Q. Western Avalon T5 Tap Changer: Please provide the oil quality testing result records for the Western Avalon T5 transformer tap changer compartment for 2010 to January 2014.

A. Hydro completes oil sampling and analysis of tap changer compartments on a three-year cycle as indicated in Hydro's response to PUB-NLH-174 in the *Investigation and Hearing into Supply Issues and Power Outages on the Island Interconnected System*, attached as PR-PUB-NLH-034 Attachment 1. All oil sample analysis results are reviewed by Hydro engineers and re-sampling and close monitoring occurs if readings fall outside accepted levels to ensure appropriate actions are implemented.

For Western Avalon T5, there are two oil quality testing records during this period: one from March 6, 2012 and the other from May 9, 2012. The May 9, 2012 was a re-sample based on Hydro's criteria to take another oil sample within six months if the TASA result is greater than 3. Both records are contained in the attached laboratory report (see PR-PUB-NLH-034 Attachment 2). The tap changer compartment oil was replaced with new oil in July 2012.

Q. Please describe Hydro's terminal station and substation inspections policies and practices. In the response include who conducts the inspections treatments, how the inspections and the resulting repairs are tracked, whether inspectors use paper forms or handheld computers, whether Hydro has a formal policy stating the number of inspections to be completed each year and the expected inspection and repair (CM) completion rates, the level of management who monitors the completions consistent with policy and schedules and the title of the person held accountable for the completion of the inspection work consistent with the policy and the schedule.

A. Hydro's terminal station inspection practices are outlined in PUB-NLH-174 Attachment 1 and Hydro's substation inspections practices are outlined in Hydro's response to PUB-NLH-174 Attachment 2. Inspections are planned by the regional planning group and are placed in weekly schedules to be executed by the appropriate front line supervisors. The front line supervisors are then tasked with ensuring the weekly schedule is completed as outlined. All work is completed using a work order system and any new work identified during the course of the requested job, is either completed at that time or documented on the work order to ensure there is another work request placed on the system. All work orders are given to the crews in paper copies and they are expected to document the actual work performed on the paper copied work orders. Each work order upon completion is reviewed and signed off by the supervisor to ensure quality of documentation of actual work performed, test results are reviewed and to understand if there is any follow up work required. All new work requests for corrective maintenance (CM) work are typically keyed by an office clerk when they key the actual work performed from the paper copy completed work order.

Once a new work request comes onto the system, this work order is reviewed by the work execution group to approve the work request for planning and define the priority. The Short Term Planning and Scheduling (STPS) Group assesses the job for parts and labour and once parts are received, the job is placed in a "waiting to be scheduled" status. Jobs waiting to be scheduled are considered in "backlog". To maximize productivity and minimize cost, planners review the backlog to, where possible, group work for a given location.

For preventative maintenance (PM) work, the STPS Group will generate the PM work orders within the Computerized Maintenance Management System (CMMS) in accordance with the frequency as set up within the management system. PM activities are identified on the annual work plan and are placed in the weekly schedule by the planner responsible for the given area. Like CM work orders, workers use paper copies of the work orders but in the case of PMs, maintenance staff also use paper checksheets to document their findings. Checksheets along with the completed work orders are reviewed and signed off by the supervisor. If equipment problems were identified, the supervisor would either contact a management person in the Work Execution Group or contact an equipment engineer or asset specialist within the Long Term Asset Planning Group for further direction. All completed work orders, after being reviewed by the supervisor, are passed along to an office clerk for keying the actual work performed into the CMMS system and also scanning the work order and the associated checksheets. All PM work orders are also sent to the asset specialist for a follow up review.

Hydro schedules inspections in accordance with its PM program, which varies by equipment. At this point, Hydro has not established a formal policy stating the number of inspections to be completed each year and the expected inspection and repair (CM) completion rates. However, Hydro does set an annual inspection (PM) target of 90% of the inspections planned for each year.

There are three functions of asset management that ensure inspections are identified, scheduled, executed and tracked. They are:

1. Long Term Asset Planning (LTAP) - the LTAP Manager is accountable for developing the preventive maintenance program. Accountability's include setting/modifying inspection frequencies, determining/modifying maintenance tactics and ensuring the PM program is set up in the CMMS. The LTAP Manager also tracks any changes to the PM program.

2. STPS - the STPS Supervisor ensures the PM program is included on the annual work plan, that revisions/additions to PMs are entered into the CMMS, all activities have resources identified and that weekly work schedules are developed. The STPS Supervisor also tracks progress of the annual work plan through monthly reports and annual work plan review meetings.

3. Work Execution (WE) - the WE Manager is accountable for execution of the PM program as identified in weekly schedules and annual work plans and to report back through the STPS Supervisor any deviation of actual work completed verses plan. The WE manager also ensures details of actual work completed are recorded in the CMMS and that corrective maintenance work orders are initiated for deficiencies found during PM inspections.

