

1 Q. Is T5 tested on a regular PM cycle? When was the last time it was tested/inspected?
2 Please provide the results of this inspection.

3

4

5 A. Transformer T5 was tested during PMs completed in 2006 and again in April and
6 June of 2014, under Hydro's Preventative Maintenance program. The results of the
7 latest PM indicate that the transformer is fit for service and are attached as PUB-
8 NLH-4 Attachment 1 (transformer power factor results) and Attachment 2
9 (additional transformer maintenance results). As indicated in Hydro's response to
10 CA-NLH-5 however, Hydro has consulted with Doble Engineering on this issue and
11 they have advised that the results obtained to date are inconclusive. Refer to CA-
12 NLH-5 for details on Hydro's plan to determine the moisture level in transformer T5.

Nameplate - Two-winding Transformer

Company	NL Hydro	Serial Number	2-306740
Location	Wabush TS	Special ID	T5
Division	TROL	Circuit Designation	T5
Manufacturer	FTPK	Configuration	D-Y
Year Mfg.	1978	Tank Type	SEALED
Mfr. Location	St Catherine, Ont. Canada	Coolant	OIL
Phases	3	Class	ONAN
Oil Volume	4850 LB	BIL	kV
Weight	19600 LB	Winding Config.	Delta-Wye
kV	44, 12.5	VA Rating	39.6, 38.6, 37.7, 36.7 kVA
Note			

Test Date	6/7/2014	Test Time	5:32:14 PM	Weather	SUNNY
Air Temperature	21 °C	Tank Temp.	20 °C	RH.	12 %
Tested by		Work Order #		Last Test Date	4/7/2014
Checked by		Test Set Type	M4K	Retest Date	
Checked Date		Set Top S/N		Reason	
Last Sheet #		Set Bottom S/N			

Bushing Nameplate

Dsg	Serial	Mfr	Type	C1 % PF	C1 Cap	C2 % PF	C2 Cap	kV	Amps	Year
H1	H1-45913-5300-25522	COB	GK	3	258			46	400	1978
H2	H2-45913-5300-25522	COB	GK	3	258			46	400	1978
H3	H3-45913-5300-25522	COB	GK	3	258			46	400	1978
X1	X1									1978
X2	X2									1978
X3	X3									1978
X0	X0									1978

Overall Tests

Meas.	Test kV	mA	Watts	%PF corr	Corr Fctr	Cap(pF)	IR _{auto}	IR _{man}
CH + CHL	10.004	20.695	0.7370		1.00	5489.3		
CH	10.004	9.135	0.3820	0.42	1.00	2423.2	G	
CHL(UST)	10.003	11.559	0.3590	0.31	1.00	3066.0	G	
CHL		11.560	0.355	0.31	1.00	3066.100	G	
CL + CHL	5.001	30.981	1.032		1.00	8217.9		
CL	5.002	19.423	0.6750	0.35	1.00	5152.0	G	

PUB-NLH-4, Attachment 1

Page 2 of 3, Wabush - Additional Transformation

CHL(UST)	5.002	11.560	0.3590	0.31	1.00	3066.3	G	
CHL		11.558	0.357	0.31	1.00	3065.900	G	
IWC:	mA: 20.695/20.695 , 1/1		watts: 0.7370/0.737 , 1/1		pF: 5489.3/5489.347 , 1/1			
IWC:	mA: 9.135/9.135 , 1/1		watts: 0.3820/0.382 , 1/1		pF: 2423.2/2423.157 , 1/1			
IWC:	mA: 11.559/11.559 , 1/1		watts: 0.3590/0.359 , 1/1		pF: 3066.0/3066.007 , 1/1			
IWC:	mA: 30.981/30.981 , 1/1		watts: 1.032/1.032 , 1/1		pF: 8217.9/8217.85 , 1/1			
IWC:	mA: 19.423/19.423 , 1/1		watts: 0.6750/0.675 , 1/1		pF: 5152.0/5152.019 , 1/1			
IWC:	mA: 11.560/11.56 , 1/1		watts: 0.3590/0.359 , 1/1		pF: 3066.3/3066.251 , 1/1			

