. These short-term solution locations are currently as follows:

- Northern Peninsula, Newfoundland (preferably Cow Head or Port Saunders),
- Bishop Falls, Newfoundland, and
- Forteau, Labrador.

Further to these storage locations, Operations is considering temporary equipment laydown and storage locations inside the Long Range Mountains Alpine zone, along with a line crew camp in Central Labrador as part of the 2021 Nalcor capital plan.

9.2 MOVEMENT OF MATERIALS FROM STORAGE AREAS

The material storage locations are yet to be finalized. The materials for each store must be allocated based on the towers in that section(s) of the line so that the storage locations are optimized concerning size and materials.

Due to good road infrastructure and the availability of helicopters, the plan will utilize tractor and trailers to bring the materials and equipment close to the line and then airlift them into position in bad weather or poor site access conditions. All the storage locations must be fitted with suitable rigging equipment to assist in the loading and off-loading of materials and equipment. Several transport companies are available that can be utilized to move the materials and equipment, and many of the contractors on the island have suitable equipment to assist in these activities.

Open flatbed trailers will be utilized for material transport as this will facilitate offloading of materials on-site using helicopters, thereby speeding up the process of getting the required materials and equipment to the site. All materials and equipment must be packaged to help support the utilization of helicopters in the restoration activities.

9.3 LINE REPLACEMENT SPARING PHILOSOPHY

Nalcor Energy has developed the following philosophy for stocking extra operational spares to be used in the event of maintenance or emergency repairs.

For LITL there will be enough maintenance spares to replace one section of the transmission line between Anti-Cascade structures. The line design consists of no more than 22 structures between Anti-Cascade tower placements. Maintenance spares will be obtained for:

- All main tower bodies and extensions,
- Hardware assemblies (tangent suspension, dead-end, jumper, OPGW and OHSW),

- Cables (Conductor, OPGW and OHSW), and
- Insulators.

Due to the design capacities and line failure sequence, there will be no maintenance spares obtained for the transmission tower foundations. However, at the conclusion of construction, selected "ground level" foundation surplus have been retained. Due to diverse meteorological conditions encountered across the 350 kV HVdc transmission line there are 11 tower types, therefore there is a larger quantity of spares required, mainly tower bodies and extensions. To determine the quantity of tower bodies and extensions required an analysis was performed examining the quantity and type (including extensions) of structures used throughout the HVdc line. This ensures that if a cascade failure occurs on any section there will adequate parts available to quickly perform the required repairs. Detailed spare lists are available for review and outline in document LCP-PT-ED-6000-TL-LS-0001-01.

In addition, spare wooden pole and accompanying equipment for 2 km of transmission lines are procured and stored for use for emergency response for use as bypasses. This quantity will be refined over the next years.

10 OPERATIONAL READINESS

10.1 REQUIRED EQUIPMENT/TOOLS & TRAINING

Nalcor Energy operates from two locations, Soldier's Pond and Muskrat Falls. Each location has a dedicated operational crew of linespeople with a complement of tools and equipment.

In an effort to prepare for operational readiness the Work Execution Team of Nalcor Operations has developed, and continues to refine, a prioritized list of tools and equipment that is required for day-to-day operations, as well as, in response to an emergency situation. The majority of the identified equipment (except fleet) and tools has already been procured and larger construction and maintenance equipment such as boom trucks, tracked machines, etc. are outline in Nalcor's capital budget plan and expected to be acquired in the next few years.

To further support operational readiness, all personnel training records are tracked via the corporate Learning Management System (LMS). The training provided includes:

- Basic safety,
- Survival skills,
- Rescue,
- Line construction and rigging, and
- Live line maintenance, etc.

The operational philosophy for continued education requires all linespeople to participate in routine inspections, maintenance and day-to-day repair work, and participation in operational emergency response mock exercises. This list will be updated to reflect emerging technologies and industry best practices.

10.2 OPERATIONAL APPROACH, WORK METHODS & PROCEDURES FOR ENGINEERING SOLUTIONS

Work Methods and Procedures for Emergency Response

Nalcor Energy has developed and follows the Corporate Emergency Response Plan (CERP). Operational personal at the local field level, be it in Labrador or on the Island, will coordinate with the CERP team to deal with any incident.

When tower failure occurs the ERP process needs to be activated. Each failure can be different and it is important to have identified the variability that needs to be dealt with in respect to: type of failure, site condition, weather condition, access, etc. To be properly prepared to deal efficiently with a failure it is important to have studied various failures scenarios and have available a toolkit of solutions that can be selected based on the actual condition. The main steps in the ERP process in power restoration are as follows and they are described in more detail in ref. [4].

- Initial safeguards,
- Site assessment and quantification of impact,
- Formulate solution and project planning for restoration,
- Implementation of restoration, both first restoration of power and final restoration, and
- Closeout.

The typical steps in an emergency response are as follows:

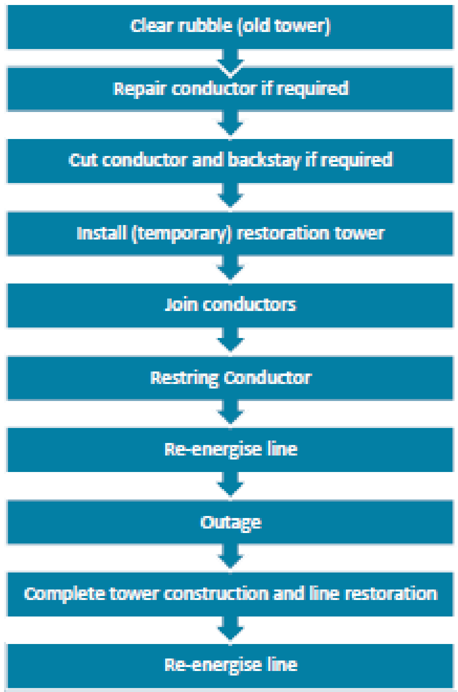

Figure 8: Emergency Response Steps [1]

The priority to get at least one of the HVdc Poles in operation as quickly as possible leads to unconventional solutions being considered along with more traditional solutions in the tower restoration work.

In conventional line restoration method, transmission line towers are restored using the same Right of Way (RoW) which involves the following steps:

- Removal of tower debris,
- Repairing foundations,
- Arranging of tower(s) and other transmission line material,
- Tower and hardware erection, and
- Conductor stringing.

The other way of restoration is to bypass the damaged portion of the transmission line using temporary structures. By this method, the damaged portion of the transmission line is bypassed on either side of the existing RoW on temporary structures. This may have advantages like:

- Saving downtime,
- Permanent restoration in the damaged portion can resume without requiring a shutdown. (Fewer hours shut down is required for linking the repaired portion with existing line), and
- The temporary structures can be reused in future emergencies.

The two main questions to consider in restoration solutions are what type of tower to install and where to place it.

What type of tower to install?

I. Temporary structure, or
II. Final structure.

Where to install the structure?

III. Same location as the failed tower,
IV. Along the centerline but outside the failed tower, or
V. By-pass, outside the centerline.

If a temporary structure is erected, then it should be considered for how long it is expected to be in operation. At least three different temporary solutions are possible that are intended to be in operation for different time spans:

Table 6: Restoration of Power

Restoration of Power	Time in Operation	Description
Preliminary	1 to a few days	Rapid restoration solution to put the line in operation in extreme cases
Temporary, short-term	1 month	E.g. in-line or by-pass constructed to put line in operation as quickly as possible. Final restoration work starts immediately
Temporary, long-term	1 year	E.g. in-line or by-pass constructed to put line in operation as quickly as possible. Final restoration is made when site conditions improve.
Permanent	50 years	Permanent Solution

Depending on a number of factors such as the method of failure, location of the failure, the extent of failure, ground conditions, and accessibility, five alternatives are to be considered:

- Rapid restoration of power,
- Supporting the failed structure(s) or restoring the failed structure(s),
- Constructing a temporary by-pass,
- Constructing temporary structure in existing RoW Centerline, and
- Constructing the final structure.

The engineering toolkit of solutions, as mentioned in *Section 8*, is in development and the associated work methods and procedures prepared and available. Work methods are documents provided to contractors to perform the work, whereas work procedures are internal detailed procedures for each.

It is essential that the solutions mentioned above are developed, documented, and tested. The necessary training must be conducted on the systems. The design documentation must be available for all of the systems during emergencies for reference purposes. It is important to note that the most appropriate solutions for restoration may differ depending on the location of the fault and site condition.

10.3 FOREST FIRE DAMAGE & MITIGATION/AWARENESS

In addition to vegetation management, to prevent fires on along the HVdc line, the following preventative measures will be followed:

- Reduction of activities along the line that can start fires during fire season, (based on the forest fire index),
- Perform an engineering analysis on the structural risk based on system design and typical forest fires in the regions of the line (future project),
- Initiate discussions with Forestry on the impact/urgency of a fire near transmission lines in remote areas, and
- Line crews to carry "spray backpacks" during fire season for small fire fighting.

Monitoring activities will include:

- Reviewing of the provincial fire tracker website,
- Participation on an e-mail list for active fires,
- Lightning monitoring (potentially with NLSO), and
- Any visual observations from the people working on the line, (reported back to the control room or supervisor on-call).

Emergency response activities for active fires include:

- Reporting the fire to the provincial forest fire line,
- Reduce system voltage and power transfer when the fire is very close to the RoW,
- Inspect the system after the fire is over and engage in standard restoration activities, and
- Assess structures for heat stress that could cause structural integrity issues.

10.4 THIRD PARTY CONTRACTOR AGREEMENT

Nalcor Energy currently has a contract in place from an operational perspective with a third party transmission line contractor. Further to this Nalcor is currently in the process of issuing a Request for Proposal for the services of a 3rd party emergency response contractor. The contractor would be called upon in the event of an incident to assist Nalcor Energy (Company) personnel with the initial response. The scope of work for the third party contractor is as follows;

The Work will consist of providing support, as required, to perform restoration activities in response to a Transmission Line incident that has caused a loss of power. The work performed will be per previously approved Safe Work Activity Plans (SWAPs). The desired response time to mobilize to the affected site(s) to address all issues covered in this Scope of Work is within 24-hours.

The Contractor must guarantee the availability of the correct and appropriate resources, including adequately trained workers, proper tools, and proper equipment as per the applicable standards and SWAPs.

Due to the nature of emergency response work, the Contractor shall be prepared to respond to a call-out during all seasons and in all types of weather conditions. Nalcor Energy will endeavour to maintain access as is practical; however, there may be times when the access has been compromised due to the similar conditions that would necessitate an emergency call out. These conditions could be downed trees, washouts, snow, ice, etc. The Contractor shall, therefore, be prepared, either through its own resources or through a 3rd party subcontractor, to perform necessary civil and/or snow-clearing work to reach the incident zone.

In the event of an incident, upon notification from Company, Contractor will immediately and safely begin to clear the area of any debris in preparation for the emergency restoration of power. The restoration work could cover a varied range of activities, including anything from an insulator replacement, to wood pole by-pass construction including back-staying and stringing, to a full restoration of the transmission line including the towers, foundations, guy wires and stringing.

The Contractor must work collaboratively with the Company's personnel, other contractors, and human resources that may be provided by neighbouring utilities.

10.5 MUTUAL ASSISTANCE AGREEMENTS

Nalcor Energy has operational agreements with Newfoundland and Labrador Hydro. In the event of an emergency those agreements would be leveraged where possible to provide assistance in restoring power. Concurrently, Power Supply is also investigating opportunities for mutual assistance agreements with other utilities within the province and in neighbouring provinces to supplement the services provided by the third party contractor as mentioned in *Section 10.4*. Neighbouring utility (Newfoundland Power, Nova Scotia Power, New Brunswick Power, Hydro Quebec, etc.) and contractor assistance will be essential during an emergency situation. Nalcor will continue to initiate discussions in 2020 with these various entities to discuss the technical details and physical characteristic of the LITL.

10.6 MOCK EXERCISES 2018

In the support of implementing the recommendations from the EFLA ERP, Nalcor Operations have successfully executed four exercises cumulating in the construction of a wood pole bypass near Salmonier Line in Newfoundland. Each exercise progressively added further capability to Operations, enhanced processes, refined design, and provided training opportunities for personnel. These exercises establish the foundation upon which Operations will continue to develop. The four exercises were:

1. Desktop,
2. Constructability,
3. First Assessment, and
4. In-field bypass construction.

The full report can be viewed in *Appendix B: 2018 Exercises Assessment.*

The first exercise was desktop-based. An outage scenario was played out and the Soldiers Pond (SOP) Emergency Operations Center (EOC) mobilized to go through the motions on how to address and ultimately restore the line. Many observations were made and lessons learned by bringing new groups of people together to solve the problem collaboratively. From the desktop exercise, two further exercises evolved. One was developed to deploy a First Assessment Team to the field to test the gathering and relaying of data back from the incident site to engineering in real-time so that a solution could be fashioned. The other exercise was developed to test the design and construct of the wood pole by-pass in a controlled location to validate constructability and test fitting of hardware. Both these endeavors revealed insights and adjustments to be incorporated into ERP efforts moving forward.

The final exercise for 2018 was the full construction of a bypass adjacent to the HVdc transmission line. This multi-day effort deployed labor, materials, and equipment into the field and was coordinated through the SOP EOC and with support from the Corporate Emergency Response Plan (CERP). It brought together everything learned thus far and ultimately provided a timing benchmark to estimate future restorations. Due to some constraints, the scope was limited to a half bypass construction (1 angled, 1 tangent, and 2 dead-end structures with stringing), which took three days to complete. It is important to note that these activities were completed under ideal conditions (excellent access and weather, materials available nearby, and timely mobilization of powerline contractor). Therefore a best-case scenario for a full bypass under similar conditions could be extrapolated to 10-12 days to execute from start to finish, which includes estimates for cutting conductor, backstay, and flying taps which have not been performed yet.

10.6.1 EXERCISE #1 – DESKTOP

This exercise was designed to:

- Test response procedures (e.g., who to call, what information to share, etc.),
- Ensure all partners, vendors, and contractors are reachable,
- Ability to retrieve asset and GIS data promptly,
- Reach key team members (e.g., engineering),
- Measure response times,
- Review solutions in the toolkit to assess suitability to a scenario, and
- Validate materials are locatable and available.

Key learnings from this exercise include:

- CERP overview required for the operations team. Also clarification on what and how they support the Operations Team in the event of an incident,
- Organizational chart for SOP EOC needed including clearly identified roles and responsibilities,
- Current and widely available contact list of key personnel,
- Checklists needed for key groups (e.g., engineering, First Assessment Team, etc.),

- Communications gear needed for lines crew (satellite phones, smart mobile devices, GPS with current maps, etc.),
- Need a survey resource at the site,
- SOP EOC positions need binders and checklist packages readily available to them,
- An updated model for the transmission line is required for engineering,
- Inventory of materials at the site needs to be performed,
- Note takers needed at both SOP EOC and at the site,
- Early heads-up call needed to be placed to support partners (powerline contractors, materials/transportation, etc.),
- Nomination and identification of on-site construction coordinator,
- Washroom and medical services need arranging,
- Location and accessibility of key technical data (drawings, maps, relevant layers, etc.), and
- Hard copies of the line route are needed.

10.6.2 EXERCISE #2 – CONSTRUCTABILITY EXERCISE

This exercise was designed to check that all the hardware fits and that all work methods and procedures perform as expected. It was also a chance to determine that the materials, tools, and equipment are correct for the construction. One of each of the three types of wood pole structures were to be framed, erected, and dressed, complete with foundations and guy wires.