The Regional Manager is accountable for oversight and measurement of the STPS and WE functions and to ensure recovery plans are in place when the actual work completed deviates from the plan. In addition, the Regional Manager is accountable for reporting progress of the PM program to the General Manager and status of any required recovery plans. The General Manager is ultimately accountable for all facets of asset management and to be fully engaged in ensuring recovery plans are in place and that performance measures are reported to the Leadership Team.

Summary of Inspection Practices in Terminal Stations	
Air System Monthly PM	Check oil, belts, record running hours, discharge system to check cut in/out of compressors, clean unloaders, check filters, operate dryer, and take dew point.
Air System Annual PM	Check Dew point Change filters, change oil, replace desiccant, clean condensate drain, function test compressors and dryers, and complete ultrasonic leak detection.
120 Day Station PM (some are 180 Day)	Visually inspect building and grounds, check battery bank and chargers, compressors and dryers (if applicable), visually inspect transformers, breakers, CT's, PT's and disconnects, confirm terminal station supplies, and change eye wash station solution.
Station Annual Infrared Scanning PM	Complete a scan of each connection in station using infrared camera looking for hot spots.
Breaker Annual PM	Operate breaker locally and remotely to confirm operation
Breaker 6 Year PM	Air Blast- Conduct ductor, timing, trip coil measurement, check auxiliary contact, check pressure switches, function test breaker, measure trip coil resistance SF6- Check SF6 pressure, timing , operating mechanism pressure, ductor, measure trip coil resistance, check pressure settings, check primary connections, lubricate mechanism and function test breaker. OCB - Change oil in compressor. Check dash pot oil level, breaker in open position. Check pressure switches and record if applicable. Inspect contactors. Lubricate Operating mechanism. Measure and record run time of compressor from cut-in to cut-out Measure interrupter resistors (138 KV kSO only) Check bushings and wipe down if required. Complete a dielectric test ASTM 877 of the oil. Perform megger of each phase to ground with the breaker in the closed position . Perform ductor. Items added in 2014 are : to make timing and doble a required test for OCB's, make timing test a required test for all 69 kV breakers and above (regardless of type and function) in areas that currently have timing sets. Other areas to start timing tests in 2015. For SF6 and Air Blast 230 kV breakers, function test breaker through the protection.
Breaker Air System Annual PM	Check Dew Point, Change filters, change oil, replace desiccant, clean condensate drain, function test compressors and dryers
OCB Oil Sample PM (BOA) (3 year PM)	Complete oil analysis for condition ranking of Oil Circuit Breakers

Summary of Inspection Practices in Terminal Stations	
Transformer Oil Sample Annual PM (DGA and Oil Quality)	Sample all non sealed transformers annually or as recommended by Equipment Engineer for Dissolved Gas Analysis and Oil Quality. (Sealed units are completed every three years). Furan analysis is completed every 4 years
Tap Changer Oil Sample PM (TASA) (3 year PM)	Complete DGA and particle count analysis for condition ranking of tap changers
Power Transformer 6 Year PM	Perform oil dielectric for main tank and diverter switches (as required), testing of protective devices (gas relay, fault pressure devices, winding and oil temperature devices), winding resistance testing, megger testing, Doble testing, check radiators and radiator fan controls, check main tank for rust, inspects bushings (confirm oil level) and arrestors, check core ground and inspect/replace silica gel. Check filter unit if equipped for diverter switch compartment
Disconnect Switch 6 Year PM	Manually operate the switch and check contact alignment, toggles, stops, linkage and ease of operation, Check contact pressure - observe jaw spread as blade rotates in jaw. On Kearney switches check that the blade is positioned opposite the pressure springs in the jaws. Check contacts for burns or wear. Check the silver plating for peeling or deterioration. Check hinge end shunts or wiping contact. Clean contacts and lubricate by applying grease and then removing so there is only a light film left. Lubricate linkage pivot points. If the switch is equipped with arcing horns, see that beads of material caused by burning are removed. Lubricate gears. Check ground mats. Test operate manually and electrically (locally and remote). Contacts on auxiliary switches and motor circuits should be cleaned. Apply a light film of grease to the gear train.
Instrument Transformer 6 Year PM	Visually inspect bushings, inspect junction boxes gaskets etc., check oil level and rust condition, check heaters and perform doble test (Updated as a required test in 2014 and will be will be implemented over a 6 year cycle)
Capacitor Bank 6 Year PM	Check primary connections, check grounding connections, clean bushings and support Insulators, check all fuses, record nameplate capacitance per phase, Measure capacitance for each phase. Compare to nameplate values, perform 5 kV Megger test phase to ground, check for leaks, after capacitor bank is energized record load current and voltage.