Hot Collar Tests

Term ID	ID	Test Mode	Skirt #	Test kV	mA	Watts	IR _{auto}	IR _{man}
H1-45913-5300	H1	GROUND	1	10.003	0.0870	0.0110	G	
H2-45913-5300-25522	H2	GROUND	1	10.004	0.0870	0.0120	G	
H3-45913-5300-25522	H3	GROUND	1	10.006	0.0850	0.0120	G	
X1	X1	GROUND	1	5.002	0.0720	0.0040	G	
X2	X2	GROUND	1	5.002	0.0720	0.0030	G	
X3	X3	GROUND	1	5.003	0.0730	0.0030	G	
X0	X0	GROUND	1	5.001	0.0680	0.0030	G	
IWC:	mA: 0.0870/0.087 , 1/1		watts: 0.0110/0.011 , 1/1		pF: 23.025/23.025 , 1/1			
IWC:	mA: 0.0870/0.087 , 1/1		watts: 0.0120/0.012 , 1/1		pF: 22.948/22.948 , 1/1			
IWC:	mA: 0.0850/0.085 , 1/1		watts: 0.0120/0.012 , 1/1		pF: 22.592/22.592 , 1/1			
IWC:	mA: 0.0720/0.072 , 1/1		watts: 0.0040/0.004 , 1/1		pF: 19.001/19.001 , 1/1			
IWC:	mA: 0.0720/0.072 , 1/1		watts: 0.0030/0.003 , 1/1		pF: 19.051/19.051 , 1/1			
IWC:	mA: 0.0730/0.073 , 1/1		watts: 0.0030/0.003 , 1/1		pF: 19.306/19.306 , 1/1			
IWC:	mA: 0.0680/0.068 , 1/1		watts: 0.0030/0.003 , 1/1		pF: 17.996/17.996 , 1/1			

Insulating Fluid Tests

Sample Location	Deg C	Test kV	mA	Watts	%PF corr.	Corr Fact	IR _{auto}	IR _{man}
Main Tank		10	0.8870	0.0000	0.00	1.00	G	
IWC:	mA: 0.8870/0.887 , 1/1		watts: 0.0000/0 , 1/1		pF: 235.34/235.343 , 1/1			

Exciting Current Tests

	Mfr.	Type	Steps	Boost %	Buck %	Position Found	Position Left	Oil Volume
De-Energized Tap Changer								
On-Load Tap Changer								

			H1 - H3			H2 - H1			H3 - H2				
DETC	LTC	Test kV	mA	Watts	X	mA	Watts	X	mA	Watts	X	IR _{auto}	IR _{man}
3		10.042	15.468	141.56	L	5.991	59.346	C	15.326	142.95	L	G	
IWC:	mA: 15.468/15.468 , 1/1		watts: 141.56/141.559 , 1/1		pF: -1653.43/-1653.432 , 1/1								
IWC:	mA: 5.991/5.991 , 1/1		watts: 59.346/59.346 , 1/1		pF: 216.68/216.684 , 1/1								

IWC:	mA: 15.326/15.326 , 1/1	watts: 142.95/142.949 , 1/1	pF: -1465.98/-1465.983 , 1/1
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6 YEAR PM – TRANSFORMER (SEALED TANK TYPE) INSPECTION

System ID: T5 Station: WA Serial No.: 2-306740
 Manufacturer: Ferranti-Packard Type: ONAN K.V.A: 3000 KVA
 Test Date: 2014-06-07 Test Completed By: Phil W. J.D. J.D.E. W/O #: 1052764

NOTE: ALL TESTS MUST BE COMPLETED OR MARKED N/A (Unless Otherwise Instructed).