Key learnings from this exercise include:

- Additional equipment (e.g., boom truck) would have sped up construction,
- A dedicated Health, Safety, and Environment (HSE) resource at the site would have been preferred,
- The design of structures was available as sketches. Detailed CAD drawings are required and should have been made available to the contractor well in advance,
- Nalcor Operations team and contractor crew worked very well together,
- There should be an overall construction coordinator or supervisor identified to all persons at the site, and
- Jumper assembly clearance issues noted against guy wires. Some design adjustments required.

10.6.3 EXERCISE #3 – FIRST ASSESSMENT TEAM EXERCISE

This exercise was designed to test the effectiveness of a First Assessment Team. An incident was declared at a location, and the team, consisting of Nalcor Energy operations and engineering, was deployed to that site. The following are examined in this exercise:

- Notification from Emergency Control Centre (ECC) (or others) of an incident,
- Mobilize SOP EOC to dispatch the First Assessment Team to an actual predetermined site along the transmission line,

- Obtain real-time key data from the site by the team. This would include information such as assessment of damage, photos (structure/structural elements, environment, terrain, foundations, etc.), elevation, site conditions, weather, accessibility, etc.,
- Ability to receive and use data from the field to input Engineering to determine the optimal solution(s) for restoration. This step also checks communications between teams,
- Perform post-exercise debrief to identify lessons learned and adapt procedures as required, and
- Timing for Engineering to build out a solution, see *Appendix C: Before & After Engineering Checklist* that was created to aid in this step.

Key Learnings from this exercise include:

- Contact list and phone numbers of all relevant parties to be made available before the team leaves the office,
- The field crew did not have suitable smart mobile devices that could send/receive e-mails and attachments but were instead reliant on engineering team members,
- Reliance on only one engineer at the office who could perform the design work in real-time – bottleneck and single point of failure,
- The use of an on-site surveyor would have avoided a redesign due to clarity of site conditions (e.g., bog) and save time,
- The location had good cellular coverage – the best-case scenario. Resolution time would have been vastly worse if dependent on satellite communication, for example, and
- First Assessment Team and engineering team should spend time together reviewing the drawings and familiarizing themselves with the intent of the work.

10.6.4 EXERCISE #4 – IN FIELD BY-PASS CONSTRUCTION

This was a full and integrated field exercise. It was designed to test the ability to mobilize all resources, including such as 3rd party contractors and internal staff, to construct a restoration solution on the RoW of the HVdc transmission line. It also included full coordination at the site level, SOP EOC, CERP, plus logistics. As this was not a real emergency incident, saving costs and minimizing health and safety risks were key factors in the planning. As a result, the following limitations and parameters were taken into account:

- No interruption of service (no cutting of conductor),
- Materials were sourced from the Argentia Marshalling Yard. They were prepackaged and scheduled to be delivered to the site at the same time that the contractor arrived,
- Transportation contract was not in place, so this was handled separately,
- Not using a fault location system – incident location independently determined,
- No removal of debris or salvage of materials at the site,
- The fault site was chosen to be close enough to SOP to minimize costs (no overnight or hotels, minimize driving time, etc.),
- Safety hazards minimized by choosing a location away from any crossings (road, water, other lines/utilities),

- Engineering design was predetermined to minimize the costs of contractor idle or on standby. There was no further need to measure the time for engineering to produce a solution,
- Only a half bypass was constructed. The exercise was to gather benchmark timing data. It can easily extrapolate timing for another half without unnecessary extra costs, and
- Work was limited to daylight hours to minimize fatigue and exposure risks.

As a fully coordinated effort, the following was deployed in this exercise:

- Powerline contractor,
- Establish lay down area,
- Security,
- Health and Safety advisor,
- Port-a-potty,
- Coordination with SOP EOC, ECC, and full CERP team, and
- Mobile command shelter.

With these parameters, the objectives remained to:

- Understand timing to build a bypass and deploy resources effectively,
- Identify chronic gaps in processes, communications,
- Coordinate with multiple groups,
- Ensure effective and timely communications across the organization and with the team,
- Constructability and work methods feedback,
- Identify working constraints and resolve real-time issues, and
- Build out an action plan of improvements to make for subsequent exercises.

It was originally envisioned to build a full by-pass, but decisions were made to reduce complexity, unnecessary costs, exercise duration, and minimize material usage (as the intent was to reuse as much as possible and return to spares in case of a real emergency). A half by-pass allowed exercising everything as much as possible, and the data could be easily extrapolated to determine how long a full bypass would take.

Key Learnings from this exercise include:

- Engineering checklist clarifications required. Also, a printed copy should be available to all,
- Current LiDAR data not available to engineering (no RoW or access road details); inaccuracies and rework in design as a result,
- Contact list of all pertinent personnel should be available to all from the beginning,
- Having surveyor on-site from the beginning was invaluable –it was prearranged in this case, Needs to be available either through Nalcor Operations, NL Hydro or contractor,
- Initial design for proposed construction was inside Protected Public Water Supply Area. This is not allowed without lengthy approval process for a permit,

- The initial design proposed construction was outside of RoW and necessitated guy anchors in crown land. This is not allowed without a lengthy approval process and wood cutting permits,
- Single Point of Contact (SPOC) needed in Engineering to relay engineering updates in field,
- Checklist needed for the surveyor. The surveyor must have the capability to measure cable heights and attachment points,
- Confusion in use of temporary construction structure numbers and permanent structure numbers,
- Unclear on protocol at the site for visitors, location of tailboards, and command structure (who is in charge),
- Misunderstanding on work protection and site orientations; who has it already and who needs it,
- Dealing with environment and lands constraints was an excellent opportunity to perform real-time engineering redesign and adjustments, and
- No weather or access impediments.

After completion of the 2018 Emergency Response Preparedness exercises a list of actions was collaboratively developed to address the "Key Learnings" from the four exercises. The actions have been addressed, except for a handful that will require some external resources such as a new third party contractor, and more mutual assistance agreements, all of which are being addressed.

10.7 MOCK EXERCISES 2019

To further prepare the employees and to support the Emergency Response plan, four exercises have been planned and/or executed for the 2019 calendar year.

10.7.1 TOWER ASSEMBLIES

Two tower assembly exercises have been planned, one each for the Island and Labrador line crews. Although it is not anticipated that Nalcor Energy Operations would be directly responsible to provide labour in the event of an actual tower assembly, the purpose of these exercises is to provide comfort and familiarity of tower assembly to Nalcor employees that would be directly involved in the work should an emergency situation require it. The expected outcomes of these exercises include the following:

- Person hours required,
- Tools and equipment required,
- External factors affecting construction, and
- Lessons Learned.

Tower Assembly – Labrador

The Labrador Tower Assembly exercise was completed in November 2019 at the Lower Churchill Project (LCP) marshalling yard adjacent to the Trans-Labrador Highway. The chosen tower was an A2+0 as this particular tower type is fairly common in Labrador.

This exercise was completed in two phases, the initial phase included:

- Utilizing resources from the Operations Materials and Warehousing Department to confirm the location of materials and ensure all required quantities were on site,
- Operations Support Engineering provided a complete drawing set for the crew completing the assembly, and
- Operations ensured the equipment and other miscellaneous materials required to assist the team in the assembly were acquired and on-site.

Phase two of the exercise included all activities required to assemble the A2+0 tower on the ground in the marshalling yard.

Tower Assembly – Island

The Island Tower Assembly Exercise commenced in November 2019 and took place at Soldiers Pond. The chosen tower with be an A1+0 and the same plan and procedure will be followed as for the Labrador exercise, with the addition of land transport of materials from Argentia to Soldiers Pond.

10.7.2 TABLETOP EXERCISE

This exercise did not involve any deployment of labour or equipment. At minimum it was designed to:

- Test response procedures (e.g. who to call, what information to share, etc.)
- Ensure all partners, vendors and contractors contact information is accurate and available.
- Ability to retrieve asset and GIS data in a timely manner.
- Reach key team members (e.g. engineering).
- Review solutions in toolkit to assess suitability to scenario.

The exercise was performed in a conference room at the Soldiers pond administration building on October 17, 2019. Representatives of the anticipated response team were invited to run through the devised scenario.

The mock scenario was for a fault to occur between structures 595 and 601 on the Labrador section of the HVdc line. The specific simulated event was a failure at structure 597 in which the insulator string for pole two had broken and fallen to the ground from what appeared to be excessive weight due to ice accumulation on the conductor. The damage was severe enough to cause a power outage that alerted the ECC. The ECC duly contacted Nalcor Operations on-call for resolution.

Key Learnings from this exercise include:

- Organization chart for SOP EOC needed with clearly identified roles and responsibilities.
- Current and widely available contact list of key personnel needs to be updated.
- Checklists for key groups (e.g. engineering, First Assessment Team, etc.) need to be added to the first responders kit.

- Remote access needed for lines crew (in addition to obtained satellite phones, smart mobile devices, GPS with current maps, etc.)
- In the event of an actual failure a survey resource will also be required as part of the first response team.
- SOP EOC binders need checklist packages readily available for transmission emergency response.
- Once all agreements are finalized, contacts for support partners to be included in procedural documents (powerline contractors, materials/transportation, etc.).
- Location and accessibility of applicable technical data (drawings, maps, relevant layers, etc.) to be provided in first response.

The exercise brought together different parts of the organization to work collaboratively on solving the problem, and test the success of actions that came from lessons learned from the 2018 desktop exercise. There was active and engaging discussion to further clarify the roles and responsibilities of the individual team members and departments on how to respond in the event of an emergency situation.

10.7.3 ENGINEERING FIRST RESPONSE EXERCISE

The engineering first response exercise is designed to test the communication limitations between home office, where the engineering will be completed, and a remote site location. A failure scenario has been planted along the Transmission Line; the exercise is expected to take place in November of 2019.

The Island line crew will be notified of a failure at a particular tower. Upon notification, the crew is expected to immediately head to the failure location and report back and accurately describe the site conditions to the engineering team. If possible, the design engineer will initiate a design solution for temporary restoration of power and once completed the solution, including a visual representation, will be forwarded to the on-site team. The on-site team will need to verify the constructability of the design and report back to the engineering team of any issues. This process will be iterative until a solution can be agreed upon by all parties.

The performance indicators of this exercise include:

1- Time for response - This would be the time it takes to receive the call, identify the issue on the ground, and relay the information back to engineering. This performance indicator is complete when engineering has enough info to begin planning an engineered solution,
2- Engineered solution(s) complete - This performance indicator is complete when Engineering can provide a visual product to the on-site response team. (pdfs/printed drawings/i-pad images, etc.),
3- Field verification of solution - This performance indicator is complete when the on-site team can verify the constructability of the proposed solution (Ideally this step requires a surveyor), and
4- Repeat steps 2 and 3 as necessary.

11 FUTURE RECOMMENDATIONS FOR ENGINEERING & OPERATIONS

Preparation and planning for emergency preparedness will be on-going throughout the lifetime of the HVdc Transmission line. All items discussed previously in this plan will be continuously updated and expanded upon as detailed in the following sub-sections. On-going investigations into further engineering solutions including further discussion with other utilities with a focus on their lessons learned and practices will also be on-going and updated in this document annually. The below highlights the general plan forward for the next several calendar years and aligns with the Nalcor capital and operational plan.

11.1 MOCK EXERCISES 2020- 2021

In 2020, Nalcor will continue its efforts to give employees exposure to the processes and procedures involved in an emergency response situation. Some items that are being considered for future preparedness exercises include the following:

- Mock tower failure and subsequent construction of a temporary wood pole structure utilizing the backstay solution,
  - Planned for quarter two of 2020. To practice the use and requirement for a temporary backstay installation while using a wood pole solution.
- Engineering and first response exercise in Labrador,
  - To test communication protocols, failure scenarios, logistics, and engineering response. Planned for the third quarter of 2020
- Further tower assembly exercises,
  - Using a different tower type and using modified tower/ swivel base adapter to install tower/ tower sections. Planned for third quarter of 2020
  - Full tower mock installation planned for quarter two of 2021
  - Identify and acquire land area for yearly exercises in both Labrador and Newfoundland.
- Practice and Mock Exercises utilizing procured engineering solutions such as the Beam Gantry, Modified Tower and ERS,
  - Planned for quarter three of 2020, to review equipment, discuss with line crew the use and details of each solution.
- Further tabletop exercises.
  - Planned for the first quarter of 2020 to practice a wintertime scenario, focusing on activating and integrating with the CERP team.
- Transmission Line specific failure response workshop.
  - Session to be lead by third party transmission line construction/operations resource.
  - Session to run through logistical considerations and construction approach in the event of a catastrophic failure.
  - Workshop expected to provide key detailed engineering and operational actions based on how a large scale failure would be tackled.
  - Planned for the second quarter of 2020

11.2 HELICOPTER WORK

Numerous recommendations from EFLA involved helicopter assistance for emergency response and preparedness. Nalcor Energy is committed to further investigating the options for helicopter assistance where practical, such as crew transport, utilizing medium and heavy-lift helicopters for the purpose of temporary restoration solutions, and potential de-icing applications. Further investigation on the availability of helicopters in neighbouring provinces is planned within 2020.

11.3 FUTURE ENGINEERING ANALYSIS, REAL-TIME MONITORING & WEATHER PREDICTION MODELS

As mention above, further detailed engineering will aid in refining both the failure scenarios and operational readiness for LITL. The following engineering objectives are planned for 2020:

- An engineering analysis of failure scenarios per region to identify the estimated number of towers that are likely to fail sequentially, this can then be utilized to refine operational response time and the meantime to repair (to commence in quarter one of 2020).
- An engineering and operational review of LITL focusing on ground characteristics, logistics in order to identify the most probable method of failure and ranking of the best restoration alternatives for each region (planned for quarter two 2020 and updated annually).
- Continuous evaluation of the spare quantity requirements for all temporary and permanent restoration material.
- As-built LiDAR and ortho-photography for LITL (see *Section 7.2*, planned for quarter three of 2020).
- Upgrade and expand Nalcor's Alpine region meteorological Test Spans (see *Section 7.2*). Planned retrofit of existing test span in 2020 and identification of new test span locations with construction planned for one site in late 2020.

The causes of a transmission line failure would likely be a result of an extreme weather event, for this reason, Nalcor Energy is investigating and eventually implementing a real-time monitoring and weather prediction model for the transmission line. The expected outcomes of these tools are:

- Increased awareness of impending weather events from location(s) of event and time of year perspectives,
- Information that can be integrated with asset management philosophies to identify areas that are subjected to abnormal weathering to improve and optimize preventative maintenance cycles, and
- Information that can be used for verifying the various load cases leading to improved engineering design decisions.

11.4 PROCUREMENT OF ENGINEERING TOOLKIT SOLUTIONS

As previously discussed in *Section 8*, the toolkit of engineering solutions and the plan for procurement includes the following:

- Composite Insulators package for wood pole by-pass solution (Supply awarded in 2019) with delivery in quarter two of 2020,
- Steel Lattice Emergency Restoration Structure, engineering and procurement contract to be award by the first quarter of 2020 with expected engineering and delivery through 2020.
- Existing tower modification steel and components to be procured in quarter two of 2020,
- Swivel Base Adapter strategic quantities to be finalized and procured by quarter three of 2020, and
- Beam Gantry, engineering will be complete in 2019. Further analysis required surrounding the decision to purchase.

