Q. Please provide a copy of Hydro's most recent Asset Management Strategy Update.

A. Please refer to PUB-NLH-034, Attachment 1: "Asset Management Strategy Update," October 15, 2018.

Asset Management Strategy Update

October 15, 2018

A Report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro
a nalcor energy company

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1. Introduction

On September 19, 2018, the Board requested that Hydro provide a more full response to Liberty's Recommendation 4 as outlined in the August 30, 2018 report and provide *"a specific plan on organizational actions that need to be taken to provide both an improved program and improved skills and capabilities in asset management."*

Attached to this report (Appendix A) is a summary of Hydro's Asset Management Plan, outlining key tasks/activities accomplished during the 2016-2018 period and areas of focus identified for the 2019-2021 period. The information found within this report applies to Hydro's entire generation fleet (i.e., hydraulic, gas turbine, and the Holyrood thermal generating assets). Certain aspects of Hydro's generating fleet asset management activities are further advanced than others, a reflection of the evolving nature of an Asset Management Plan which encompasses assets at varying ages and conditions.

Hydro's Asset Management Plan is built on the pillars of people, process, and equipment.

1) People: the asset management focus which includes, but is not limited to, identifying required skills and capabilities, obtaining necessary training, the development of a supportive organizational structure, recruitment and retention for keys roles in a supporting structure, and development of key responsibility areas and objectives for roles in each functional area, as identified in the Asset Management Plan.
2) Process: the portion of asset management that focuses on establishing, improving, reviewing, and auditing formal processes for use throughout all functional areas of the company, where appropriate.
3) Equipment: the management of the physical assets, including, but is not limited to, preventive maintenance programs and corrective maintenance, the use of operational technology to gain a better understanding of the asset health and condition, the execution of required capital upgrades, and the identification and procurement of critical spares.

Since 2016, Hydro's initiatives for its Asset Management Plan have been largely identified, documented, and monitored inside of annual Reliability Improvement Plans. These annual initiatives are prepared by each generating asset class during the latter portion of the fourth quarter of each year and finalized in the first quarter of the following year. The initiatives highlight key deliverables in the areas of people, process, and equipment and are developed considering asset performance. As would be expected with varying levels of asset performance, the deliverables differ across the asset classes. While they do differ, they follow the corporate reliability improvement focus and asset management framework. The annual deliverables of the Reliability Improvement Plan are a combination of items selected from the departmental plans, the Enterprise Risk Management Risk Register, the Integrated Annual Work Plan – which includes the Winter Readiness Plan and the Capital Plan – as well as items identified in each functional area as having potential impact on asset reliability. In addition to items identified through the Reliability Improvement Plans, other initiatives may be completed based on criticality of need or appropriate opportunity for completion (e.g., known issues with a particular asset component which is applicable across the fleet).

Hydro is currently in the process of completing its planning for 2019 through which initiatives will be identified for 2019 and beyond. As such, the Asset Management Plan activities for 2019-2021 found in Appendix A do not provide timeframes for various activities as the planning process will not be complete until the first quarter of 2019.

2. Asset Management Overview

Hydro defines asset management as the comprehensive management of assets: requirements, planning, procurement, operations, maintenance, and evaluation in terms of life extension or rehabilitation, replacement, or retirement to achieve maximum value for the stakeholders based on the required standard of service. It is a holistic lifecycle view on the management of assets.

Hydro has established an asset management system which is modelled after industry best practices. The framework for the asset management system is laid out and has undergone revisions to ensure best practices are being utilized in a manner that is practical and within Hydro's ability. Using this framework contributes to Hydro's progress on asset maintenance, reliability and lifecycle management. A hallmark of a strong asset management system is continual improvement. Hydro is committed to annually assessing its asset management capabilities and establishing plans to improve people, process and equipment with the objective to improve reliability and asset management capabilities.

3. Past Initiatives

In recent years, Hydro has implemented a number of improvements in the area of asset management as it relates to the generating asset classes. There have been a number of initiatives in the areas of people, process and equipment that have been successfully implemented across all three generating asset classes – Hydraulic, Gas Turbine, and Holyrood Thermal. Additionally, there have been improvements implemented in individual asset classes, with particular distinction in the area of equipment. Not all improvement initiatives will be common to each generating asset class; this is due to the difference in current life cycle maturity of the physical assets and the supporting organizational structure.

3.1 People

3.1.1 Hydraulic Group

The focus to date for the Hydraulic group in the area of people has been on the effective utilization of the available resources to sustain and monitor the Asset Management Program. Training completed has focused on required training for operations personnel, as well as training in physical asset management and asset health related training such as Partial Discharge Analysis, Vibration Monitoring techniques, and generator basics and condition monitoring.

Other key accomplishments include:

1) Employee Complement Changes: Two Asset Specialist positions were established in the Hydraulic Production group; one with accountability of focusing on asset performance and reliability; one with accountability for electrical/protection and control operational oversight, data trending, and response to operational issues. Both positions did not previously exist inside the Hydraulic Production organizational structure and the job duties were spread across various other individuals, or were not previously captured. With these new resources dedicated to monitoring reliability performance as well as equipment performance, there is a single-point accountability for Long-Term Asset Planning ("LTAP") to ensure that issues are investigated in a timely and thorough manner and that the appropriate remedial actions are identified and completed. Additionally, there is now a single person responsible for ensuring that appropriate data is being collected and that key equipment indicators are being trended. As these positions are new, the development of required skills and capabilities is ongoing.
2) Owner's Engineer: To ensure that the appropriate expertise is present when completing complex, critical pieces of work (major unit overhauls to improve the technical knowledge basis of employees) the Hydraulic Production team has started engaging external consultants. These external consultants act as Hydro's "Owner's Engineer" in the execution of pieces of work. This has helped staff gain exposure while working with subject matter experts in the preparation of necessary procedures, drawings, and commissioning plans and is growing the knowledge base of Hydro.