Summary of Inspection Practices in Terminal Stations	
Battery Annual PM	Check D.C. voltage, check that the charger ammeter reading. Check and record the voltage, conductance (MHOS) and temperature of each cell and inter-cell connecting straps. Flooded Cells :Measure and record the voltage and specific gravity of the pilot cell. Add water as required to bring levels in all cells to upper limits. Determine the pilot cell by lowest specific gravity. If water is added: Apply an equalize charge for 24 hours at 2.33 volts per cell If the equalize charge does not return the specific gravity of the pilot cell to "normal", continue the equalize charge for another 24 hour period. Check each cell for cracks, corrosion and Leaks . Inspect the plates for deterioration, buckling, etc. Working with FM Global as well on discharge testing critical battery banks on a 5 year cycle for flooded cell and a lower frequency for critical valve regulated lead acid (VRLA)
Station Relay/Meter Maintenance PM (6 year PM)	Complete relay testing of all protection relays in the station through current and voltage injections. Use Doble Protest Software to record test results. Complete function testing of the protection circuits.

Summary of Inspection Practices in Sub-Stations	
Substation PM - 120 days	Visually inspect building and grounds, check all pole structures and associated hardware. Visually inspect all sub-station equipment (regulators/reclosers) for general condition and signs of oil leaks.
Recloser - Monthly	Reclosers and associated hardware will be visually inspected by members of the linecrew. Demand load readings, counter operations and battery voltage will be recorded
Recloser - 120 Day	Visual inspection to be performed by electrical maintenance personnel which will include battery/charger and lamp test. Inspection also looks for sign of arcing, cracked bushings, deteriorated gaskets, oil leaks and signs of rust on both the recloser and the control cabinet.
Recloser - Annual	Visual inspection to be performed by electrical maintenance personnel which will include battery/charger and lamp test. Inspection also looks for sign of arcing, cracked bushings, deteriorated gaskets, oil leaks and signs of rust on both the recloser and the control cabinet.
Recloser - Duty Cycle	Frequency varies. The number of operations and magnitude of load current and fault operations are governing factors. Recloser is de-tanked and the interior is inspected for signs of water ingress and carbon build up. Oil is changed if necessary. Mechanism is cleaned and contacts inspected for burns and loose connections. Recloser is also fully function tested.
Regulator - Monthly	Regulators and associated hardware will be visually inspected by members of the linecrew. Regulator readings, counter operations and test terminal voltages to be recorder.
Regulator - 120 Day	Visual inspection to be performed by electrical maintenance personnel. Inspection also looks for sign of arcing, cracked bushings, deteriorated gaskets, oil leaks and signs of rust on both the regulator and the control cabinet. Visual check of all primary connections, and switches for signs of overheating. Regulator is also manually operated to confirm correct operation.
Regulator - 3 - 5 Year	Visual inspection to be performed by electrical maintenance personnel. Inspection also looks for sign of arcing, cracked bushings, deteriorated gaskets, oil leaks and signs of rust on both the regulator and the control cabinet. Visual check of all primary connections, and switches for signs of overheating. Complete meggar test on windings and an oil insulation test. Regulator is also manually operated to confirm correct operation.

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Tapchanger Activity Signature Analysis TASA ™

David Hicks	Location :	W.A.V	Date :	5/11/2012
Newfoundland Labrador Hydro	Bank & Phase :		Report Number :	5040672
	Serial Number :	066205-LTC	Purchase Order Number:	914315
P.O. Box 12400	Ventilation :		Manufacturer :	MR Reinhausen
St John's, NF A1B 4K7	Compartment :	Transfer	Model :	H111D40014510193W

		Sample Date :	5/9/2012	3/6/2012
		Laboratory No. :	5040672	5040113
		Container No. :	19157	19660
		Temperature :	30	35
H2	Hydrogen	(ppm) :	34195	14183
CH4	Methane	(ppm) :	2514	24
C2H6	Ethane	(ppm) :	122	41
C2H4	Ethylene	(ppm) :	2018	618
C2H2	Acetylene	(ppm) :	2291	617
CO	Carbon monoxide	(ppm) :	385	151
CO2	Carbon dioxide	(ppm) :	72	185
N2	Nitrogen	(ppm) :	54290	101868
O2	Oxygen	(ppm) :	6645	24789
		Total (ppm) :	102532	142476
		TDCG (ppm) :	41525	15634
		SHL (%) :	4.01	4.01
		ETCG (% in blanket) :	51.10	17.71
Particles		5 to 15 um :	9590	15075
Particles		15 to 25 um :	750	945
Particles		25 to 50 um :	200	100
Particles		50 to 100 um :	20	5
Particles		> 100 um :	0	0
D1533	Moisture	(ppm) :	8	6
D1816	Dielectric BV	(kV) :	35	36
D974	Acid Number	(mg KOH/g) :	0.005	0.018
D971	Interfacial Tension	(dynes/cm) :	39.6	37.2
D1500	Color Number	:	0.5	<2.0

Tapchanger Activity Signature Analysis Diagnostic Evaluation

TASA Assessment : 3

Sampling Interval : Recommend retest within in 90 days. Schedule overhaul within 6 months.

Operating Procedure : Monitor for increased heating. Evaluate range of LTC operation. Evaluate heating at different contacts.

Comments : A moderately abnormal dissipation of energy is noted. This is an advancing indication of fault or wear activity.
Partial discharge is indicated.
Heating is indicated.
Follow guidelines for oils with high flammable gas content.

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