12 References

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Appendix A: Next Steps Registry

ERP Next Steps - Implementation Schedule

ACTIVITY GROUP	ACTIVITY	DESCRIPTION	PRIORITY	ACCOUNTABLE GROUP	TIMELINE	COMMENTS
ERP EXECUTION AND FINANCIAL CONTROL	**SMS system**	Bulk SMS system with restoration team members contact details preprogramed.	H	EMERGENCY RESPONSE COORDINATOR (TTO)	6 months	Already exists within NALCOR, to be documented specifically for LITL.
ERP EXECUTION AND FINANCIAL CONTROL	**Command Centre**	Create a Incident command centre in St.Johns as recommended in ERP document. Special room, comms, computers, furniture, RTM links, hardcopies of as built documentation (Coporate response Procedure - tie-ing in).	H	EMERGENCY RESPONSE COORDINATOR (TTO)	3 months	Already exists within NALCOR, to be confirmed if speparate ICC at Soldiers Pond or use Hydro Place.
ERP EXECUTION AND FINANCIAL CONTROL	**Mobile Application**	Evaluate and approve a mobile application that can be used for sharing information such as Whattsapp.	L	EMERGENCY RESPONSE COORDINATOR (TTO)	6 months	
ERP EXECUTION AND FINANCIAL CONTROL	**Report Templates**	Create templates for reports to support the ERP. Site, Management & Incident report templates.	Complete	FINANCE		
ERP EXECUTION AND FINANCIAL CONTROL	**Financial Approvals**	Establish levels of financial authorisations for restoration team during emergency situations. A different level of finance approval should be provided for each incident level.	Complete	FINANCE	12 months	
ERP EXECUTION AND FINANCIAL CONTROL	**Financial Approval process**	Create and document the process to be followed for financial approvals of expenditure during emergencies. This is only required if it is expected that the process will differ from normally accepted processes.	Complete	FINANCE	12 months	
ERP EXECUTION AND FINANCIAL CONTROL	**Restoration Time & Cost Estimation Model**	Establish a program to assist in estimating costs and time for the restoration effort. Useful to give management an expected cost and expected restoration times after the initial site inspection and decision on the work required for restoration.	H	ASSET MANAGEMENT	6 Months	Initially have a basic model and evolve over time.
DATA AND INFORMATION	**ALS survey of line**	Aerial laser survey of the line with video and photos. Survey to be calibrated. Photos to be stored according to tower number or geo-referenced position, may require processing. Images of the access roads to be captured as well during the survey.	Not Required	ENGINEERING		
DATA AND INFORMATION	**GPS data**	GPS data of the line, indicating towers, rivers, access roads, bogs. Create from ALS survey and existing information.	Complete	ENGINEERING	1 year	
DATA AND INFORMATION	**GIS data**	Gather as built information for the line, store digitally on GIS system. Capture information on bridges, access roads, rivers etc.	Complete	ENGINEERING	1 year	
DATA AND INFORMATION	**Landownwers**	Ensure the landowner database is kept current, establish procedures to ensure the database is regularly maintained.	Complete	ENGINEERING	1 year	Information exists, documentation to be handed over from the project to operations
DATA AND INFORMATION	**RTM monitoring systems**	Link RTM systems to the control centre with set alarms. Systems deployed in Labrador, Long range mountains and Avalon Peninsula. Identify the spots, design, construction and testing of the system is required; RTM systems required for pollution measurements and monitoring of weather. System must be calibrated to trigger emergency situations. Research the potential use of leakage current monitors for insulators as well as on line measurements of conductor tensions etc. to provide information on various aspects of the line.	L	ENGINEERING	6 months	Work must commence imediately. Detail scope of work, project proposal. Basic monitoring system by next winter.
DATA AND INFORMATION	**Weather Monitoring Stations**	Establishment of sufficient weather monitoring stations at critical areas on the line. Required for input to weather modelling software.	L	ENGINEERING	9 months	Work must commence imediately. Detail scope of work, project proposal. Basic monitoring system by next winter.

ACTIVITY GROUP	ACTIVITY	DESCRIPTION	PRIORITY	ACCOUNTABLE GROUP	TIMELINE	COMMENTS
DATA AND INFORMATION	**Weather Prediction Model**	Development and implementation a weather prediction model for the area. Will assist with planning restoration work and notification of impending failures - used to create alert status together with RTM system.	L	ENGINEERING	6 months	Get experience with the RTM system first
DATA AND INFORMATION	**As built documentation**	Rearrange filing of documentation to support easy extraction of information. Hardcopy and electronic information required.	Complete	ENGINEERING	1 year	Information exists, documentation to be handed over from the project to operations
DATA AND INFORMATION	**Transport route data**	Identify all line crossings and bridges along the routes used to access the powerline and create a list with the position and height restrictions. This will assist in knowing which areas may require lines to be lifted.	H	ENGINEERING	1 year	Information exists, documentation to be handed over from the project to operations
EQUIPMENT AND TOOLS	**Satellite phones and modems**	Purchase satellite phones and satelite modems. For use by first responders as well as construction teams. Training on the use of the units, periodic testing.	H	EMERGENCY RESPONSE COORDINATOR (TTO)	3 months	Purchase within Ops for maintenance. Determine additional for ERR?
EQUIPMENT AND TOOLS	**RF network for Labrador**	Establish a RF network along the line route in Labrador for enhanced communication between teams. Assistance during emergencies as well as normal maintenance. Second form of communication on Labrador. Currently only Satellite is possible.	Not Required	EMERGENCY RESPONSE COORDINATOR (TTO)		
EQUIPMENT AND TOOLS	**Two way radios**	Purchase and install in construction vehicles as well as purchase portable units.	H	EMERGENCY RESPONSE COORDINATOR (TTO)	3 months	Purchase within Ops for maintenance. Determine additional for ERR?
EQUIPMENT AND TOOLS	**Communication centre - portable office**	Temporary Field Office Useful for large failures, this could be rented when required.	M	EMERGENCY RESPONSE COORDINATOR (TTO)	1 year	short term solution will be developed for next winter. Permanent solution to be purchased
EQUIPMENT AND TOOLS	**First Responder equipment**	Purchase tools and safety equipment for first responders as per list provided in ERP document. Equipment to be available at maintenance crew locations.	H	WORK EXECUTION	3 months	
EQUIPMENT AND TOOLS	**Swivel base adapter**	Design, manufacture and test swivel base adapter for existing suspension tower foundations. Used to install new tower with minimal equipment.	M	ENGINEERING	2 years	Helicopter construction to be utilised
EQUIPMENT AND TOOLS	**Beam/gantry support**	Design, manufacture and test beam/gantry support for rapid restoration efforts.	H	ENGINEERING	1 year	
EQUIPMENT AND TOOLS	**Small Tools & Equipment**	Purchase tools required to satisfy incident level 0-3 restoration requirements. Rigging equipment, Derricks, Aluminium Ladders, Pole grabber attachment, Auger attachment, Drill for rock anchors, Arm to drive screw piles, portable generators etc as per ERS and EPR documents. Equipment will be needed for at least 4 storage locations, depending on the equipment and its ease of transport.	H	WORK EXECUTION	6 months	Determine equipment required outside o f regular Operations.
EQUIPMENT AND TOOLS	**Excavator**	Secure the use of a miniature excavator (purchase or rent) that can be airlifted into position. Must be easily available and reliable if rented.	H	WORK EXECUTION	6 months	Intially to research on size, capabilities and requirements
EQUIPMENT AND TOOLS	**Puller and Tensioner**	Puller and tensioner that can be airlifted into position suitable for stringing the bypass conductor. Secure the use of this machine or purchase for NALCOR.	Not Required	WORK EXECUTION		
MATERIALS AND STORAGE	**Storage Locations**	Design and construct storage yards (5 off), 3 Labrador and 2 on the Island. Decommission existing yards not used in new plan. Move Materials to new yards, after optimisation. Purchase the necessary rigging and loading equipment for storage areas.	H	ASSET MANAGEMENT	2-3 years	Wendy March handling items for short term.
MATERIALS AND STORAGE	**Material Modules**	Sort material into suggested modules. Easy dispatch to site, faster installation time - ensures all materials are available on site for a module. Materials to be stored according to areas they are required.	H	ASSET MANAGEMENT	2-3 years	
MATERIALS AND STORAGE	**Packaging for materials**	Design packaging for easy lifting and carrying, suitable for helicopter transport and use with a forklift for quick and easy loading.	H	ASSET MANAGEMENT	2-3 years	

ACTIVITY GROUP	ACTIVITY	DESCRIPTION	PRIORITY	ACCOUNTABLE GROUP	TIMELINE	COMMENTS
MATERIALS AND STORAGE	**Material Mangement system**	Update materials management system with material location.	L	ASSET MANAGEMENT	9 months	Information to be transferred from the project to operations
MATERIALS AND STORAGE	**Readymade ERS**	Purchase readymade restoration structures. Required for 5 locations, possibly 4 complete crossrope structures for each set. Create specification, evaluate suppliers products, purchase units.	M	ENGINEERING	2 years	
MATERIALS AND STORAGE	**Purpose built ERS**	Design and test purpose build restoration structures (stackable lattice towers). Help speed up the final restoration and higher reliability of the repair solution, less space, lighter to use, faster to assemble. Purchase units for the 5 storage locations.	M	ENGINEERING	1 year	Look at modifications to existing tower.
MATERIALS AND STORAGE	**Woodpole ERS**	Design a wood pole structure that can be deployed quickly, produce drawings and limits for the towers. Purchase Materials for the structure and preassemble sections, store at the storage locations identified.	H	ENGINEERING	6 months	
MATERIALS AND STORAGE	**Anchors and Foundations**	(For wood poles for now)Purchase various anchors suitable for all conditions. Screw and rock anchors, concrete sledges etc as per ERS document. Design and test anchors and foundations, produce the required drawings with the limits for each foundation type. Rock anchors, sledge for concrete blocks, selection of appropriate helical anchors, test operation.	H	ENGINEERING	6 months - 2 years	varied with the ERS solution development
MATERIALS AND STORAGE	**Special line materials**	(For this years design) Purchase additional materials required for line restoration. (special materials for fast restoration). Materials include: Varigrip dead ends, preformed splices and repair sleeves, Wedge clamp dead ends, Bolted clamps for T-offs, Composite insulators for straining off the conductors, Compression dead-ends and midspan joints, ADSS conductor, ACSR emergency bypass conductor, glass disk insulators, vibration dampers.	H	ENGINEERING	6 months	Sizing of equipment to be completed and purchase equipment and materials
MATERIALS AND STORAGE	**Additional Materials**	Map suppliers of additional materials. Required for level 5 incidents should the available materials not be sufficent.	M	ENGINEERING	2 years	
MATERIALS AND STORAGE	**Guyed Tension tower**	Develop a guyed tension tower for fast restoration.	M	ENGINEERING		
TRANSPORTATION	**Vehicle Fleet**	Purchase vehicles required to access the line. Create specification for the vehicles, tender and evaluation of suppliers and products. **Beyond existing routine maintenance material.**	H	WORK EXECUTION	6 months - 1 year	GAP analysis, create specifications, tender & procurement process
TRANSPORTATION	**Helicopter Modifications**	Investigate the possibility to equip Nalcor helicopters at Churchill Falls with instrumentation to fly at night. Install equip if possible. Look at this option for Gander helicopter as well.	H	WORK EXECUTION	6 months	Used for first response and people mover at night. Night construction work to be developed in the future
TRANSPORTATION	**Helicopter Mods. - Service providers**	Initiate modifications to helicopters of service providers to enable them to fly at night.	M	WORK EXECUTION	1 year	
TRANSPORTATION	**Refuelling station modifications**	Refuelling stations to be fitted with emergency lighting and other equipment to enable night refueling, else other alternatives must be developed such as fuel trucks transporting fuel to required locations. **Establish cache of fuel.**	M	WORK EXECUTION	1 year	
TRANSPORTATION	**Vehicle maintenance programs**	Establish maintenance programs for vehicle and equipment fleet.	Not Required	WORK EXECUTION	1 year	
TRAINING AND DEVELOPMENT	**Training program (ERP)**	Develop a comprehensive training program as per the training requirements document. Training on ERP to be included as well as activities for line workers. Include costs for training.	H	WORK EXECUTION	6 months - 1 year	Stagged process, plan now for next winter

ACTIVITY GROUP	ACTIVITY	DESCRIPTION	PRIORITY	ACCOUNTABLE GROUP	TIMELINE	COMMENTS
TRAINING AND DEVELOPMENT	**Training program (Line Workers)**	Develop a comprehensive training program as per the training requirements in the crew complement and training document. Include costs for training. Training of line workers must include the use of the special materials and equipmen, tTraining on ERP as well as line construction activities.	H	WORK EXECUTION	3 years	Project initiated
TRAINING AND DEVELOPMENT	**Contractor Training**	Create a list of mandatory line construction related courses that the contractors are required to participate in. Courses can be provided by independant training facilities.	Not Required	WORK EXECUTION	2-3 years	
TRAINING AND DEVELOPMENT	**Event assessment**	Develop training program on failure assessment and potential repairs. Include costs for training. DUPLICATION.	Not Required	WORK EXECUTION	6 months	
TRAINING AND DEVELOPMENT	**Staff Retention program**	Develop a comprehensive staff retention strategy, possibly based on the Bath Model. The importance of this activity will increase as the line workers become more skilled.	Not Required	WORK EXECUTION		
CONTRACTS AND AGREEMENTS	**Local Contractors**	Establish contracts with local contractors for maintenance and restoration assistance. Perform indepth evaluation of each of the local contractors capabilities and equipment. Evaluation should be periodic - 2 yearly.	H	WORK EXECUTION	6 months	Equipment plus people
CONTRACTS AND AGREEMENTS	**Medical Services**	Medical Services to be deployed at site to assist with injuries and stabilisation of injured persons before transportation to medical services.	H	EMERGENCY RESPONSE COORDINATOR (TTO)	6 months	
CONTRACTS AND AGREEMENTS	**Large contractors**	Establish contracts with large contractors for restoration assistance during incident level 4 and 5. Contractors to provide people, equipment and tools required for restoration assistance. Perform indepth evaluation of the large contractors capabilities and equipment. Response time to be agreed on.	H	WORK EXECUTION	6 months - 1 year	First phase is to establish list of contractors
CONTRACTS AND AGREEMENTS	**Mutual Assistance agreements**	Establish mutual assistance agreements with neighbouring utilities.	H	WORK EXECUTION	3 months	
CONTRACTS AND AGREEMENTS	**Aircrane services (Heavy lift Helicopters)**	Establish contract rates and deployment times for heavy lift helicopter services (Erickson is an example).	L	WORK EXECUTION	6 months - 1 year	Look for permanent solution for 1-2 years
CONTRACTS AND AGREEMENTS	**Local Helicoper companies**	Establish service agreements with helicopter service providers. Helicopters to have lifting hooks available, fuel storages around the island and labrador. These are already available with most helicopter service providers in Newfoundland and Labrador.	H	WORK EXECUTION	6 months	
CONTRACTS AND AGREEMENTS	**Pilot Training**	Ensure suitable line construction training for pilots.	Not Required	WORK EXECUTION	6 months-2 years	Churchill falls pilots to be trained as soon as possible
CONTRACTS AND AGREEMENTS	**Fuel Supply**	Establish service agreements with fuel suppliers along the line route. Ensure minimum quantities kept throughout the line route. Large failures will require substantial quantities of fuel.	H	WORK EXECUTION	2 years	Future risk mitigation exercise
CONTRACTS AND AGREEMENTS	**Crane Companies**	Establish service agreements with **mobile** crane service providers. 4x4 cranes preferred.	H	WORK EXECUTION	6 months	
CONTRACTS AND AGREEMENTS	**Material bulk transport**	Service agreements for bulk material transportation (road and sea). Service agreements will assist in saving time during the outage.	H	WORK EXECUTION	6 months	
CONTRACTS AND AGREEMENTS	**Snow removal and road clearing**	Establish service agreements with potential service providers for the removal of snow and development of ice roads when required.	H	WORK EXECUTION	3 months	Ongoing. Will be place by next winter.
CONTRACTS AND AGREEMENTS	**Ice Roads**	Ice road creation.	M	WORK EXECUTION	1 year	