3.1.2 Gas Turbine Group

Over the last few years, the Gas Turbine group has been focused on building a team to operate and manage the gas turbine assets. The training completed by the group has focused on control system training for Gas Turbine Operators as well as the maintenance staff responsible for relief operation and troubleshooting of the unit in Happy Valley-Goose Bay. Training has also been completed on Programmable Logic Controllers ("PLCs") for the Holyrood Gas Turbine operations and maintenance crews to facilitate the ability to troubleshoot more effectively.

Additional training on the Hardwoods Automatic Voltage Regulator ("AVR") was completed to aid in the troubleshooting and diagnostic efforts for this unit.

Key accomplishments include:

1) Organizational Structure: Recruited staff for approved positions – general manager, asset specialist, equipment engineer, and production supervisor – to establish a supporting organizational structure dedicated to the operations and management of the gas turbine assets. This dedicated structure with the mentioned employee complement did not previously exist several years ago.
2) Engagement of Outside Expertise: Established relationships with Gas Turbine Original Equipment Manufacturers ("OEMs") to assist in troubleshooting operational issues, repeat failure issues, and the development and revision of maintenance strategies. The initial engagement of this outside expertise in the items listed has allowed for timely resolution of issues and facilitated knowledge transfer between the OEM experts and Gas Turbine staff. This has better prepared Hydro staff to troubleshoot and resolve operational issues and better manage the asset availability and reliability.
3) Training: with the development of necessary foundation training and ongoing hands-on development, there has been improved response to unit start-up issues, forced outages, and other operational concerns. The improved knowledge and ability to interrogate and resolve issues has resulted in improved asset availability and reliability.

3.1.3 Holyrood Thermal Generating Station

For the Holyrood Thermal Generating Station ("Holyrood"), the focus has been on maintaining the trained staff and stabilizing the workforce through securing key personnel to operate and maintain the plant asset through March 2021. Effective asset management requires competent people to execute and enhance the process, and manage the equipment. As a result of the coming operational changes at Holyrood, Hydro is focused on ensuring that the people required to maintain the asset, execute the preventive maintenance program and other asset management processes, and reliably operate the equipment, are secured through the

remaining life of the plant. To support the people aspect of the Asset Management Plan for Holyrood, a dedicated Human Resources position was implemented to focus on recruiting, engaging, and retaining key people that impact the asset management work at Holyrood. From a training perspective, training completed has focused on mandatory training and in-house group training on key reliability topics including turbine governor training for plant instrumentation staff, and boiler training for plant operations staff which has contributed to an improved ability to monitor the asset base and respond to operational concerns in advance of issues.

The Holyrood group has also focused on ensuring strong contracts are in place to supplement internal resources, aiming to provide for appropriate asset management and ability to respond in the event of issues.

Select examples include:

1) Extended service agreements with OEM Contractors for major assets including turbines, generators, boilers, major pumps. These companies provide regular maintenance of major assets, utilizing industry experts. As the OEM, they provide engineering and field service expertise to ensure safe and reliable operations of the equipment.
2) Awarded service agreement to local motor service provider. This company is well experienced in motor servicing and provides local, rapid service.
3) Awarded Maintenance Contract to a local labour contractor to protect from any future inability to adequately staff the Holyrood shops. This ensures that Holyrood will always have skilled resources to perform maintenance activities and execute the PM Program and Capital Program.

3.2 Process

In the last number of years, there have been many corporate process improvements which have been successfully implemented across all generating asset classes. These include the implementation of corporate work management processes, the development of the Integrated

Annual Work Plan (including the Winter Readiness Plan and the Capital Plan), the development and regular update of the Enterprise Risk Management Risk Register, the development and proper use of management of change processes, as well as the use of formal outage tracking and investigation reporting templates.

Select previous process-related initiatives include:

1) Established a Reliability Improvement Plan, which is implemented annually and tracked monthly which focuses on reliability centered items from the various corporate plans.
2) Recently upgraded JD Edwards EnterpriseOne software and, in conjunction with the upgrade, Hydro has implemented five asset management system business processes. This upgrade allows Hydro to avail of improved aspects of the new software and these updated processes, such as the improved ability to record, analyze and report on equipment data software and asset management applications.
3) Improved operational readiness focus by prioritizing the annual work plan to include Winter Readiness activities, conducting monthly reviews of completion, and regular tracking to ensure winter readiness activities.

3.2.1 Hydraulic Group

In addition to the common process improvement initiatives, there have been new processes and process improvements implemented in the last number of years by the Hydraulic group that focus on improving reliability and generating asset performance.

Select examples include:

1) Established Enterprise Risk Management ("ERM") system. In the past, equipment issues were captured in work orders but transparency regarding risk to reliability from a system perspective was lacking. Hydro determined that it was appropriate to capture these risks and mitigating actions in a formal register as a methodical means of review. The update and evaluation of risk is reviewed and updated on a quarterly basis to continually manage and mitigate risks.