Sheet 1 of 2

WEATHER CONDITIONS: dry: ☒ rain: ☐ humidity: ☐ ambient temperature: °C

DIELECTRIC OIL TEST ASTM D-1816 (kV): Main Tank (Sample to be taken ONLY if Vacuum/ Pressure Gauge reads 0 or + Pressure)

Liquid

TEMP RELAY: (Check if Applicable)

First Stage Fans: Setting: <u>75</u> °C	Found <u>N/A</u> <u>75</u> °C	Left <u>75</u> °C
Second Stage Fans Setting: °C	Found <u>N/A</u> °C	Left °C
Alarm: Setting: °C	Found <u>N/A</u> °C	Left °C
Trip: Setting: °C	Found <u>N/A</u> °C	Left °C

LIQUID TEMP RELAY: (Check if Applicable)

Alarm: Setting: °C	Found °C	Left °C
Trip: Setting: °C	Found °C	Left °C

FAULT PRESSURE RELAY: (GAS DETECTOR)

Function Test control Circuit:	Tested Ok N/A ☒
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FAULT PRESSURE RELEASE DEVICE:

Function Test Control Circuit:	Tested Ok N/A
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VACUUM/PRESSURE GAUGE: (KPA)	Pressure	Zero	Vacuum
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RESISTANCE CHECKS

(including Wiring to Terminal Boards) 500 Volt Test

Test & record in Mega Ohms or N/A (Acceptable readings > 500 Mega Ohms)

		Line 1-line 2	Line 1/2 - GND
Winding Temp Relay:	Alarm	<u>N/A</u>	<u>N/A</u>
	Trip		
Liquid Temp Relay:	Alarm		
	Trip	<u>N/A</u>	<u>N/A</u>
Fault Pressure Relay:	Alarm		
	Trip		
Fault Pressure device:	Alarm		

**** Caution: Confirm all Primary Protection Circuits are open before Closing Links.**

OIL LEVELS(High , Normal , Low)

Main Tank:	Neutral Bushing:					
HV BUSHINGS:	H 1	<u>N/A</u>	H2	<u>N/A</u>	H3	<u>N/A</u>
LV BUSHINGS:	X1	<u>N/A</u>	X2	<u>N/A</u>	X3	<u>N/A</u>

6 YEAR PM – TRANSFORMER (SEALED TANK TYPE) INSPECTION

System ID: T5 Station: WA Serial No.: 2-306740
 Manufacturer: Ferranti-Packard Type: ONAN K.V.A.: 3000 KVA
 Test Date: 2014-06-07 Test Completed By: Phil W. J.D. J.D.E. W/O #: 1052764

OPERATING AMPERAGE: (If Applicable)

1 st STAGE FANS; 3.8 2 nd STAGE FANS: N/A CABINET HEATER OK

GROUND CONTINUITY (RESISTANCE): (Micro-Ohms)

NEUTRAL BUSHING:

HV. ARRESTORS:	H1	<u>N/A</u>	H2	<u>N/A</u>	H3	<u>N/A</u>
LV. ARRESTORS:	X1	<u>N/A</u>	X2	<u>N/A</u>	X3	<u>N/A</u>

OFF LOAD TAP CHANGER: (Located on the HV Winding)

Tap Position: 3 Found: 3 Left: 3

Off load Tap Changer (Confirm Mechanical Center):

Transformer Winding Resistance: Completed ☒ Yes ☐ No

DIELECTRIC ABSORPTION (5 KV): 10 MIN. DIVIDED BY 1 MIN. = INDEX

H-LG	1 Min.	<u>100,000</u> Mega Ω	10 Min.	<u>0</u> Mega Ω	Index.	%
L-HG	1 Min.	<u>100,000</u> Mega Ω	10 Min.	<u>0</u> Mega Ω	Index.	%
HL-G <u>H-L</u>	1 Min.	<u>103,000</u> Mega Ω	10 Min.	<u>0</u> Mega Ω	Index.	%

CORE GROUND: (500 Volt test)

Externally Connected Yes ☐ No ☒

RESISTOR: (Ohms) N/A CORE GROUND: (Mega Ohms)

RUST/PAINT CONDITION (A - Minor , B - Moderate , C - Severe)

MAIN TANK: <u>A</u>	RADIATORS: <u>A</u>
CONTROL CABINET: <u>A</u>	OTHER:

CHECKS COMPLETED:

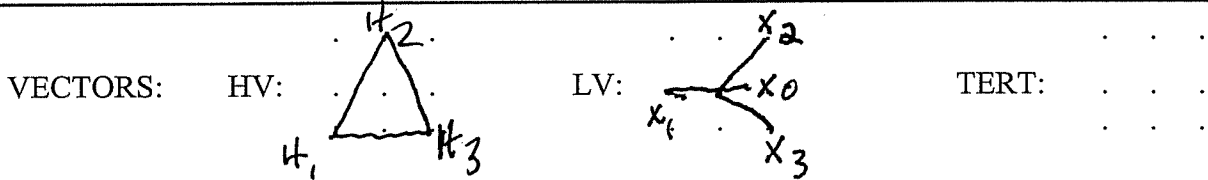
- ☒ Manually Operate Fans
- ☒ Check HV & LV Connections
- ☒ N/A Ladder Guards
- ☒ Check porcelain insulators for chips or cracks
- ☒ Visual Check For Dirty Insulators & Clean if Necessary

CHECKS COMPLETED ONLY IF INSTRUCTED:

- ☒ Obtain Gas Analysis Sample
- ☒ Transformer Ratio Readings
- ☒ N/A Capacitive Bridge Testing

COMMENTS:

System ID: T5 Station: WA Serial No: 2-306740 Manufacturer: Ferranti Packard
Type: OLTC ☒ TC High Voltage 46KV Low Voltage 12470 Tester Serial No: 45456
Test Date: 2014-06-07 Test Completed By: Phil W. J.D.E. W/O #: _____



- NOTE: 1. Complete Winding Resistance Test on Tap Position Found.
2. Complete Winding Resistance Test on Maximum Tap Position Raise.
3. Complete Winding Resistance Test on Maximum Tap Position Lower.
4. Confirm Mechanical Center (Off Load Tap Changers).
5. Complete Winding Resistance Test on Tap Position Left.

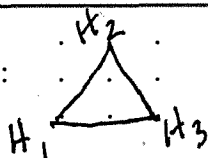
TAP CHANGER LOCATION: HV ☒ LV _____

TAP POSITION	WINDING TESTED	CURRENT RANGE	RESISTANCE RANGE	% CURRENT	RESISTANCE	RESISTANCE DELTA x 1.5
Found <u>3</u>	<u>H₁ - H₂</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.7</u>	<u>3.25</u>	
Found <u>3</u>	<u>H₁ - H₃</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.7</u>	<u>3.25</u>	
Found <u>3</u>	<u>H₂ - H₃</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.7</u>	<u>3.26</u>	
Max. Raise <u>5</u>	<u>H₁ - H₂</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.9</u>	<u>3.09</u>	
Max. Raise <u>5</u>	<u>H₁ - H₃</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.9</u>	<u>3.09</u>	
Max. Raise <u>5</u>	<u>H₂ - H₃</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.9</u>	<u>3.10</u>	
Max. Lower <u>1</u>	<u>H₁ - H₂</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.4</u>	<u>3.41</u>	
Max. Lower <u>1</u>	<u>H₂ - H₃</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.4</u>	<u>3.42</u>	
Max. Lower <u>1</u>	<u>H₂ - H₃</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.4</u>	<u>3.42</u>	
Left <u>3</u>	<u>H₁ - H₂</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.6</u>	<u>3.25</u>	
Left <u>3</u>	<u>H₁ - H₃</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.7</u>	<u>3.26</u>	
Left <u>3</u>	<u>H₂ - H₃</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.6</u>	<u>3.25</u>	
Non Tap Winding	<u>X₁ - X₀</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.4</u>	<u>.119</u>	
Non Tap Winding	<u>X₂ - X₀</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.4</u>	<u>.118</u>	
Non Tap Winding	<u>X₃ - X₀</u>	<u>500 mA</u>	<u>20Ω</u>	<u>101.4</u>	<u>.119</u>	
Tertiary Winding						
Tertiary Winding						
Tertiary Winding						

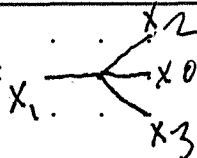
Note: Observe Indicator Light & Record OHMS or MILLI-OHMS

REMARKS:

HV:



LV:



TERT:

[illegible]