ACTIVITY GROUP	ACTIVITY	DESCRIPTION	PRIORITY	ACCOUNTABLE GROUP	TIMELINE	COMMENTS
CONTRACTS AND AGREEMENTS	**Equipment & Vehicle repairs / Fleet Management**	Service agreement for equipment and transportation repair services. This may be alleviated by the use of rental equipment instead of purchasing.	M	WORK EXECUTION	6 months	Create a list of who can assist and understand the associated response times
CONTRACTS AND AGREEMENTS	**Accomodation**	Service agreements for accomodation with hotels and guest houses along the line route. System relies on the availability of guest houses, hotels etc in the area. Service agreements will assist in saving time during the outage.	L	EMERGENCY RESPONSE COORDINATOR (TTO)		For Portable
CONTRACTS AND AGREEMENTS	**Portable offices**	Service agreement for the supply of portable office space with computers, internet and tables and chairs. Required for large scale failures, incident level 4 and 5 (Combined with other).	L	EMERGENCY RESPONSE COORDINATOR (TTO)	2 years	short term, assess who can assist with supply of portable offices
CONTRACTS AND AGREEMENTS	**Security Services**	Service agreement for security services at the laydown area. Could be required for larger failures to help prevent theft of materials.	Not Required	ASSET MANAGEMENT		
CONTRACTS AND AGREEMENTS	**Lighting, Generators and mobile comms**	Identify suppliers and prices for portable lighting, generators, mobile communication. Contracts may need to be established with service providers in similar area to the material storage locations if possible. Contracts will assist in saving time during the outage.	H	EMERGENCY RESPONSE COORDINATOR (TTO)	6 months	Create specs and purchase
CONTRACTOR MANAGEMENT & DEVELOPMENT	**Contractor development**	Establish a development program for contractors that will assist in restoration efforts. This could include involvement in training activities conducted as part of the emergency readiness training.	Not Required	WORK EXECUTION		
CONTRACTOR MANAGEMENT & DEVELOPMENT	**Work distribution**	Establish a method to distribute work evenly so as to ensure many contractors remain operative. Establish work load and the areas the work will occur. Create a system to distribute the work amongst contractors to ensure they survive in the industry.	Not Required	WORK EXECUTION	2 years	
PROCEDURES AND WORK INSTRUCTIONS	**Electrical Grounding Practices**	Develop a procedure for grounding practice of HVDC lines. This is particularly important to address any induction related issues from energised lines. Also important to establish safe grounding procedure for working in close proximity to energised lines, see live line work section below.	H	WORK EXECUTION	3 months	In progress
PROCEDURES AND WORK INSTRUCTIONS	**Night Work**	Determine the night actvities and their limits considering employee safety. Create procedures for each activity to be performed at night to enure employee safety.	H	WORK EXECUTION	2 years	
PROCEDURES AND WORK INSTRUCTIONS	**Site Extraction**	Establish procedure to deal with extraction from site should this be required due to poor weather. Procedure should detail what is detail how people are to be extracted, the line is to be stabilised and site secured. Staying on site.	H	WORK EXECUTION	6 months	Continuous improvement
PROCEDURES AND WORK INSTRUCTIONS	**Site Emergency**	Establish a procedure to deal with emergencies on site such as injury of a person.	H	EMERGENCY RESPONSE COORDINATOR (TTO)	6 months	Already exists within NALCOR, to be documented specifically for LITL.
PROCEDURES AND WORK INSTRUCTIONS	**Travelling**	Procedure for travel to and from site. Include information on what vehicles will be used and how personal will be secured etc.	H	WORK EXECUTION	6 months	Already exists within NALCOR, to be documented specifically for LITL.
PROCEDURES AND WORK INSTRUCTIONS	**Site Camp**	Develop and document a procedure for site camp establishment; Site layout, size, management, mapping of roles and responsibilities for the camp.	M	WORK EXECUTION	2 years	
PROCEDURES AND WORK INSTRUCTIONS	**Marshalling yards**	Procedure for creation of a marshalling yard, mapping of roles and responsibilities for creation and management of the yard.	M	ASSET MANAGEMENT	1 year	In progress
PROCEDURES AND WORK INSTRUCTIONS	**Stringing and tensioning**	Calculate the maximum stringing tensions to be used for the bypass and main line. Create a procedure documenting the process of stringing and tensioning the line with the maximum allowable values.	H	ENGINEERING	6 months	Slack stringing

ACTIVITY GROUP	ACTIVITY	DESCRIPTION	PRIORITY	ACCOUNTABLE GROUP	TIMELINE	COMMENTS
PROCEDURES AND WORK INSTRUCTIONS	**Inspection and Maintenance Program**	Establish and document a comprehensive program for monitoring key parameters and maintenance activities for the line.	H	ASSET MANAGEMENT	6 months - 1 year	
PROCEDURES AND WORK INSTRUCTIONS	**Preliminary Investigation and Stabilisation**	Procedure for investigation and assessment of the failure including stabilisation methods.	H	ENGINEERING	1 year	
PROCEDURES AND WORK INSTRUCTIONS	**Tower assembly**	ERS towers and normal structures.	M	WORK EXECUTION	2 years	
PROCEDURES AND WORK INSTRUCTIONS	**Tower Erection**	Using various equipment - derricks, cranes, helicopters. Each method to be described for ERS and normal towers (WOOD POLE ONLY).	H	WORK EXECUTION	6 months	Required to install main tower without specialised equipment e.g the swivel base and no cranes
PROCEDURES AND WORK INSTRUCTIONS	**Foundation Construction**	Procedure for installation or use of the different achors as mentioned in the ERS document. This activity is dependant on the site conditions.(WOOD POLE ONLY).	H	WORK EXECUTION	6 months	
PROCEDURES AND WORK INSTRUCTIONS	**Helicopter construction**	Procedures for changing crossarms, insulators and hardware. Limits for equipment and risk analysis for each activity.	H	WORK EXECUTION	2 years	
PROCEDURES AND WORK INSTRUCTIONS	**Helicopter construction - towers**	Construction of tower using helicopters.	L	WORK EXECUTION	6 months	
PROCEDURES AND WORK INSTRUCTIONS	**Material Transportation**	Helicopter and bulk road transport - safe loading and off -loading procedures.	M	WORK EXECUTION	6 month - 2 years	Initially for materials, later for heavy structures and construction
PROCEDURES AND WORK INSTRUCTIONS	**Insulator and Hardware replacement**	Procedures for changing insulators and hardware using minimal equipment and tools. This is different to the processes used in conjunction with helicopters.	H	WORK EXECUTION	6 months	Already exists within NALCOR to be performed without helicopter
PROCEDURES AND WORK INSTRUCTIONS	**Forest Fires**	Establish procedures to deal with Forest fires that may impact on line performance. This may include the development of an application or modification of existing applications to support the tracking of wild fires. Perform laboratory tests to establish the impact of the burning vegetation on the line and clearances available. This will help inform the decisions to be taken with respect to enhancing the line performance against forest fires.	H	EMERGENCY RESPONSE COORDINATOR (TTO)	1 year	
PROCEDURES AND WORK INSTRUCTIONS	**Vegetation Management**	Establish a procedure for vegetation management along the line route.	M	WORK EXECUTION	3 years	
PROCEDURES AND WORK INSTRUCTIONS	**Voltage Reduction**	Establish the procedures and limits for voltage reduction to help resolve temporary faults on the line or to assist with live line maintenance.	M	PROJECT DEL	3 years	
PROCEDURES AND WORK INSTRUCTIONS	**Common Failures**	Create work procedures for all common failures and the methods to deal with each failure.	M	WORK EXECUTION	6 months - 1 year	Write a play book for known or common failures.
PROCEDURES AND WORK INSTRUCTIONS	**De-icing procedures**	Establish procedures for effective removal of ice from powerlines. This could include the use of helicopters with suspended wooden poles to hit the conductors. It is essential to determine when to deploy the helicopter to the line and the key parameters to be maintained when de-icing the line with mechanical methods.	M	WORK EXECUTION	6 months	
PROCEDURES AND WORK INSTRUCTIONS	**Joule Heating**	Test the anti-icing feature for the line and establish the systems effectiveness and risks to the line. Produce guidelines to assist control centre in deployment of the system.	L	ENGINEERING	1-2 years	

ACTIVITY GROUP	ACTIVITY	DESCRIPTION	PRIORITY	ACCOUNTABLE GROUP	TIMELINE	COMMENTS
PROCEDURES AND WORK INSTRUCTIONS	**Road Inspection and Maintenance**	Establish a procedure for the inspection and maintenance of the road infrastructure.	Complete	WORK EXECUTION	1 year	
PROCEDURES AND WORK INSTRUCTIONS	**Bridges**	Complete the necessary compliance procedures to allow the bridges to remain. Insert chains as required to inhibit access.	H	WORK EXECUTION	6 months	Ongoing
LIVE LINE WORK	**Financial Assessment**	Assessment to establish if live work is to be done inhouse or subcontracted. Financial and risk assessment is required.	L	WORK EXECUTION	1 year	
LIVE LINE WORK	**Assessment of Techniques**	Assess the live line techniques to be used - helicopter or insulated boom bucket.	L	WORK EXECUTION	1 year	
LIVE LINE WORK	**Safe Working clearances**	Establishment and testing of safe working clearances for live line maintenance. Required if live line maintenance is pursued.	L	WORK EXECUTION	1 year	
LIVE LINE WORK	**EF & MF**	Assessment of electric and magnetic field exposure to workers during live line work.	Not Required	WORK EXECUTION	1 year	
LIVE LINE WORK	**Safe work procedures - Live**	Establishment of the live line working procedures. Procedures to be developed for activities identified for live line work.	L	WORK EXECUTION	2 years	
LIVE LINE WORK	**Risk Assessment - Close proximity**	Risk assessment for working in close proximity to energised lines. This activity will be tied to the grounding practices/procedure for HVDC lines.	H	ENGINEERING	6 months	Will occur with maintenance procedures
LIVE LINE WORK	**Safe work procedures - Close Proximity**	Procedures for working in close proximity to energised lines. Particularly important if only one pole on the tower is out and restoration can be done with the remaining pole energised.	H	ENGINEERING	6 months	Will occur with maintenance procedures
LIVE LINE WORK	**Robotics**	Investigate possible robots that can be utilised to help reduce maintainance by line workers.	L	WORK EXECUTION		

Appendix B: 2018 Exercises Assessment

2018-10-29

LITL ERP 2018 EXERCISES ASSESSMENT

LITL Emergency Restoration Plan
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Document information

Rev #	By	Date	Description of Revision / Phase of Project	Approval
0	S. Parmar	2018-10-29	Initiation of Document	

Executive summary

In the support of implementing the recommendations from the EFLA ERP, Power Supply Operations have successfully executed four exercises cumulating in the construction of a wood pole ERS bypass near Salmonier Line in Newfoundland. Each exercise progressively added further capability to Operations, enhanced processes, refined design and honed the skillset of personnel. These exercises establish the foundation upon which Operations will continue to develop.

The four exercises were:

1. Desktop
2. Constructability
3. First Assessment
4. In-field bypass construction

The first exercise was desktop only. An outage scenario was played out and the SOP EOC mobilized to go through the motions on how to address and ultimately restore the line. Many observations were made and lessons learned bringing new groups of people together to solve the problem collaboratively. From this two further exercises evolved. One was to deploy a First Assessment Team to the field to test the gathering and relaying of data back from the incident site to engineering in real time so that a solution could be fashioned. The other was to test the design and construct the wood pole ERS in a controlled location to validate constructability and test fitting of hardware. Both these endeavors revealed insights and adjustments moving forward.

The final exercise for 2018 was the full construction of a bypass adjacent to the HVdc TL. This multi day effort deployed labour, materials and equipment into the field and was coordinated through the SOP EOC and with support from the CERP. It brought together everything learned thus far and ultimately provided a timing benchmark to estimate future restorations. Due to some constraints the scope was limited to a half bypass construction which took 3 days to do (3 dead ends and 1 tangent structure with stringing). It is important to note that these were under ideal conditions (excellent access and weather, materials available nearby and timely mobilization of powerline contractor). Therefore a best case scenario for a full bypass under similar conditions could be extrapolated to 10-12 days to execute from start to finish which includes estimates for cutting conductor, back stay and flying taps which have not been performed yet.

A three year ERP roadmap (Snehal Parmar, 2018)was developed for the organization. The goals are to achieve technical solutions to address a fuller range of scenarios, preventative forecasting, procuring tools and equipment, hone processes and finally develop capability tackle everything from an insulator replacement to a full restoration in a remote location such as the Long Range Mountains or southern Labrador. This can be achieved by continuing to perform progressively complex exercises on a regular basis. Not only will this improve Power Supply Operations' fluency, but also serve as a template to collaborate with other groups within Nalcor Energy such as NL Hydro.

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Abbreviations

CERP	Corporate Emergency Response Plan
ECC	Energy Control Center
EOC	Emergency Operations Center
ERP	Emergency Restoration Plan
ERS	Emergency Restoration Structure
GIS	Graphical Information System
HSE	Health, Safety, Environment
HVdc TL	High Voltage Direct Current Transmission Line
LCP	Lower Churchill Project
LITL	Labrador Island Transmission Link
PPWSA	Public Protected Watershed Area
RoW	Right of Way
SOP	Soldiers Pond switch yard and converter station
SPOC	Single Point of Contact

Definitions

EFLA	Name of a third party consulting engineering group based in Norway that performed an analysis of the HVdc TL and produced a number of recommendations to build out an Emergency Restoration Plan for Power Supply.
ERP	For this program, it is a restoration plan to return power as quick as possible in the case of an outage as a result of an incident on the HVdc TL assets only. These assets comprise the dc line from Muskrat Falls to Forteau transition compound in Labrador and then from the Shoal Cove transition compound through to Soliders Pond on the Island of Newfoundland. The undersea cable across the Strait of Belle Isle is excluded.

1.0 Background

The primary goal of the Lower Churchill Project (LCP) is to provide power from Muskrat Falls to the Island of Newfoundland for reliable domestic and export consumption. Power is transmitted via a 1,100 km 350 kV HVdc Overland Transmission Line from Muskrat Falls through southern Labrador and across the Island to Soldiers Pond. Sanction for the LCP was granted based on a commitment to provide a robust and reliable link.