2) The Hydraulic Production Team began daily priority review meetings for newly entered work orders. The attendance was expanded to include a representative of the Asset Management group
3) Monthly Generation Performance Meetings are conducted by the Asset Specialist - Performance and Reliability to review and discuss production statistics, outage data, complete and outstanding action plans, ongoing and new reliability concerns and work order reports. These meetings are working to improve the equipment and system reliability as they bring focus to ongoing and repeat issues, as well as provide an opportunity for all key stakeholders to come together and discuss the asset base
4) Forced Outage Investigation standard was revised.
5) Forced outages and deratings which have been tracked in an excel document since 2008 are now also captured inside a Forced Outage Remedial Action Database. There has been increased emphasis on using this tool. This database provides documentation and tracking tool, not only for outages, but also for the follow up remedial actions generated as a result of the investigations. These remedial actions are one of the most important tools Hydro uses to ensure root causes have been addressed and to prevent future occurrence of similar issues across the hydraulic generating fleet. Unlike the original excel document, this database has functionality to send automatic reminders and complete simple reporting on the status of investigations and remedial actions. This allows an automatic process to assure that after actions are assigned, individuals are notified and reminded of the actions assigned to them and the due dates associated.
6) Work Order Management Reports were created and implemented as part of Hydro's ongoing effort to increase visibility of reliability drivers. Hydro recognized gaps in the work order management of work orders that were cancelled or not completed in the planned timeframe. This lack of visibility on incomplete or cancelled items had the potential to result in pieces of work being missed and then creating reliability risks.
7) Established an on-going In-Service Failure capital project to facilitate refurbishment of failed equipment. This project allows work to be completed when necessary, in an

efficient, timely manner without an extended approval process, thus minimizing potential availability interruptions.

3.2.2 Gas Turbine Group

New processes and process improvements that focus on improving reliability and availability have been implemented within the Gas Turbine group in the past couple of years.

Select examples include:

1) Gas Turbine reliability was previously tracked using the Utilization Forced Outage Probability ("UFOP"). However, the gas turbines group has now also established asset availability tracking through the Derated Adjusted Utilization Forced Outage Probability ("DAUFOP"). This metric provides a better indication of asset availability and focuses attention to equipment issues that impact the ability to operate a plant a full capacity.
2) Established monthly review of asset performance against annual target and time to next maintenance interval (Holyrood Gas Turbine). A monthly performance report is now prepared by the Gas Turbine Asset Specialist which discusses asset performance and UFOP and DAUFOP data. This report is shared with the Gas Turbine team and contributes to the development of capital plans, departmental plans and items for the Operational Reliability Improvement Plan.
3) Implemented a system to track forced outages and forced de-ratings and associated investigations and remedial and follow-up actions. Investigations into equipment issues are completed and root causes identified. Remedial actions are implemented and lessons learned are applied to other gas turbine generating assets, where appropriate.

3.2.3 Holyrood Thermal Generating Station

At the Holyrood Thermal Generating Station, new processes and process improvements that focus on improving reliability and availability have been implemented in recent years.

Examples include:

1) Assigned Asset Specialist with strong operations background to daily production meetings.
2) Consolidated the Business Continuity Plan and the plant Risk Registry into an Enterprise Risk Management system that is tracked and updated quarterly.
3) Expanded the roles and responsibilities of on-call personnel to better understand the whole system perspective and how Holyrood's operation is impacted by or affects other parts of the system.
4) Implemented a system to track forced outages and forced de-ratings and associated investigations and remedial and follow-up actions. This process ensures that issues what impact plant Derated Adjusted Forced Outage Rate ("DAFOR") are documented and investigated. Remedial actions are assigned to ensure root causes are eliminated.
5) Completed asset management self-assessments and winter readiness self-assessments. This is an annual self-reflection, which identifies strengths, areas of improvements, and areas of relative weakness that can be improved.
6) Established an on-going In-Service Failure capital project to facilitate refurbishment of failed equipment. This project allows work to be completed when necessary, in an efficient, timely manner without an extended approval process, thus minimizing potential availability interruptions.

3.3 Equipment

For all generating asset classes, personnel have focused on identifying gaps in critical spares and have begun to close the gaps identified to ensure continued reliability of the generating fleet. This is working to ensure that various equipment components which, if damaged, would result in asset unavailability, is readily available to mitigate downtime and to ensure the equipment can be returned to reliable operation. Through identifying critical equipment and critical components, a list of critical spares has been developed in each asset class and work continues to close the gaps. As new equipment is installed and equipment is replaced, critical spares are identified and acquired.

3.3.1 Hydraulic Group

The Hydraulic group has focused on monitoring and improving equipment condition and performance. Improvement work on equipment to date has been driven by current condition assessments, ongoing performance trending – including key equipment indicators and preventative maintenance work and obsolescence. The focus has been on understanding current condition and planning necessary interventions to ensure continued reliable operation while providing the right time, right actions.

Select examples include:

1) Implemented a capital program to increase the presence of asset health and condition monitoring systems on its generating assets.
2) Ongoing review and updates of Preventative Maintenance checks to ensure that the current checks are thorough at discovering pre-indicators of equipment deterioration and are assisting in the development of the capital plan for overhauls, upgrades and replacement. This review also ensures that Preventative Maintenance ("PM") programs are modelled after current industry best practice for maintenance of specific equipment to ensure continued reliability of the asset base.
3) Began implementing improved collection, tracking, technical review and follow-up action of key equipment indicators. An example of an item that is now tracked more deliberately is the rotational seal clearances on generating units. The improved tracking of this measurement, as well as others, has improved the visibility on current asset health and as better equipped staff with adequate time to prepare for necessary intervention.

3.3.2 Gas Turbine Group

For the Gas Turbines group, the initial and ongoing focus has been on equipment condition and performance. Work on the equipment has been guided by condition, performance and obsolescence issues. Increased operation of standby assets has presented challenges from maintenance strategy and planning perspective. Capital work has primarily focused on

condition assessment and refurbishment work that is required to establish the condition of key components/assets, and replacing or refurbishing such assets as required ensuring reliable operation as well as acceptable levels of availability.

Select examples include:

1) Completed thorough site walk downs of Hardwoods and Stephenville Gas Turbines with stakeholders from the asset management, operations and maintenance personnel to identify and document operational issues, component obsolescence, history of repeat failure issues, etc. This exercise provided input to the development of capital plans, departmental plans as well as identified items for inclusion on the Reliability Improvement Plans.
2) Completed a review of maintenance practices with a renewed focus on the current operating requirements of the gas turbines. Through consultation with OEMs, industry best practice maintenance strategies were implemented, as appropriate at each site. This ensured that an adequate PM program was in place to ensure continued reliability of generating assets.
3) Retained loaner engines to allow for timely return to full capacity of the plant in the event of an engine failure. With the loaner engines secured, the downtime associated with an engine failure has been reduced, as now the only downtime experienced due to engine failure is that which is required to remove the failed engine and install the loaner. Prior to acquiring the loaner engines, the gas turbine plant would be operating at reduced capacity for the duration of the repair of the failed engine.
4) Established a Service contract with the OEM (Siemens) for Holyrood Gas Turbine. This service contract includes major maintenance activities as well as online remote monitoring and review of the unit performance by individuals at the Siemens office. Through online monitoring of the unit in operation, the Siemens staff are able to identify issues based on pre-warning indicators and can communicate these to operations and maintenance staff to ensure timely intervention. For the major

maintenance activities, leveraging the OEM facilitates knowledge transfer and access to subject matter experts to provide technical guidance and oversight.

5) The completion of capital projects related to replacement of obsolete equipment and equipment that has reached end of life. Replacing obsolete equipment allows for the asset management team to adequately stock spare parts as well as securing support from OEMs. Identifying end of life equipment and planning for its replacement was necessary to ensure continued reliable operation of the gas turbine plant.
6) Given the life stage of some of the gas turbine assets, it was necessary to perform major equipment maintenance activities to overhaul and replace components and ensure the units are prepared for continued operation.

3.3.3 Holyrood Thermal Generating Station

At the Holyrood Thermal Generating Station, work on the equipment has been guided by ongoing condition assessments which feed into the Capital Plan and the PM programs. Changes in the in-service dates for the Labrador-Island Link and the Labrador Transmission Assets has caused some challenges in ensuring that the right work is completed at the right time. Capital work has primarily focused on condition assessment work, which is required to establish the condition of key assets, and replacing or refurbishing such assets, as required, to ensure safe and reliable operation.

Select related initiatives include:

1) Completed Condition Assessment projects in accordance with the capital plan. Included Level 1 Condition Assessment Refresh which updated the previous extensive Level 1 assessment completed by AMEC by focusing on updated end of steam service dates and long-term assets required to operate beyond that time; Level 2 Condition Assessment of boiler and pressure parts, which is an ongoing project to ensure that critical safety equipment work is planned and executed; Stacks, Tank Farm life extension to ensure that fuel oil storage requirements are met for the life of the plant.

2) Completed significant reliability upgrades and replacements including, installation of a redundant Water Supply Line from Quarry Brook Dam, rewinding of the Unit 3 generator rotor, replacement of aging battery banks.
3) As a result of deratings associated with boiler air flow issues, an Engineering Assessment was completed. This identified work required to restore the boilers to full load capability. Work was completed on Unit 1 and Unit 2 and is in progress on Unit 3. Unit 2 has since returned to full load capability and similar results are expected for Unit 1 and Unit 3.
4) Refreshed the Asset Retirement Obligation Report, which includes a decommissioning plan for Holyrood assets. This plan feeds the Capital and PM programs and is a useful tool in making asset management decisions.
5) In addition to completing improvement work on critical spares. Holyrood has enhanced the critical spares database to facilitate quick and accurate tracking of spare parts status. This database directly queries the inventory in JD Edwards EnterpriseOne and provides updates on spares status.
6) Implemented Asset Specialist review of completed preventive maintenance check-sheets. This review ensures that all required checks are completed and that necessary data and detail is documented as expected. This provides an opportunity for any equipment abnormalities or variances to be identified and investigated appropriately.

4. 2019-2021

Looking forward, to align with the three-year planning period used in Hydro's departmental plans, the Production division of Hydro is undertaking the expansion of its Reliability Improvement Plans to multi-year plans. These multi-year plans will focus on the asset management areas of people, process and equipment. There will be improvement initiatives and organizational actions that will be common across all generating asset classes. However, as a result of the life cycle stage of each asset class, as well as the stage of maturity of the supporting organizational structure, there will be specific improvement initiatives in each asset class that may or may not be appropriate for the others.