The aim of the ERP project is to provide the Power Supply Operations team access to the resources, materials, tools, processes and work methods to deal with an emergency situation. This project will support the execution of simulations and field drills to refine the logistics and processes critical to restoring power in a safe and timely manner.

Activities have been divided into 2 phases. Phase 1 deliverables include a goal of performing a field restoration exercise (Snehal Parmar, 2018) by the fall of 2018. Phase 2 elaborates on the deliverables for 2019 and 2020 to address longer term recommendations as defined in the EFLA Consulting Engineers report (Naidoo, Viven, 2017). All planned work has been scheduled in an overarching three-year roadmap.

Phase 1 activities, as taken from the Project Charter (Snehal Parmar, 2018), are summarized as:

- Finalize and approve of all project framework (charter, schedule, budget, etc).
- Design of a wood pole emergency restoration structure solution with glass insulators (this solution is referred to as Stage 1).
- Procure all materials required to construct 2 km of this solution.
- Procurement of associated tools and equipment to support this work.
- Review and adjustment of any work methods and processes.
- Conduct both a desktop and field simulation of a restoration scenario.
- Contracts in place with constructors and vendors to be on stand-by to assist any such restoration scenario.
- Establish mutual assistance agreements with partner utilities and organizations.
- Strategic deployment of material storage areas across line, supply depots (e.g. fuel), etc.
- Communication plan in place for solution implementation.
- Data reorganization to assist quick access to As-Built drawings.
- Gap analysis to build out or refine processes, work methods, and other documentation including integration with existing Power Supply EOC processes/organization.

2.0 Objectives

These exercises are ultimately to progressively prepare and ready Power Supply Operations to restore the line in a timely manner. Specifically they seek to address the following objectives:

- Exercise internal processes.
- Validate work methods and procedures.
- Ensure constructability of solutions.
- Test effectiveness of communications, chain of command and interfacing with stakeholders (e.g. ECC).
- Demonstrate effective logistics for material picking, handling and shipping to site.
- Ensure robust coordination with all facets of an incident response.
- Construct a viable solution in the field.
- Continuous improvement by adapting lessons learned and closing any gaps identified from each exercise.

2018 being the first year is the most critical as all these activities will be done for the very first time. As a result precursor exercises or simulations must also be performed prior to a full field construction simulation. Table 1 taken from the ERP 3 year roadmap document lists all the planned exercises.

ID	Year	Category	Objective	Simulation exercise
12	2018	Procedural	Perform desktop simulation to exercise coordination, logistics, communications, processes, etc.	2018.A
9	2018	Execution	Execute a constructability exercise (of wood pole solution) with powerline contractor.	2018.B
10	2018	Execution	Simulate dispatch of first assessment team to locate, assess and report on failure.	2018.C
8	2018	Execution	Perform simulation exercise in field to construct wood pole bypass solution (Stage 1).	2018.1
25	2019	Execution	Simulate construction of a bypass using modular Emergency Response Structures and/or with composite insulators (Stage 2). Can be performed at a local controlled site but still involve use of helicopters to transport materials and modules from separate storage areas to construction site.	2019.1
26	2019	Execution	Perform simulation exercise in field to construct wood pole bypass solution, more complex scenario (Stage 2).	2019.2
27	2019	Execution	Repeat the simulation of the dispatch of first responders but revised based on lessons learned in 2018. Add involvement of incident command centre and engineering design. Target to have more of a back and forth in the communications by having each group in possession of specific information that is needed by the others.	2019.A
28	2019	Execution	Construct emergency response structures (either ready-made and purchased from a supplier or internally designed). Emergency response structures should be modular and light enough to be transported to site by helicopter.	2019.B
44	2020	Execution	Perform a complete end-to-end simulation of an emergency response for a category 4 or 5 incident. The simulation should be structured in such a way that interdependent tasks are coordinated. For example, the construction crews cannot start until an assessment of the failure has been completed and a response strategy is prepared. Possibly a decision could be made to choose between a wood pole bypass and a modular design and then handed off to the construction team. Include executive, incident command centre, external resources and media communications personnel in simulation.	2020.1
45	2020	Execution	Perform simulation exercise in field to construct wood pole bypass solution, more complex scenario (Stage 2).	2020.2

Table 1 - Simulation Exercise

At this time Power Supply Operations have concluded the four Phase 1 exercises in 2018. This report therefore documents the results, learnings, recommendations and planning for future exercises and Phase 2 activities. Details of each and their outcomes are described in this document.

3.0 2018.A Desktop exercise

3.1 Scope

This exercise does not involve any deployment of labour or equipment. At minimum it was designed to:

- Test response procedures (e.g. who to call, what information to share, etc.)
- Ensure all partners, vendors and contractors are reachable.
- Ability to retrieve asset and GIS data in a timely manner.
- Reach key team members (e.g. engineering).
- Measure response times.
- Review solutions in toolkit to assess suitability to scenario.
- Validate materials are locatable and available.

The exercise was performed at a conference room at the Soldiers pond administration building on August 22, 2018. All members of the anticipated response team were invited to run through the devised scenario.

The scenario imagined that a category 1 hurricane had passed through the Island bringing heavy winds and rain. The storm managed to cause a large tree to fall onto structure 2251 of the HVdc TL causing damage to the conductor, insulators and hardware. The damage was severe enough to cause a power outage that alerted the ECC. The ECC duly contacted Power Supply on-call for resolution.

3.2 Timeline

DAY	TIME	Activity
2018-08-22	1000 hrs	Team gathered in room and exercise start.
2018-08-22	1200 hrs	Exercise conclusion.

Table 2 - Desktop Exercise Timeline

3.3 Observations

The full list of observations and actions are noted in Appendix A.1. Key observations are noted here.

- CERP overview required for the larger team. Also clarification on what and how they support Power Supply team in the event of an incident.
- Organization chart for SOP EOC needed, clearly identify roles and responsibilities.
- Current and widely available contact list of key personnel.
- Checklists needed for key groups (e.g. engineering, First Assessment Team, etc.)
- Communications gear needed for lines crew (satellite phones, smart mobile devices, GPS with current maps, etc.)
- Need survey resource at site.
- SOP EOC positions need binders and checklist packages readily available to them.
- Updated model for transmission line needed for engineering.
- Inventory of materials at site needs to be performed.
- Note takers needed at both SOP EOC and at site.
- Early heads-up call needed to be placed to support partners (powerline contractors, materials/transportation, etc.)
- Nomination and identification of on-site construction coordinator.
- Washroom and medical services need arranging.
- Location and accessibility of key technical data (drawings, maps, relevant layers, etc.)
- Hard copies of line route needed.

3.4 Outcomes

As a very first exercise it was regarded a success. It brought together different parts of the organization to work collaboratively on solving the problem. There was active and engaging discussion, questions on how to do things, whom to contact, where to find information and when to keeps others and stakeholders notified of status throughout. The team discovered a number of gaps and opportunities to be addressed.

The ECC, CERP Executive On Call and SOP EOC groups were fully engaged in the execution of the exercise. Representatives from environment, engineering, health and safety, lines crews and the Power Supply management team were all in attendance.

4.0 2018.B Constructability exercise

4.1 Scope

Before building a restoration solution in the field it is critical that there is has confidence in constructing the wood pole line per design. This exercise is for the powerline contractor to assemble and erect the wood pole ERS at an easy and controlled location, such as Soldiers Pond. This exercise looks to check that all hardware fits and that all work methods and procedures perform as expected. It is also a chance to determine that the materials, tools and equipment are correct for construction. One of each of the three types of wood pole ERS were to be framed, erected and dressed, complete with foundations and guy wires.

This exercise excludes stringing and performing the back staying of the 3633 kcmil HVdc conductor. Upon receipt of the custom materials a further activity will be planned in the future to perform the back stay.

On the morning of September 24, 2018, the powerline contractor Locke's Electrical mobilized to Soldiers Pond. The materials and wood poles were delivered to site by the project beforehand.

4.2 Timeline

A detailed timeline is found in Appendix B.1.

DAY	TIME	Activity
2018-09-24	0700 hrs	All teams mobilized to site.
2018-09-24	0745 hrs	Start construction of first structure.
2018-09-25	1300 hrs	Third and final structure fully erected and dressed.
2018-09-25	1530 hrs	Finished at site and packed up.

Table 3 - Constructability Exercise Timeline

4.3 Observations

The full list of observations and actions are noted in Appendix B.2. Key observations are noted here.

- Additional equipment (e.g. boom truck) would have sped up construction.
- Dedicated HSE resource at site would have been preferred.
- Design of structures is only sketches. Detailed CAD drawings are required and should have been made available to contractor well in advance.
- Power Supply Operations team and contractor crew worked very well together.
- Overall construction coordinator or supervisor required and identified to all at site.
- Jumper assembly clearance issues noted against guy wires. Some design adjustments required for the future.

Figure 1- Wood Pole ERS Construction at SOP

Figure 2 - Completed Wood Pole ERS at SOP

4.4 Outcomes

The three structures were successfully built and dressed. Both the contractor Locke's Electrical and Power Supply Operations line crews worked well together. The ground conditions were a bit tougher to work with and slowed progress somewhat. Though it took a day and a half to construct, this exercise mainly was to understand constructability, not timing. Weather conditions and access were both excellent.

By performing the construction of these new structures in a controlled environment beforehand, any fitment and assembly issues were resolved in good time. Design issues were identified and will be addressed. Having to resolve these issues during an actual event when the clock is ticking are additional stresses and delay that cannot be afforded. Finally both the contractor and Power Supply Operations became familiar with the design, construction and layout.

5.0 2018.C First Assessment Team exercise

5.1 Scope

This exercise is to test the effectiveness of a First Assessment Team. An incident will be declared at a location and this team will be deployed to that site. The following are examined in this exercise:

- Notification from ECC (or others) of an incident.

- Mobilize SOP EOC to dispatch the First Assessment Team to an actual predetermined site along the TL.
- Obtain in real time key data from the site by the team. Information such as assessment of damage, photos (structure/structural elements, environment, terrain, foundations, etc.), elevation, site conditions, weather, accessibility, etc.
- Ability to receive and use data from the field to input Engineering to determine optimal solution(s) for restoration. This step also checks communications between teams.
- Perform post exercise debrief to identify lessons learned and adapt procedures as required.
- Timing for Engineering to build out a solution.

The Field Assessment Team consists of Power Supply Operations line crew members and personnel from Engineering. Together they are to mobilize to assess the site.

At 0900 hrs on September 14, 2018, a call was made to kick-off the exercise. The first call identified an approximate location of an imagined incident, near structures 2955 and 2978 of the HVdc TL on the Island. Once the team arrived in the vicinity, they were updated and notified of the exact structure with the issue (structure 2970).

5.2 Timeline

A detailed timeline is found in Appendix C.1.

DAY	TIME	Activity
2018-09-14	0900 hrs	Call made to kick-off exercise.
2108-09-14	0920 hrs	Team departed SOP base.
2018-09-14	1034 hrs	Team arrived to structure.
2018-09-14	1109 hrs	All pertinent data relayed to engineering.
2018-09-14	1249 hrs	Completed design relayed to field team.

Table 4 - First Assessment Team Exercise Timeline

5.3 Observations

The full list of observations and actions are noted in Appendix C.2. Key observations are noted here.

- Contact list and phone numbers of all relevant parties to be made available before team leaves office.
- Field crew did not have suitable smart mobile devices that could send/receive e-mails and attachments, but were instead reliant on engineering team members.
- Reliance on only one engineer at the office who could perform the design work in real time – bottleneck and single point of failure.
- On-site surveyor would have avoided a redesign due to clarity of site conditions (e.g. bog) and save time.
- Location had good cellular coverage – best case scenario. Resolution time would have been vastly worse if dependent on satellite communication, for example.
- First Assessment Team and engineering team should spend time together reviewing the drawings and familiarizing themselves with the intent of the work.

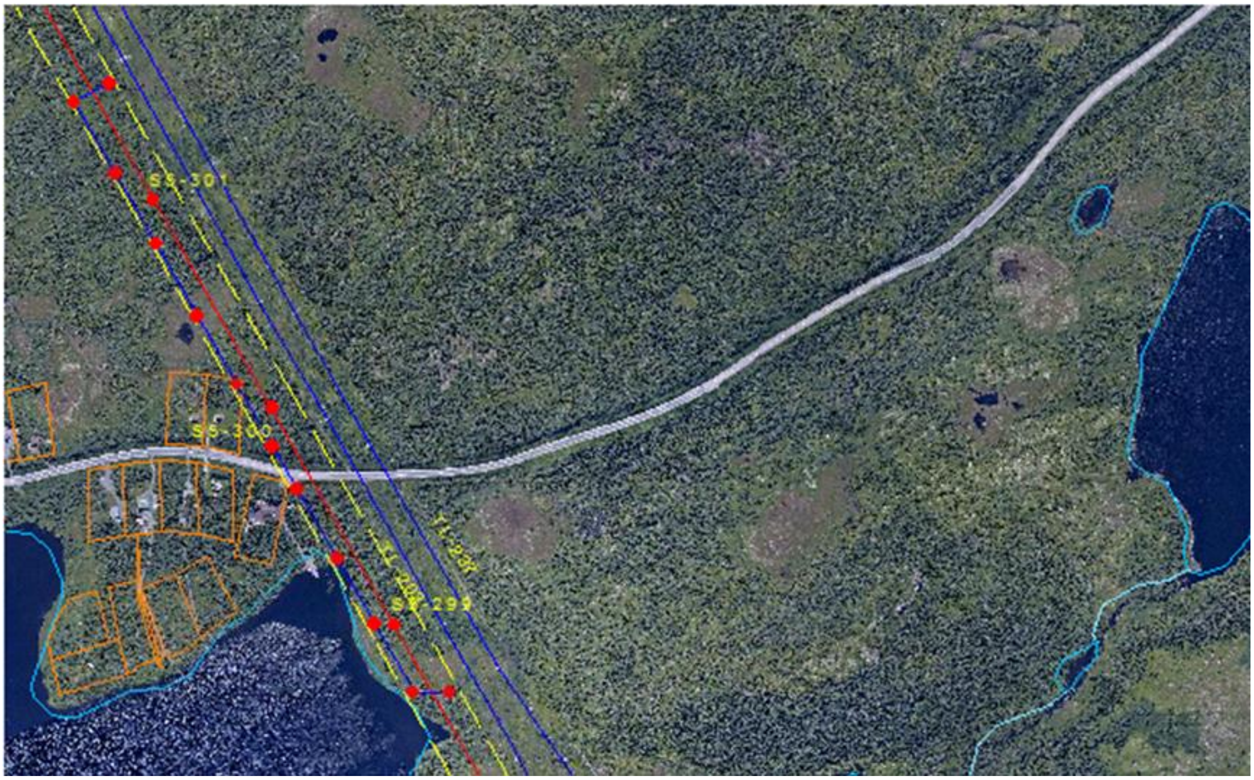

Figure 3 - Bypass design for structure 2970.

5.4 Outcomes

A few messages were reinforced from this exercise. There is a key dependency on one engineering resource to formulate a design solution. What if that person is not available, who is the backup? Similarly the line crew would not have been able to relay nor receive data if the engineering team members were not with them. They may not always be mobilized together so it is imperative for the line crew to have suitable devices. The final design had the bypass line to be installed in a boggy area. Having a surveyor at site with this team, or at least some method to measure locations reliably, could have avoided this and resulted in a more constructable solution.