4.1 People

In the area of people, a common focus across all generating asset classes is to confirm training and skill requirements and establish reasonable training plans for key resources. This will include:

4.1.1 Hydraulic Group

Improvement work for the Hydraulic group in the area of people will focus on the evolution of the organizational structure that will better support the areas of asset management thereby improving reliability and will determine training plans to further develop the knowledge base of the current team and the formalization of foundational training on processes for new hires and employee transfers.

Current select expected Initiatives include, but specific initiatives will be confirmed in annual planning:

1) Modify the organizational structure to better focus the LTAP group on long-term planning, and asset technical knowledge and analysis.
2) Determine training requirements to further improve asset management of equipment (i.e., condition monitoring such as vibration analysis, air gap monitoring, etc.).
3) Formalize foundation training plan on asset management process for new hires and transfers.
4) Establish cross-functional team to monitor effectiveness of reliability improvement efforts – individual areas are presently tracking efforts on their own.
5) Continue to leverage outside expertise in the form of “Owner’s Engineers” for major projects to facilitate knowledge transfer with Hydro staff as well as ensuring appropriate work is completed on assets.

4.1.2 Gas Turbines Group

The Gas Turbines group will focus on the evolution of the organizational structure for the gas turbines and diesel group and improving the knowledge base of the current team. Training requirements for operational and maintenance staff will be determined and executed.

Current select expected Initiatives include, but specific initiatives will be confirmed in annual planning:

1) Develop succession plan for Gas Turbine resources.
2) Develop future staffing plan for Gas Turbines and Diesel groups.
3) Determine training requirements to further the knowledge base of the asset management, operations and maintenance team.

4.1.3 Holyrood Thermal Generating Station

At the Holyrood Thermal Generating Station, the focus will be on retention and development of the key personnel including the continued technical training of staff on critical equipment.

Current select expected Initiatives include, but specific initiatives will be confirmed in annual planning:

1) Continue to emphasize the single-point accountability of asset ownership for LTAP personnel. This will involve asset management/reliability training, and more integration of the Long-Term Asset Planners in the PM program.
2) Leverage agreements with engineering consultants to assess and improve reliability initiatives within the plant. Hydro will reach out to consultants to look for opportunities to improve plant equipment reliability as well as facilitate knowledge and skills transfer to current staff.
3) Continue with retention plans for key personnel to ensure that the critical people required for continued successful asset management are retained.

4.2 Process

Beginning in 2019, the expansion of the Reliability Improvement Plan into a multi-year plan will be an initiative across all generating asset classes. In addition, improved consistency of forced outage and de-rating tracking and analysis will occur throughout the Production Division. This multi-year plan will also include ongoing assessment of performance in relation to the asset management system business processes and, if appropriate, actions to implement improvements.

4.2.1 Hydraulic Group

In the area of process, the Hydraulic group will focus on operating and maintenance data review, as well as the improvement of equipment performance.

Current select expected Initiatives include, but specific initiatives will be confirmed in annual planning:

1) Establish a temporary changes/jumper management standard for Hydraulic Production to formally capture modifications to equipment, both temporary and permanent. As well as establish a formal review process for evaluating the temporary changes.
2) Establish structured PM completion process to include Asset Specialist review of completed PM check sheets and trending of key indicators to improve early intervention on potential reliability issues.
3) Implement a formalized PM review process to ensure field mark-ups and suggested updates are completed prior to the next maintenance cycle.
4) Improve operations input into final decision on 5-year and 20-year capital plans with input from operations/maintenance staff.

4.2.2 Gas Turbine Group

The Gas Turbines group will focus on the review of operating and maintenance procedures and the improving asset performance review. In addition, improvements to forced outage tracking and analysis will be made consistent with the rest of the Production Division.

Current select expected Initiatives include, but specific initiatives will be confirmed in annual planning:

1) Review plant operating procedures and determine if there are requirements for additional/revised procedures.
2) Continue to review maintenance strategies and programs to ensure continual improvement.
3) Continue to review the results of preventative maintenance activities to ensure continual improvement.
4) Continue to work to improve planning, scheduling and execution of the Integrated Annual Work Plan ("IAWP") for the gas turbines.

4.2.3 Holyrood Thermal Generating Station

As Holyrood is nearing end of life, long-term initiatives are not planned. Therefore, recently implemented processes will continue to be refined.

Current select expected Initiatives include, but specific initiatives will be confirmed in annual planning:

1) Complete self-assessments of condition monitoring programs including lube oil, hydraulic fluid, and vibration monitoring. This will identify opportunities for improvements within these programs and will lead to improved reliability.
2) Investigate improving on-line condition and trend monitoring by leveraging service agreements with GE (turbine generator) and B&W (boilers and related equipment). Hydro will work with these companies to identify opportunities to detect problems before the happen.
3) Implement a formal process to improve review and evaluation of preventive maintenance program activities by LTAP personnel. This will create a more full review process for the current PM program by ensuring the LTAP reviews the work done and results achieved by reviewing check sheets and other documents.

4) Improve daily production meetings to ensure that key boiler process indicators are discussed and any issues identified and resolved. Agenda to be driven by safety, production threats, fouling prevention initiatives, forced outage database items, and results from Reliability Improvement Plan activities.

4.3 Equipment

The focus for equipment for the period 2019 to 2021 regarding equipment will be on the timely execution of preventive maintenance programs and required corrective maintenance for all assets, with continued diligence in the area of monitoring and analyzing key equipment indicators such as operations daily checks and condition monitoring. Ensuring that data is routinely collected, recorded and analyzed against operating parameters will contribute to a more robust long-term plan and the timely identification of future work.

4.3.1 Hydraulic Group

Improvement work for the Hydraulic group in the area of equipment will focus on execution of projects identified in the capital plan, planning for new equipment, upgrades, and modifications as required to ensure continued reliable operation of generating assets. Further, a focus will be on data collection, analysis and review to monitor asset health.

Current select expected Initiatives include, but specific initiatives will be confirmed in annual planning:

1) Continuing executing capital program to increase asset health and condition monitoring information including replacement of existing obsolete systems and installation of new dynamic monitoring systems for vibration, partial discharge, etc. The installation and upgrades to these systems will provide real time monitoring of asset condition which will aid in the analysis of system performance and will provide indication if deteriorating equipment condition prior to an issue occurring. This will allow for the asset management group to address these upcoming issues in a timely fashion and implement

mitigating measures in the interim to ensure continued reliable operation of the asset base.

2) Expand use of mobile data capture for operations inspections.
3) Review critical spares list and confirm the required testing/monitoring for each spare. Where identified, make required changes to PM program.

4.3.2 Gas Turbines Group

The Gas Turbines group will focus on ensuring continuing improvements in reliability and availability of the gas turbine assets through appropriate monitoring and tracking of performance, critical spares, and preventive maintenance.

Current select expected Initiatives include, but specific initiatives will be confirmed in annual planning:

1) Continue to monitor and track performance of all assets and complete monthly review of operational, reliability and availability data including recommendations for improvements. Having up to date information as well as regular discussion on the top of equipment performance enhances the asset management program by keeping focus on what is requiring attention.
2) Review critical spares and confirm the requirement for maintenance activities on those items. For any which are identified that require modifications, add to PM program as required.

4.3.3 Holyrood Thermal Generating Station

At Holyrood, work will focus on the execution of the capital plan, planning for new equipment, upgrades, and modifications for the transition to post-steam operation, and controlling boiler fouling through process control and optimization.

Current select expected Initiatives include, but specific initiatives will be confirmed in annual planning:

1) Focus on key boiler process indicators such as fuel additive dosage rates, Average Cold End Temperature with the intention to control boiler fouling. This will be executed through the daily production meetings and on-call person duties.
2) Focus on on-line maintenance of critical boiler components such as burners and sootblowers to ensure optimal performance. This will be executed through daily production meetings and on-call person duties.
3) Review and execute capital plan activities required to ensure smooth transition to post steam operation including plant heating, electrical equipment upgrades and modifications.

5. Conclusion

Hydro's continued commitment to improving its asset management approach and capabilities as it relates to the generation fleet is evident in the successful implementation of the improvement initiatives completed over the last number of years (identified in the asset management plan summary included in Appendix A). This commitment continues into 2019 and beyond with a focus on people, process and equipment.

The focus to-date in each asset class has varied as a result of the life cycle stage of each asset class, as well as the stage of maturity of the supporting organizational structure. Successful improvements identified in one asset class will be implemented across other generating asset classes, where appropriate, further lending to a cohesive approach to asset management in the generating fleet.

Looking forward, Hydro will continue to identify and document gaps and opportunities for improvements to asset management. Initiatives to address the gaps and opportunities will be prioritized for inclusion inside the Reliability Improvement Plans with high level action plans for implementation and deliverables. This plan will be revised on an annual basis. The plan for

2019-2021 is presently being developed and is expected to be finalized, along with the other corporate planning initiatives, in the first quarter of 2019.

Appendix A

Asset Management Plan

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Asset Management Area	Asset Class	Category	Initiative	2016				2107				2018				2019-2021
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
People	Hydraulic (Past)	Recruitment	Conduct local school presentations providing info around career opportunities within Hydro						X							
		Organizational Structure	Two Asset Specialist positions; one with accountability of focusing on asset performance and reliability and one with accountability for electrical/protection and control operational oversight, data trending and response to operational issues.									X			X	
		Consultants	Engagement of Owner's Engineer for knowledge transfer during major work packages	Ongoing initiative as resources are required.												
		Training	Complete three year plan with specific training required to maintain and improve the technical competency of the maintenance group. Plan considers risks with loss of specific skills due to retirement.								X					
	Gas Turbines (Past)	Training	Training/support for Holyrood Gas Turbine operators, Hardwoods operator and relief, for staff of the gas turbine in Happy Valley-Goose Bay, and Holyrood Gas Turbine maintenance staff				X									
		Recruitment	Continue to hire operator positions for Holyrood Gas Turbine as well as technical head office support roles	Work has been ongoing to develop organizational structure since 2014.												
		Training	Execute Control System training for Happy Valley							X						
		Training	Execute AVR Training for Hardwoods								X					
		Training	Execute Control System training for Hardwoods and Stephenville												X	
	Holyrood Thermal Generating Station (Past)	Service and Labour Contracts	Secure service agreements with OEM contractors for major assets.				X									
		Training	Execute Operator Training Program			X										
		Recruitment	Stabilize core Holyrood management as well as key operations and maintenance staff through end of steam, with contingency plans	Ongoing initiative.												
		Organizational Structure	Establish a dedicated HR lead in Holyrood to help manage organizational transition and recruit, engage, retain key people that impact the asset management.					X								
People	All Asset Classes (Future)	Training	Improve relationships with other organizations at the Society of Maintenance and Reliability Professionals Annual Conference												X	
		Training	Determine formal asset management training requirements for positions in Asset Management (e.g., Long-Term Asset Planning Managers, Equipment Engineers, Asset Specialists)	Target dates to be determined through corporate planning process through Q4 2018. Targets for 2019 milestones will be finalized in Q1.												
	Hydraulic (Future)	Organizational Structure	Adjust organizational structure to allow for improved focus on long term asset planning as well as improved focus on supporting real time technical support for operational issues.													
		Training	Determine training plan for physical asset management - such as conditional monitoring techniques													
		Training	Formalize foundational training on work management processes for new hires and employee transfers													
		Consultants	Continue to leverage outside expertise in the form of "Owner's Engineers" to facilitate knowledge transfer to Hydro staff													
	Gas Turbines (Future)	Organizational Structure	Develop succession plan for Gas Turbine resources.													
		Organizational Structure	Develop future staffing plan for Gas Turbines and Diesels group													
		Training	Determine future training requirements for Gas Turbines staff.													
	Holyrood Thermal Generating Station (Future)	Organizational Structure	Strengthen the asset ownership within the Long Term Asset Planning group.													
		Consultants	Continue leveraging engineering consultants to assess and improve reliability initiatives within the plant.													
		Organizational Structure	Continue with retention plans for key resources.													