6.0 2018.1 In-field bypass construction

6.1 Scope

This is the first full and integrated field exercise. It will test the ability to mobilize all resources such as the contractors and internal staff to construct a restoration solution on the RoW of the HVdc TL. It also includes full coordination at both site level, SOP EOC, CERP plus logistics.

As this is not a real emergency incident, saving costs and minimizing health and safety risks were key factors in the planning. As a result, the following parameters were in play:

- No interruption of service (no cutting of conductor).
- Materials were sourced from the Argentia Marshalling Yard. They were prepackaged and scheduled to be delivered to site at same time contractor arrives.
- Transportation contract was not in place so this was handled separately.
- Not using fault location system – incident location independently determined.
- No removal of debris or salvage of materials at site.

- Location chosen to be close enough to SOP to minimize costs (no overnight or hotels, minimize driving time, etc.)
- Safety hazards minimized by choosing location away from any crossings (road, water, other lines/utilities).
- Engineering design was predetermined to minimize costs of contractor idle or on standby. There was no further need to measure the time for engineering to produce a solution.
- Only a half bypass was constructed. Exercise is to gather benchmark timing data. Can easily extrapolate timing for other half without unnecessary extra costs.
- Work was limited to daylight hours to minimize fatigue and exposure risks.

As a fully coordinated effort, the following was deployed in this exercise:

- Powerline contractor
- Establish lay down area
- Security
- Health and Safety advisor
- Portapotty
- Coordination with SOP EOC, ECC and full CERP team
- Mobile command shelter

With these parameters, the objectives remained to:

- Understand timing to build a bypass and deploy resources effectively.
- Identify chronic gaps in processes, communications.
- Coordinate with multiple groups.
- Ensure effective and timely communications across the organization, and with the team.
- Constructability and work methods feedback.
- Identify working constraints and resolve real time issues.
- Build out action plan of improvements to make for subsequent exercises.

It was originally envisioned to build a full bypass, but decisions were made to reduce complexity, unnecessary costs, exercise duration and minimize material usage (as the intent was to reuse as much as possible and return to spares in case of a real emergency). A half bypass allowed exercising everything as much as possible and the data could be easily extrapolated to determine how long a full bypass would take.

The exercise commenced at 0819 hrs on October 01, 2018 when a call was placed to the Power Supply on-call number to report an incident. It was imagined that tangent structure 3143 was down and a power transfer outage occurred. This call subsequently mobilized the SOP EOC. Through due process the CERP was also mobilized.

6.2 Timeline

A detailed timeline is found in Appendix D.1.

DAY	TIME	Activity
2018-10-01	0819 hrs	Notification of incident made to Power Supply on-call number.
2018-10-01	0845 hrs	Most people assembled at SOP conference room.
2018-10-01	0901 hrs	First Assessment Team departed SOP base.
2018-10-01	0927 hrs	First Assessment Team arrived to structure.
2018-10-01	0937 hrs	At site checklist started.
2018-10-01	1009 hrs	Locke's Electrical arrived at site.
2018-10-01	1016 hrs	Initial design sent to field team by engineering.
2018-10-01	1200 hrs	Surveyors arrived at site.
2018-10-01	1350 hrs	Initial notification from Environment that proposed location in

		violation of PPWSA. New design required (move bypass).
2018-10-01	1545 hrs	Materials from SOP delivered to site.
2018-10-01	1719 hrs	Redesign completed and sent to team
2018-10-02	0957 hrs	Construction on first pole started.
2018-10-02	1418 hrs	Emergency shelter erected.
2018-10-04	0905 hrs	Construction completed. 4 structures built and strung.
2018-10-04	1021 hrs	Survey (As-Builts) completed.
2018-10-04	1026 hrs	Instruction to contractor to disassemble.

Table 5 - In-field Bypass Construction Timeline

6.3 Observations

The full list of observations and actions are noted in Appendix D.2. Key observations are noted here.

- Engineering checklist clarifications required. Also printed copy should be available to all.
- Current LIDAR data not available to engineering (no RoW or access road details in Figure 4); inaccuracies and rework in design as a result.
- Contact list of all pertinent personnel should be available to all from the beginning.
- Having surveyor on-site from the beginning was invaluable – in this case it was prearranged. Needs to be available either through Power Supply Operations, NL Hydro or contractor.
- Initial design proposed construction was inside PPWSA. This is not allowed without lengthy approval process for permit.
- Initial design proposed construction was outside of RoW and necessitated guy anchors in crown land. This is not allowed without lengthy approval process and wood cutting permits.
- SPOC needed in Power Supply Engineering to relay engineering updates in field.
- Checklist needed for surveyor. Surveyor must have capability to measure cable heights and attachment points.
- Confusion in use of temporary construction structure numbers and permanent structure numbers.
- Unclear on protocol at site for visitors, location of tailboards, and command structure (who is in charge).
- Misunderstanding on work protection and site orientations; who has it already and who needs it.
- Dealing with environment and lands constraints was an excellent opportunity to perform real time engineering redesign and adjustments.
- No weather or access impediments.

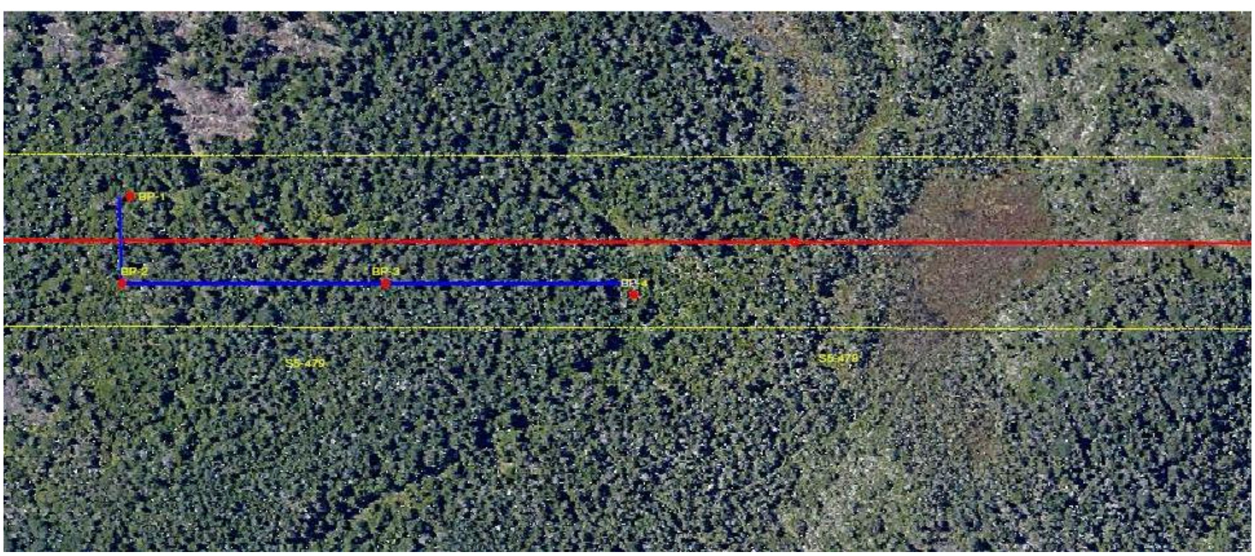

Figure 4 - Final Bypass Design

Figure 5 - Construction of Tangent ERS.

Figure 6 - View Down the Line

Figure 7 - Jumper Installation at Angle Deadend ERS.

Figure 8 - Fully Strung and Completed Half Bypass.

6.4 Outcomes

The exercise was a success. 4 wood pole ERS were built and strung in a bypass configuration. It took essentially 3 days to perform, from initial call to field completion, in ideal conditions. The weather was temperate, low winds, good daylight hours and no precipitation. Access was excellent with only very minor remediation needed at the bottom of the hill. Good real estate was available for lay down areas, placing materials and setup. This is a benchmark for a best case scenario.

Whilst material picking, transportation, and contractor availability was predetermined for this exercise, it stands to be said that this will not be the case in a real emergency event. Work needs to continue to establish contractual agreements and arrange the strategic placement of materials beforehand.

Performing real time design changes was an excellent reminder that a real event may have many complexities not considered until data is being relayed directly from the field and input from stakeholders received. While the redesign lost some time in this exercise, it reflects realities that are likely in a real situation. Another key finding was that it became imperative to know who in the field was to receive the updated design (to disseminate to the work crews) and the Bill of Materials.

Some clearance issues were realized during construction with regards to the jumpers and guy wires. Adjustments to design will be required. In addition, the transportation, handling, assembly and lifting of glass insulators was tedious and time consuming. The weight and bowing effect of the insulator strings also caused some concern.

Some bells were broken during handling as well. The use of composite insulators would greatly mitigate these issues and is recommended moving forward.

Establishing a control point at the entrance to the work site was another key finding. This is to ensure orientations, signing-on to a tailboard and knowing who is in charge. Signage for no hunting, muster points, active construction, etc. also need to be in supply and available to deploy as invariably members of the public are avid recreational users of the access roads and RoW. With safety in mind, it became imperative to ensure a HSE advisor is on site at all times. In this exercise we had some attendance by the contractor's representative, but it was not full time. Furthermore it should be made clear whom in the organization performs notifications to nearby authorities when the work is happening. This was performed in this exercise by a member of the SOP EOC, but it may be a responsibility of the CERP. Finally, it should also be made clear to all site personnel and contractors the expectations of hours of work to avoid any doubts and misunderstandings.

Having surveyors available was invaluable to the exercise. It is recommended arrangements are made so that they are also available as key personnel to respond to any restoration emergency event.

Finally, future exercises must be planned as a normal construction job, with pre engineering and permitting completed as required. No waivers are possible (from Crown lands or other government departments) if it is not an actual emergency situation. To that end, this exercise is the start of the journey for Power Supply Operations. Per the roadmap, subsequent exercises will be progressively more complex, in harder conditions and more remote locations.

7.0 Next steps (near term)

With the major exercises completed for 2018, there remain a number of priorities to be completed in the remainder of the year and planning for 2019. The following items are some of the near term focus areas from the 3 year roadmap.

- Procure back stay materials.
- Perform back stay constructability exercise.
- Retender powerline contract and award.
- Move portion of winter readiness materials to HVGB MY.
- Award material management and transportation contract.
- Tender composite insulators (Stage 2 design).
- Preliminary planning for next full exercise in first half of 2019.
- Continue designs for additional solutions (e.g. swivel base, gantry beam).
- Strategic lay down areas for materials across line.
- Enhancement of real time monitoring stations.

Appendix A – 2018.A Desktop exercise

A.1 Observations and actions

Desktop exercise Actions			
Item #	**Action (What needs to be Done?)**	**Completed Y/N?**	**Comments**
1	Finalize location for September exercise.	Y	2018-09-10: Date has changed to October 01, 2018.
2	Confirm we have space and land available to construct	Y	2018-09-10: This is for the September (now October 01, 2018) exercise.
3	Need to integrate with MF/SOP 24/7 Ops team	N	
5	Steve Tilley to do an overview of the CERP for team.	Y	Done. Jim Barnes: Session should happen at Hydro Place so all can see the EOC there. Need to decide what roles will happen at Soldiers Pond and what will be handled by Hydro Place.
6	Management structure for the ERP must be well defined. Who is the leader, the deputies?	N	Need org chart with roles and responsibilities defined.
7	Who are the contacts, contract information for deploying a helicopter? Assemble 24 hour contact info for St John's and Goose Bay Helicopters. As well as Hydro Contract helicopter.	N	Nothing at this time. Bob does have a list of numbers to add to contact list
10	Line crew to develop their own Checklist.	Y	
11	Develop "Advance Assessment team" Checklist. Should Include assessment of the access road / trail for access to work site. Investigation team needs to report on safety and environmental concerns, GPS coordinates, details of failure and landscape with pictures.	Y	
12	Develop a checklist for SOPECG (various positions)	N	90% complete as of Oct 23, 2018
13	Line crew needs GPS, satellite phones (external antennae's), coordinates, etc. Advance Assessment team should have two SAT Phones and a hand held GPS.	N	8 radios, sat phones ok. Working. Dropped off to sop tomorrow 2018-09-10: LCP will provide 3 GPS units. Bob's team to confirm satellite phones.
14	Must have a method to communicate the SAT Phone Numbers for the on call team (how do we know what phones they have with them?).	N	Will be put on white board.
16	How is line data provided to pilots?	N	
17	Helicopter landing pad a Soldiers Pond must be prepared and its location clearly defined.	N	Unknown right now because of the parking in SOP
18	Are fuel caches and depots located strategically across the province? Must	N	

	establish Helicopter fueling locations.		
21	Engineering lead needs to be notified in the workflow early in the procedure (by PSOC).	Y	Done 2018-08-28: Jim will update the ERP accordingly.
22	Current plan does not allow for onsite engineering.	Y	Same process as before. Cheryl and Kris will go out this time. Paddy will have phone, Kris will have one.
23	Survey resources must be included in the contractor's scope.	Y	2018-08-23: Captured in Addendum 2 for 76359 MA..
24	Must have a method to alert all of the PS resources to give them a heads up that there is an issue and it is under investigation.	Y	Simply a call out by cell phone -- longer terms solution, app or similar
25	Helicopter landing pad a Soldiers Pond must be prepared and its location clearly defined. Confirm landing zone, fuel drums, spill kits, wind sock, etc. at SOP for heli operations.	N	The heli landing zone had changed as of today (Oct 22) because the original place is becoming a parking lot.
26	NL Hydro (Darren/Dave) needs to be involved, informed and consulted in these ERP works.	N	
28	Establish short term contract/sole source PO with Harvey's (Hedley Burdge)	Y	
29	Once decisions are made on Soldiers Pond positions then binders will need to be developed for each position (cheat sheets/placemats)	Y	2018-08-28: Basic placemats will be available for September exercise.Binders will be created once positions are decided.
30	Who has responsibility for materials? Cannot be only Wendy.	Y	Second resource to be identified and confirmed. Geoff Skanes.
32	Confirm CFLCo helicopter / King Air available as required.	N	
33	Organization hierarchy required – especially if PS line crews will participate in the restoration actitives. Who is the overall construction coordinator in the field? They will have to direct internal and contractor resources as required and have clear demarcation of roles and responsibilities for both.	N	
34	Need to establish a baseline restoration time (i.e. how long would it take to perform a wood pole restoration?	Y	
38	Confirm September exercise date (planned is September 27).	Y	2018-08-23: Push out to October 01, 2018.
39	Lines crews to secure and confirm tools and equipment they need to support this work. Do we have dies, presses, grounds, etc.	Y	Bulk of gear in place now. Some PPE waiting for. Have stuff able to work with.
40	PS Engineering does not have an up-to-date model for the existing line. PS engineering team must have access to the LITL model. This is a critical issue and must be resolved	Y	In the works, enough to make do. Roads, bridges not up to date// lidar exercise, fine for now. Design from SNC now available. Complete, models received.