Asset Management Area	Asset Class	Category	Initiative	2016				2107				2018				2019-2021
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Process	Hydraulic (Past)	Work Management	Complete 90% of IAWP Activities								X					
		Work Management	Conduct Monthly AWP Reviews								X					
		Work Management	Conduct Daily Coordination/Update Meetings								X					
		Winter Readiness	Complete 100% of Winter Readiness Activities								X					
		Preventative Maintenance Program	Implement a PM Completion Procedure						X							
		Preventative Maintenance Program	Support Implementation of PM Cancellation & Overdue Work Report							X						
		Work Management	Support Implementation of WO Backlog Report						X							
		Reporting	Implement the standard for generation outage investigations								X					
		Work Management	Implement Backlog Review of critical assets and ensure any priority work is included in the 2019 AWP											X		
		Work Management	Continue the daily Gatekeepers meeting focusing on prioritization and completion dates.												X	
		Work Management	Continue use of Work Order Priority and Backlog Reports to report on the progress of backlog review												X	
		Engineering Directives	Revise the remaining engineering directives that were identified as requiring revisions in 2017												X	
		Reporting	Conduct year-end review of Forced Outage Investigations/Reporting for compliance to Outage Investigation Standard												X	
		Engineering Directives	Develop a jumper management program (FM/Operations)												X	
	Gas Turbines (Past)	Reporting	Monthly review of asset performance	X												
		Work Management	Utilizing system of tracking forced outages and deratings	X												
		Reporting	Formalize reporting on DAUFOP									X				
	Holyrood Thermal Generating Station (Past)	Winter Readiness	Execute winter readiness self-assessment for Holyrood					X								
		Work Management	Develop & Implement monthly cancelled work order review, Holyrood						X							
		Work Management	In-service failure project									X				
		Work Management	Develop & Implement monthly work order priority & risk oversight tool, Holyrood							X						
		Forced Outages	Develop & implement standard equipment trip reporting, Holyrood								X					
Process	All Asset Classes (Future)	Reliability Improvement Plan	Expand Reliability Improvement Plan to a multi year plan.	Target dates to be determined through corporate planning process through Q4 2018. Targets for 2019 milestones will be finalized in Q1.												
		Forced Outages	Support improvements to the Forced Outage Database, and once completed, use the improved Database to track outages.													
		Communication	Increase interactions across the production division.													
	Hydraulic (Future)	Forced Outages	Continue to work towards alignment with CEA outage tracking mechanisms,													
		Preventative Maintenance Program	Formalize the review by Asset Specialists to be included in the PM completion process.													
		Capital Program	Improve Operations input to final decisions on the 5 year and 20 year plans.													
	Gas Turbines (Future)	Operating Procedures	Continue the review of plant operating procedures and implement any required modifications													
		Preventative Maintenance Program	Continue to review the preventative maintenance strategies for gas turbine assets.													
		Preventative Maintenance Program	Continue to review and monitor the results of the preventative maintenance program.													
		Work Management	Continue to work to improve the planning, scheduling, execution of the IAWP for gas turbines.													
	Holyrood Thermal Generating Station (Future)	Preventative Maintenance Program	Complete self-assessment of condition monitoring programs such as lube oil, hydraulic fluids and vibration monitoring.													
		Preventative Maintenance Program	Investigate improvements to on line condition and trend monitoring by leveraging service contracts.													
		Preventative Maintenance Program	Implement formal process to improve LTAP review and evaluation of PM activities													
		Communication	Improve daily production meetings to ensure that key boiler process indicators are discussed.													

Asset Management Area	Asset Class	Category	Initiative	2016				2107				2018				2019-2021
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Equipment	Hydraulic (Past)	Spares	Purchase spare excitation transformer for Unit 7			X										
		Capital Program	Identify Capital Replacement plan for all remaining Excitation Transformers	X												
		Spares	Complete the Critical Spares Analysis for remaining critical parts				X									
		Spares	Purchase the capital spares as outlined in the 2017 capital spares proposal								X					
		Spares	Update the multiyear plan to close the gaps in critical spares								X					
		PM Checks	Review and refresh PM program for transformers					X								
		Capital Program	Execution of reliability centered capital projects								X					
		Capital Program	Execution of reliability centered capital projects - Cat Arm spherical valve controls, Hinds Lake coolers, Upper Salmon rotor repairs,												X	
		Spares	Identify critical spares that require a maintenance program and develop a gap closure plan												X	
		Spares	Execute the 2018 portion of the critical spares maintenance program gap closure plan												X	
		PM Checks	Implement PM changes for the Penstocks/Surge Tanks based on any new recommendations from the 2017 Hatch report.												X	
	Gas Turbines (Past)	Spares	Continue to execute spares program				X									
		Capital Program	Continue to execute capital refurbishment program execution				X									
		Equipment Improvements	Develop short term fueling resupply capability for increased operation in November/Dec 2015			X										
		Equipment Improvements	Complete CI and overhaul, bearing modifications Holyrood Gas Turbine				X									
		Spares	Risk of unexpected failure of an engine in Hardwoods or Stephenville, retain loaner engine								X					
		Spares	Continue to execute critical spares program								X					
		Capital Program	Continue to execute capital refurbishment and upgrade program								X					
		Equipment Assessments	Execute PI condition assessment on Hardwoods & Stephenville Gas Turbines						X							
		Equipment Improvements	Investigate relocation of vibration probes on Hardwoods & Stephenville to improve signal accuracy and engine protection								X					
		Equipment Improvements	Establish vibration condition monitoring program for Hardwoods, Stephenville, Holyrood & Happy Valley						X							
		Service Agreements	Establish Long-Term Service Agreements with Siemens for Holyrood Gas Turbine						X							
		Tooling	Procure critical capital tools (boroscope, pressure calibrator)						X							
		Tooling	Procure critical capital tools (lube oil filter carts)					X								
		Tooling	Procure critical capital tools (thermal imaging camera, meggar)						X							
		PM Checks	Initiate fuel quality sampling program, Hardwoods & Stephenville, consider need at Holyrood						X							
		Service Agreements	Complete remote monitoring system install for Holyrood Gas Turbine									X				
		Spares	Execute critical spares program Holyrood Gas Turbine												X	
		Equipment Improvements	Implement PI recommendations at Hardwoods & Stephenville Gas Turbines										X			
	Holyrood Thermal Generating Station (Past)	Spares	Pursue purchase of required spares				X									
		Equipment Improvements	Overhaul one set of feedwater valves per year				X									
		Equipment Assessments	U1 & U2 Stator Assessment by IRIS Power								X					
		Equipment Assessments	Amec Level 2 pressure parts condition assessment								X					
		Equipment Assessments	Fuel tank #2 In-service inspection and life extension study								X					
		Equipment Improvements	Upgrade controls section of stage 1 exciters to UNITROL 6000 standard								X					
		Equipment Improvements	Reliability improvement project: (1.) Boiler airflow & heat xfer equipment, expansion joints, air htr o/h, baskets & seals. (2.) Piping, valves, steam tracing and screens, incl. feed water, steam & cooling water systems. (3.) Turbine & generator lubrication, electrical and control equipment incl. starters, Mark V turbine controls syste, probes & cables.								X					
		Equipment Improvements	Execute planned 2017 turbine valve and major pump overhauls								X					
		Equipment Improvements	Perform boiler cleaning on U1 & U2								X					
		Equipment Improvements	Complete 2017 priorities from Level 2 condition assessments (piping)								X					
		Equipment Improvements	Replace/repair valves identified in defective valve surveys								X					
		Equipment Assessments	Mark V turbine control system reliability improvements; Interrogate inventory and determine OEM recommended critical spares & investigate options for service agreement										X			
		Equipment Improvements	Implement plan for Action items from AMEC Level 1 Condition Assessment refresh completed in 2017.										X			
		PM Checks	Ensure Emergency and Black Start Diesel PM's are completed prior to 2018/2019 operating season.											X		

Asset Management Area	Asset Class	Category	Initiative	2016				2107				2018				2019-2021
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Equipment	All Asset Classes (Future)	Equipment Assessments	Continue completing required monitoring and analysis of key equipment indicators such as operational daily checks, condition monitoring, etc.	Target dates to be determined through corporate planning process through Q4 2018. Targets for 2019 milestones will be finalized in Q1.												
		Equipment Improvements	Execute reliability and availability related projects within the Capital Plan.													
	Hydraulic (Future)	Equipment Improvements	Continuing expanding the use of asset health and condition monitoring systems by replacing existing obsolete systems and installing new systems.													
		Operational Oversight	Expand the use of mobile data capture for operations inspections.													
		Spares	Review critical spares list and confirm the required testing/monitoring required for each spare.													
	Gas Turbines (Future)	Equipment Assessments	Continue to monitor and track performance of all assets and complete monthly reviews of operational, reliability and availability data.													
		Spares	Review critical spares and confirm the requirement for maintenance activities on these spares.													
	Holyrood Thermal Generating Station (Future)	Equipment Assessments	Focus on key boiler process indicators such as fuel additive dosage rates, average cold end temperature with the intent to control boiler fouling.													
		Equipment Assessments	Focus on on-line maintenance of critical boiler components such as burners and sootblower to ensure optimal performance.													
		Equipment Improvements	Review and execute capital plan activities required to ensure smooth transitions to post steam operation - including plant heating, electrical equipment upgrades and modifications.													