	ASAP.		
41	Wash car, water, food – expectation that CERP will arrange. To be confirmed.	Y	2018-08-30: CERP Session scheduled for 1 PM on Sept 06, 2018.
42	Someone needs to inventory materials in the field when they arrive – ensure we have everything in hand. Proactively can get more if needed. Needs to happen near the beginning. Plan to ship extras.	N	Materials picking list from yard and again when delivered
43	Can you land at AMY?	Y	Yes chopper can land at SOP.
45	Need someone to take field notes – Ask Jason Pond for September exercise.	N	
46	Will need someone to take notes at SOP to identify any gaps	N	Cheryl
48	Practice (in the future) required with regard to inter-agency response and communications i.e, working with Hydro & Power Supply resources. Add this requirement to future exercise parameters.	Y	
50	Corporate Communications contact needs to be identified, i.e Deane Fisher or designate. How do we engage corporate communications? Solely through CERP?	Y	Through CERP as required.
51	Engineering (John Walsh or Maria Veitch) will need to be added to the SOP Emergency Control Group.	Y	Done
53	In early stages, we can add heads up calls to contractors (line work, transportation, etc), warehouse, supervisors and crews that could be involved while waiting on info from the assessment team. They will get a further update after the assessment team provides the details of the failure.	N	At the discretion of the IC and what contracts are in place. No action required.
54	Create a binder for first assessment team and on site commander that includes drawings of the line that show structure locations and access routes for each structure.	N	Ongoing.
55	Create an emergency kit for the first assessment team – include GPS (pre-programmed with data (coordinates) on structure numbers and access), 2 sat phones, maps. (combine with the binder, maybe put all in a box/ tub). Role tubs, info for IC, FC, First Assessment Team, etc.	N	75% complete as of Oct 23, 2018
56	Logistics – pre-developed contact information for ferries, hotels and meals for all areas of the line. Break into line areas for available logistics areas.	N	
57	Onsite Construction Coordinator must be identified. Should have an Org Chart to	N	

	show how this works. This individual will need to direct all forces on site (Contractors, Nalcor and others). He will do this by communication with the each groups' onsite supervisor.		
58	Construction coordinator – Field on-scene commander will coordinate construction activities with internal supervisors, contractors, and utility partners. Safety and Environment reps will provide on-site representation as required.	N	
59	If / when we move to 24hour operation, will need special work procedures for lighting, rest periods, on-site emergency / temporary accommodations, etc. – Future year activity.	N	
60	Transportation of material – need to clarify meeting points, who takes care of identification and loading, escort transportation contractor on access roads.	N	
61	Medical – have plans developed in case someone is hurt. Get 24 hour contact info for external service providers – can supply with 4 to 12 hours notice – cost is about $1200 a day. CF fire and security can be plan B.	N	Eye wash, FA kits available At discretion of IC, workers are trained in FA. Third party after that. No ongoing action required.
62	Need to contract a resource (or arrange for Hydro to supply) to provide survey data for where to stick structures.	Y	Complete. LCP Group provided survey work.
63	Need a contingency plan in case we need to isolate the second pole for installation.	N	
64	At the work location where the emergency work is being carried out washroom facilities will need to be concerned and food for the workers on ground.	Y	
65	Fatigue management – workers will be working long hours and will get tired.	N	
66	Review equipment / tools available.	Y	
67	Need Corporate Communications to announce / advertise the planned exercise.	Y	
68	Do we need overnight security for the restoration exercise / real life situation?	N	Cannot leave items in an unstable state, materials security, anchors marked, guy wires, guards, protection of shelter, security
69	Verify with john Cooper that we have land rights to the area planned for the exercise.	Y	Confirmed for the constructability exercise at SOP.
70	Add John Cooper to the contacts list for notification in real life situation.	Y	
71	Update the on-call group about the specifics of their responsibility in this situation.	N	
72	A "step-by-step" process must be written down or a flow chart produced.	Y	Complete for ERP.

73	Where are the drawings and maps? There needs to be a file cabinet containing drawings, etc that would be needed in an emergency.	N	Ongoing.
75	Do we need an onsite Medic? Level of risk will determine if an advance medical person (Medic) is required on Site where the emergency work is being carried out. Horizon Occupational Health Solutions could be utilized or Churchill Falls Fire & Security personnel.	N	Repeat item, see task 61.
76	Who decides when to stop work at night and when to start back up in the morning?	N	
77	PS engineering team must have access to the LITL model. This is a critical issue and must be resolved ASAP.	N	
78	Who will determine is we are in an area where we need environmental permits?	N	
79	Hard copies of the line route including access should be available in ER binder (or large map on wall at SOP conference room similar to Power House meeting room)	N	Ongoing.
80	Investigation team should contact IC with update not SOP On call	N	No action required.
81	Environment Team should be contacted based on the findings of the initial investigation (ie if there is a culvert washout, they must be contacted. Maybe a checklist of Environmental concerns should be developed so based on the initial investigation we know what issues to contact Environment about)	N	
83	Will the Lines workers, etc have a complete set of tools for the tasks that may present itself in an emergency or will we be depending on the contractor to have all of the required tools?	N	
88	Notify the appropriate Area Office Clerk of required travel arrangements, for the exercise. Logistics, travel arrangements for staff from Labrador.	Y	
91	Support Services at SOP and MF may need to be utilized in the event of an emergency.	N	Discretion of IC, no action required.
92	The phone number for Wendy March was not readily available.	N	
93	Will barriers and security guards be required at the emergency work location?	N	Discretion of IC, no action required.

Appendix B – 2018.B Constructability exercise

B.1 Timeline

Time	Description
Day 1 - September 24, 2018	
6:00 AM	Day started with driving to SOP
7:00 AM	All persons discussed plan of day. Decision on where to start planting poles. Far end of site. Building Dead end, tangent and dead end in that order to
7:45 AM	Began digging first pole structure. NOTE: ground is full of big boulders and rocks making slow digging. Plan is to plant all 6 poles first, than cross bracing and anchors than hardware. I'm estimating 1.5-2 days to finish work. All poles cut to correct length.
8:30 AM	Patt and power supply team arrived to assist Lockes. Crew brought trailer with with remaining hardware.
11:30 AM	VIP's arrived on location for observation. Nothing of concern. NOTE: reason for visit was to inspect and observe. Work continued all day.
1:00 PM	Final pole was planted. All gear and hardware is put together and ready for installation on poles.
2:25 PM	First support brace installed on tower 3. Note: Bucket truck, Picker truck and 2 climbers used for installation of bracing.
3:45 PM	Cross bracing installed on tower 3. During bracing installation excavator installed all log anchors (x6)
5:00 PM	Top bracing installed on tower 2. NOTE: Tower 2 and 3 have all hardware installed (guy wire and glass).
Day 2 - September 25, 2018	
6:00 AM	Day started with driving to SOP. All persons discussed plan of day.
7:00 AM	Begin cross bracing on Structure 2
7:30 AM	Patt and power supply team arrived to assist Lockes. Crew brought trailer with with remaining hardware. NOTE: working on structure 2. Glass and guy wire complicated
10:00 AM	Begin support bracing on Structure 1. NOTE: Patt's crew working on guy wire cutting and prep. Working on Structure 1, with glass guy wire and bracing. Finished structure @1:00 PM
1:00 PM	Move to Structure 3 to hang glass and guy wire.
3:30 PM	Finished on site and packed up.

B.2 Observations and actions

LITL ERP Implementation Project (Actions - Constructability Exercise)			
Item #	**Action (What needs to be Done?)**	**Completed Y/N?**	**Comments**
1	Additional equipment, ie boom truck and bucket truck, could have made pole installation more efficient. Sufficient ground personnel for this operation.	N/A	
2	Require more detailed drawings of structures	N	Not complete. No drafting resource.
3	Beneficial to have contractor HSE on site, should have Nalcor HSE as well.	N/A	
4	Questions regarding the angle DE structure, namely clearances from the jumper assembly and the guy wire. (most likely cleared up during second exercise)	Y	
5	Guy guards where not taken for guy wire. Caution tape was placed on guy wire and guards will be placed on tomorrow. Guy Guards should be added to the material list	N	
6	Structure 1 could pose a problem regarding jumpers and guy wire. Due to the placement of guy wire and the length of glass and size of jumpers there is a chance that conductor could come in contact with Jumpers. Pictures attached and email will be sent to Maria. Ensuring drawings and clear direction.	Y	
7	Clear chain of command to be discussed before October 1st. It's worth noting that all parties worked very well together. But in an emergency situation there should be a clear site supervisor giving direction.	N/A	

Appendix C – 2018.C First Assessment Team exercise

C.1 Timeline

Time	Description
9:00 AM	"FAT exercise kickoff" All participating members at the Soldier's Pond office gathered in John Walsh's office to call Snehal Parmar to initiate the Emergency Response Exercise. Details of the emergency scenario were given. It was understood that the outage was located between Permanent Structures (PMs) 2955 and 2978. Engineering determined the corresponding temporary structure (TS) numbers were 308 and 325. It was decided to first meet at PM 2955 (TS 285308325) which was located at Chapel Arm exit. Supplies were gathered (GPS, PPE, laptop, etc.).
9:20 AM	Two vehicles left Soldiers's Pond (engineering crew and field crew).
9:41 AM	The engineering crew received call from the engineers in the office stating the two parties driving had the wrong temporary structure numbers, therefore the planned meetup point for the first structure was incorrect. The corresponding TS numbers were actually 285 to 308. The engineering crew did not have contact information for the field crew in the first vehicle. The field crews contact information was determined at the office and then relayed back to the engineering crew.
9:57 AM	Engineering crew determined the closest tower was still PS 2978 but was actually TS 308, which is located at Fairhaven.
10:00 AM	Engineering crew contacted field crew and informed them of the temporary structure error and clarified the new meetup point was Fairhaven, at permanent structure 2978. The field crew were following the GPS and therefore had the correct location already.
10:22 AM	Both parties arrived at Fairhaven meet up point. Called John Walsh to inform engineering there was an AC Right of Way (ROW) adjacent to the DC ROW that we will be investigating.
10:24 AM	Called Snehal for more information on downed line position. Full details were explained, actually downed structure was noted to be PS 2970 (TS 300). Full details were emailed to engineer crew, but the field crew did not have work email access, therefore relied on engineering for details.
10:28 AM	Back on road headed toward downed structure (PS 2970).
10:34 AM	Arrived at PS 2970.
10:36 AM	Field crew were shown email with the specific details. Engineers on site were called to discuss the "ERP Site Assessment Checklist". Field crew began filling out the checklist while discussing answers with both engineers on site and in the field.
10:48 AM	Identified that the tower had a grillage foundation from engineering. Confusion arose around guy wire foundation re-usability/classification on damage.
10:53 AM	Started discussing possible detour options (new location for the bypass).
10:56 AM	Discussed locations of existing lines (communications and distribution).
11:01 AM	Analyzed access issues/concerns for adjacent towers.
11:06 AM	Discussed soil/bog between two of the structures where bypass will run through.
11:09 AM	Call ended with engineering.
11:12 AM	Completed the field safety report. It was noted there was no "work method" for an inspection.
12:05 PM	Called engineering (Maria) again for update. Status quo.
12:29 PM	Maria called back with the plan in pdf which she emailed to engineering crew; she was informed about how the temporary poles would probably end up in the bog.
12:55 PM	Call ended.
12:59 PM	Received call from Snehal that the exercise was complete.

C.2 Observations and actions

ERP Field Assessment Exercise			
Item Number	**Action (What needs to be Done?)**	**Completed Y/N?**	**Comments**
1	Engineering resource, there is a need to train a backup for Maria, Need two Keys for PLS CADD and 3 people trained.	N	
2	Engineering Response location, ECC would work better in and Emergency, perhaps a work station available there if possible	N	
3	Drawing Vault needed for hard copy of drawings	N	
4	Single point of contact at the field level, was unclear who was the leader in the field.	N/A	
5	Contact sheet of all involved parties should be compiled and circulated before any parties leave.	N	
6	Field crews require a device that can send/receive photos and/or documents without relying on engineering presence, in a real scenario it is likely that engineering would arrive on-site later than the linesmen.	N	
7	The biggest delay in the emergency response was waiting for engineering for a temporary pole line design. Only one engineer was there/available to design, check, compile and communicate the details of the temporary bypass design. Redundancy, backup and a reviewer/checker would be an asset.	N/A	
8	Adjustments also needed to be made to the initial bypass design to accommodate site conditions described initially (ie the bog). A surveyor or at the very least a measuring device to approximate the extents of the problematic areas would ideally eliminate the need to redesign the bypass placement.	N	
9	The location and conditions for this exercise were favorable (i.e. good weather and perfect cell service), we were able to use a blackberry for a hotspot in order to receive and view drawings on a laptop. This was a major reason why we were able to come to a engineered resolution in 4 hours. Without cell service the engineering response time could easily have doubled, a means to communicate via email, no matter the fault location or availability of cell service, would greatly improve response time.	N/A	
10	The exercise was completed in 4 hours from the time for the initial call to being on-site and having a viable engineered solution in place taking into account the obstacles in the area. It is noted that this was at a location less than an hour from site, everyone was at work when the call came in, access and weather were both ideal.	N/A	
11	Noted as outside scope of exercise that the identification of the fault would be slightly different in real life. When the LFL system is working, we will need a procedure for operators to extract preliminary data and send the event file to P&C engineering for deeper analysis. (Action: P&C Engineering D. Kavanagh to Assign?). operators will need training as well	N	

	(Action E. Oliver) Based on the initial high level data, we can start to assemble the team to deploy to site, with a very rough idea of where we are going.		
12	Add protection engineers and transmission engineers to the on-call phone list. (Action B. Woodman)	N	
13	Need to update a list of tools for the first assessment – laptop (or ideally an iPad) to view / transfer drawings and pictures between the field and engineering; range (conductor height) finder; illustrates the benefit to having a satellite data hub for cases where we are hours away from cell coverage in poor weather.	N	
14	Develop the lineworker first response checklist. Include items to bring (range finder / cable height finder, chainage tape, phones, cell / sat hubs, vehicles appropriate to area, maps, camera, etc) and exchanging cell / sat numbers with the office based engineer / team prior to leaving. (Paddy / Derek)	N	
15	The combined team of engineers and lineworkers worked well. Suggest that the standard process is for the full team to leave together, vs one group heading out first and trying to link-up later. A road assessment vs a chopper assessment will impact team size.	N/A	
16	There are two sets of structure numbers – aligning documentation to one set of numbers will reduce the potential for confusion.	N	
17	Streamline the Engineering checklist – (Maria).	Y	
18	Determine a tolerance for pole location without the need for consulting with engineering when assessing in the field. (Maria)	N	Ongoing
19	Need an alternate for Maria in the event she is not around (John).	N	
20	Notes for safety on-site. Knowledge if power is on or off (and any isolation of hold-offs that may be in-place. As well as the potential for contact with crossed lines (AC trans or dist). Maybe an item for both engineering and line worker checklists. (Maria / Paddy)	N	
21	Storm Preparation checklists – in alignment with Hydro and CF activities to ensure equipment is ready to go if we need to respond. (Bob)	N	
22	Ensure that clearances for permanent tower construction are considered when routing the by-pass line. – ie, stay to the side that will result in less customer outages when the steel tower is constructed and tied in. Use the conductor on the side of the by-pass for back-stay, then can raise the other conductor to the new permanent tower to minimize further interruption.	Y	
23	Implodes / hydraulic compression. Will need training on implodes, or have contractor provide skill set when splicing conductor as part of installing the permanent solution.	N	
24	Maria's List to be updated (Engineering List)	Y	
25	crew should have cable height meter and means to measure	N	

	chainage		
26	question 1 on the checksheet should be simplified with less combinations of possible failures categories	N	
27	Engineering to create load files for all zones to for quick assessment in PLS-CADD	Y	
28	Engineering to create Structure List template to be populated from PLS-CADD output and sent to the field team	Y	
29	Engineering to create excel template for backstay calculation and field placement	N	Ongoing
30	Engineering to consider permanent line fix in design of temporary bypass	Y	

Appendix D – 2018.1 In-field bypass construction

D.1 Timeline

Time	Description
Day 1 - October 1, 2018	
8:20 AM	Notified of a Tower on the Ground LIL Transmission Line. Tower Number 3143.
8:22 AM	Activated SOP EOC.
8:30 AM	Contacted ECC to activate CERP as a result of a tower down on LIL.
8:40 AM	Mobilized line crew and engineering to Tower 3143 to assess damage at site.
9:10 AM	Notified Warehouse to prepare for mobilization of materials to site.
9:14 AM	Received call from Jason Tobin (CERP).
9:15 AM	Notified Muskrat Falls Line Crew of issue and prepare for mobilization to SOP.
9:20 AM	Notified Locke's of issue on LIL.
9:22 AM	Notified NLH Line Crew via Darren Moore of issues on LIL.
9:25 AM	Printed drawings of affected area in preparation for Engineering design/site access issues etc.
9:37 AM	Received notification crew onsite gathering information on issue.
9:44 AM	Locke's were given notice to mobilize to site.
9:49 AM	Received information from field for Engineering assessment.
10:00 AM	Engineering Design was completed. (Note, in effort to save time and money, engineering was completed before start of exercise).
10:30 AM	Locke's arrived at site.
12:00 PM	First materials arrived at site.
1:50 PM	Notified that due to water shed near tower 3143, exercise was going to shift 1 tower East to 3144. Engineering design would have to be repeated for the new location. Anticipated to be completed before end of day.
2:00 PM	Permit in place for work on the DC Line.
2:30 PM	Remaining materials arrived at site
2:30 PM	Update from personnel on site. Plans were to remarshal materials to new location Tower 3144 before end of day. Making good progress at site. No further assistance required at this time.
Day 2 - October 2, 2018	
9:10 AM	Surveyors arrived on site
9:51 AM	Called Bishop Falls to obtain more counterpoise wire.
9:57 AM	First set of wood poles for BP4were staked and construction crews began.
10:15 AM	Started positioning first wood pole with Nodwell.
10:15 AM	Surveyors completed all wood pole stakes and moved on to staking the guy anchors.
10:31 AM	First wood pole was placed.
10:33 AM	Started raising second wood pole.
10:45 AM	Second wood pole was in place and excavator moved on to work on the tangent structure, BP3.
10:57 AM	Spoke to Lockes about setting up Nodwell so if a fail occurs, the wood pole would fall away from the existing HVdc conductor.
11:05 AM	Line crew workers began climbing the wood poles and working from bucket trucks.
11:21 AM	Began lifting top crossarm and excavator began working on the tangent structure.
11:37 AM	Secured top crossarm and began lifting crossbrace.

11:49 AM	Secured the first crossbrace and began lifting second.
12:23 PM	First wood pole of tangent structure, BP3, was placed.
12:32 PM	Two sets of anchors were surveyed.
2:18 PM	Emergency Shelter was erected.
Day 3 - October 3, 2018	
No timeline taken.	
Day 4 - October 4, 2018	
No timeline taken.	

D.2 Observations and actions

In-field bypass construction			
Item Number	**Action (What needs to be Done?)**	**Completed Y/N?**	**Comments**
1	ERP Site Assessment Checklist should be printed and within a package that emergency response crew take with them in the time of an emergency.	N	
2	On the ERP Site Assessment Checklist there was confusion if the "length of conductor damage" was per pole or in total.	N	
3	GIS software with up to date lidar information would eliminate design errors due to incorrect site elevations. Cost Estimate? John Walsh?	N	Ongoing, part of Stewardship Transfer process
4	Contact sheet of all involved parties should be compiled and circulated before any parties leave. (including contractor) Possibly insert this under a role in the binders?	N	
5	Construction staking coordinates for the actual wood pole and guy anchor locations helps prevent human errors that can happen when the field personnel are required to interpolate the structure locations based on coordinates for the conductor centerline placement.	Y	
6	Define a single point of contact within Ops team to communicate any issues to Engineering	N	
7	ROW width and clearance requirements will require construction outside the ROW in most cases	N/A	
8	Input required from Environment on what checks/permits required before construction	N/A	
9	Input required from Lands on what checks/permits required before construction	N/A	
10	Input required from Surveyor on required information and format	N	
11	Checksheet or Spec required for Surveyor for required information for Design, and required information for as-builts	N	
12	o use screen to assess layers, constraints, etc. before anyone leaves SOP/command center o review this before FAT deploys o someone at site needs to drive this	N/A	
13	o no operations binder o operations checksheet needed; Bob's team to develop	N	
14	room size limitation, multople calls, can move to other desks/offices to do this	N/A	
15	immediate identification of data recorder to transcribe to whie boards	N	
16	emergency response kit with contacts, sat phones, tools, mapping, phone list, binders, radios, etc. Jim: in plan	N	Ongoing.
17	40' seacan coming (heated) with shelving, ultimately will house -- will be located at sea can, ETA from Argentia, then modifications done by own resources	N	
18	Need survey engaged early. Need to determine options for survey going forward (Hydro?) and if essential. BW to set-up separate meeting with John Cooper and Engineering to discuss.	N	
19	Maria needs to update her PLS CADD data file to permanent numbers	N/A	

20	Maria: spec from surveyors, on how they want things presented	N	
21	Kris: confirm connections points per design (cross beam could have been shorter)	N	
22	engineering field presence if possible	N/A	
23	structures need to be properly drafted -- we only have Excel sketches	N	
24	potential to bridge/jumper to conductor directly instead of flying tap // may not be possisble if in reality the bypass is about 10 m away	Y	Not an option
25	Jim: soliciting comments on shelter	Y	
26	contracts -- gamed; not in place for future <-- risk! Looking to set up a long term contract	N	In progress
27	adjust capital plan for appropriate procurement to support in the future.	Y	
28	who is recipient for design and BoM? Ability to disseminate to right people in timely manner. Work of electronic design, or print outs?	N	
29	Affirmation of on-site HSSE representatives	N/A	
30	getting survey as-builts	Y	
31	site control, day 1 haphazard	N/A	
32	version control of documents in field	N/A	
33	Initial notification and immediate response was good. Gathering in the Soldiers Pond meeting room and getting organized occurred efficiently and effectively.	N/A	
34	Some initial confusion on tailboards as Nalcor had one and so did Locke's on the first day. Plan was made to keep one tailboard which worked well for the remainder of the exercise.	N/A	
35	The nature of the surprise location resulted in a missed opportunity to identify the protected public water supply area. Perhaps include Environment earlier to assist with identification of such zones.	N/A	
36	Some hesitation by the surveyors to complete the WPC Awareness training provided on site. Took some insisting to get them to participate. They were under the impression that they had all the required orientations. The understood the value of the session once it was held.	N/A	
37	Locke's safety - A full time resource was not present at the end of the exercise. It was Nalcor's understanding that this would be in place however it may not have been explicitly written in the contract.	Y	
38	Muster Station and No hunting Signs - Locke's agreed to provide and post these signs however I never did see it during my visits. My follow ups resulted in being told it was on the way.	N	In progress, add to requirements of contractor
39	Once the work started, it was completed safety and efficiently. Good crews.	N/A	
40	Emergency Shelter Pilot - Design needs some work. Assembling the unit as it currently sits would be next to impossible in harsh conditions.	Y	
41	Command Center requires a form of mapping displayed in the room - on screen showing location of incident, materials, and other resources	N	
42	First Assessment Team. Would be beneficial to have a response kit prepared. Add mapping, checklists, have a runner maid tub that we can put in a sea can from Argentia – the same one as for the foam trailer.	N	

43	Use of construction tower number vs permanent number. We need to move towards one number set. - Jackie initiated to have permanent numbers as main number and to replace S numbers in all documentation. - Maria needs to update some layers as well	N	Updating PLS-CADD model, not layers. New resource required?
44	Permits are required for practice exercises. For instance, we will always need to install structures outside of ROW to achieve clearances when energized. Tolerances?? For future exercises, engage Environment, comms, lands, etc to review scope to ensure permits, etc are in place.	N	
45	There was some confusion over the angel structure. It was built to design which had to be built with available material, so the clearances could not be achieved. The permanent design needs to be updated to reflect learnings.	Y	
46	Need to have designs drafted including BOM for each structure type.	N	
47	Create, and award long term contracts for emergency work, and material transportation. Provide maps of the line and access based on structure number to emergency response contractors including lines contractor, transportation contractor, etc.	N	In progress
48	Having our own excavators, and tracked material handlers with booms equipped with a man basket and a jib crane would strengthen our internal ability to respond.	N	
49	Add verbage in line contractor contract to provide a full time HSE person on the ground at all times.	N	In progress
50	No need to stay in the room after things get moving – move to offices to perform duties and come together periodically to regroup	N/A	
51	We started using the whiteboards. Room for improvement to use more including having phone lists transferred to the whiteboards asap.	N/A	
52	Went well – engineering check sheet was available	N/A	
53	Hard to compare this part of the exercise to real life given the preparation time.	N/A	
54	Future – Comms to make contact / public Notice to local communities when inside boundaries. Add to I/C checklist.	N/A	
55	Distribute design to recipients (determine who needs and put in binder) in a timely manner. Paper copies work best in the field. Need to determine the best way to facilitate this (printer, internet hub, etc).	N/A	
56	This exercise reflected a benchmark for an ideal situation. We can extrapolate from it to account for less ideal situations- remote locations, deep snow, reduced daylight hours, etc.	N/A	
57	Site control was a bit hap hazard on day one during mobilization. Need to know who is who, where to put things, location of safety info / supplies, have a report in location) accountability list / chart). Improved over time as site became less congested and we had someone in place to control access (was good for the first couple of hours until we repurposed the GM / logistics support people).	N/A	
58	Communication / framework of activities including agreement on hours of work, scope of work, etc.	N/A	
59	Excellent cooperation on the ground between contractor crew, SOP crew and MF crew. All worked homogenously as one team.	N/A	
60	There was a lack of signage for muster / no hunting.	N/A	

61	More exercises to practice different scenarios, lotation, logistics and response designs. – in the plans for more in 2018 and 2019.	N/A	
62	Build out schedule of work	N	

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Appendix C: Before & After Engineering Checklist

Power Supply - Nalcor Energy
Emergency Response Plan Site Assessment Check sheet
Date:

PURPOSE: Try and record as much information about the fault as possible so that the correct response can be implemented.

Incident Checklist	Yes	No
1. What is the possible cause of the fault?		
a. Tower foundation damage		
b. Guy foundation damage		
c. Guyed tower Failure		
d. Guyed tower failure and foundation failure		
e. Guyed tower failure with foundation failure and 2 Guy failure		
f. Tower failure with tower and 2 guys and guy foundation damage		
g. Self-supporting tower failure		
h. Self-supporting tower failure and 2 legs foundation failure		
i. Self-supporting tower failure and 2 legs and foundation failure		
j. Tower head and cross arm damage		
k. Cross arm failure		
l. Cross arm failure with insulator damage		
m. Cross arm failure with insulator and hardware damage		
n. Cross arm failure with insulator, hardware and conductor damage		
o. Self-supporting Tower leg failure		
p. Guyed tower mast failure		
q. Guyed tower mast failure and guy failure		
r. Guyed tower mast failure, guy and guy foundation failure		
s. Guyed tower mast failure, foundation, guy and guy foundation failure		
t. Tower leaning with foundation and guy damage		
u. Tower leaning with tower and guy foundation and guy wire damage		
v. Guy wire failure		
w. Guy wire failure with guy foundation damage		
x. Guy wire failure with insulator damaged		
y. Guy wire failure with guy foundation and insulator damage		
z. Earth wire peak failure		
aa. Earth wire peak failure with conductor damage		
bb. Earth wire peak failure with earth wire damage		
cc. Earth wire peak failure with earth wire and conductor damage		
dd. Conductor damage external fault		
ee. Conductor damage vibration/galloping/lightning		
ff. Earth wire conductor damage		
gg. Insulator failure		
hh. Insulator failure with conductor damage		
ii. Insulator failure with conductor and hardware damage		
jj. Hardware failure		
kk. Hardware failure with insulator damage		
ll. Hardware failure with insulator and conductor damage		

2. How many structures are damaged? (Ensure to check adjacent structures for damage damage that may not be intially apparent).

3. Record the identification numbers of the structures that are damaged or have damaged hardware on them.

4. Can the legs/mast of the tower be re-used? – (take pictures of tower sections).

Yes ☐ No ☐

Comments

5. If conductor is damaged, between which structures is the damage located?

6. Can the structures be reused?

Yes ☐ No ☐

Comments

7. Can the structure foundations be reused?

Yes ☐ No ☐

Comments

8. Can the guy wire foundations be reused?

Yes ☐ No ☐

Comments

9. How many meters of conductor is damaged? (1 full step ~ 1m)

10. Give a description of the failure and possible cause.

11. Give details of possible bypass route (include GPS coordinates or measurements).

12. Is the access route clear of obstacles? Provide any details on obstacles (waterbodies, culverts, bridges).

Yes ☐ No ☐

Comments

13. Give details on soil conditions in the area (rock outcrops, wetland/bogs).

14. Give details on snow depth and clearance to lines/jumpers.

15. Any other notes, observations.

Power Supply - Nalcor Energy
Emergency Response Plan Site Assessment Check sheet
Date:

PURPOSE: Try and record as much information about the fault as possible so that the correct response can be implemented.

Safety Check	Yes	No
Is the power to TL 3501 shut off (confrmed with ECC)?		
Is the section of failed line isolated (grounds in place)?		
Are there near by transmission or distribution lines that might be of concern for flashover or induction?		

Incident Checklist	Yes	No
1. What is the possible cause of the fault?		
a. Tower foundation damage		
b. Guy foundation damage		
c. Guyed tower Failure		
d. Self-supporting tower failure		
f. Cross arm failure		
g. Self-supporting Tower leg failure		
h. Guyed tower mast failure		
i. Guy wire failure		
j. Anchor failure		
k. Earth wire peak failure		
l. Conductor damage external fault		
m. Conductor damage vibration/galloping/lightning		
n. OPGW damage		
o. Insulator failure		
p. Hardware failure		

2. How many structures are damaged? (Ensure to check adjacent structures for damage that may not be intially apparent).

3. Record the identification numbers of the structures that are damaged or have damaged hardware on them.

4. Can the legs/mast of the tower be re-used? – (take pictures of tower sections).

Yes ☐ No ☐

Comments

5. If conductor is damaged, between which structures is the damage located?

6. Can the structures be reused?

Yes ☐ No ☐

Comments

7. Can the structure foundations be reused?

Yes ☐ No ☐

Comments

8. Can the guy wire anchors be reused?

Yes ☐ No ☐

Comments

9. How many meters of conductor is damaged (considering both pole)? (1 full step ~ 1m)

10. Give a description of the failure and possible cause.

11. Give details of possible bypass route (include GPS coordinates or measurements).

12. Is the access route clear of obstacles? Provide any details on obstacles (waterbodies, culverts, bridges).

Comments — Yes ☐ No ☐

13. Give details on soil conditions in the area (rock outcrops, wetland/bogs).

14. Give details on snow depth and clearance to lines/jumpers.

15. Any other notes, observations.