



## ADDENDUM NO.1

From: **Tony Chartrand**  
Subject: **Addendum No. 1**

Project No.: **6044**  
Issue Date: **10/15/2024**

Project Name: **Parsons #1 Used Substation  
Transformer**

These items part of Addendum No. 1 and this contract.

1. Attached are documents from the last time this transformer received maintenance, 2023.
2. Attached is the most recent oil sample with comparison to previous years.
3. We will allow the winning bidder to use subcontractors for the removal of the transformer.
4. The transformer would be available to be picked up shortly after the bid is awarded. An exact date can be negotiated.
5. The transformer currently has a Beckwith adapter plate and M-2001D controller. TCLP plans to remove the M-2001D from the unit prior to sale. If bidder would like to retain the M-2001D they should submit an alternate price in their bid for TCLP to leave the M-2001D installed.
6. Attached are pictures of the transformer.

Signed: \_\_\_\_\_  
Traverse City Light & Power

# 272700-87-1\_Transformer #1 Doble



**Report Source** Two-winding Transformer

**Session Test Date** 5/16/2023 2:43:02 PM

## Nameplate - Two-winding Transformer

<b>Company</b>	Traverse City Light & Power	<b>Serial Number</b>	272700-87-1
<b>Location</b>	Parsons Substation	<b>Special ID</b>	Transformer #1
<b>Division</b>		<b>Circuit Designation</b>	
<b>Manufacturer</b>	Kuhlman Electric	<b>Configuration</b>	Y_Y
<b>Year Manufactured</b>		<b>Tank Type</b>	Sealed
<b>Mfr Location</b>	Crystal Springs	<b>Coolant</b>	Oil
<b>Phases</b>	Three	<b>Class</b>	OA/FA
<b>Oil Volume</b>	3522 UG	<b>BIL</b>	350 kV
<b>Weight</b>	93700 LB		
<b>kV</b>	67, 13.8	<b>VA Rating</b>	12, 16, *, *, MVA

## Administration

<b>Test Date</b>	5/16/2023	<b>Test Time:</b>	2:43 PM	<b>Weather</b>	Partly Cloudy
<b>Air Temperature</b>	21.2°C	<b>Apparatus Temperature</b>	30°C	<b>Humidity</b>	20.965 %
<b>Tester</b>	ZLB	<b>Work Order</b>	GRB23075-350	<b>Date Last Tested</b>	
<b>Verified</b>		<b>Test Set Type</b>		<b>Date Retested</b>	
<b>Verification Date</b>		<b>Set Top Serial #</b>		<b>Reason</b>	Routine
<b>Last Sheet #</b>		<b>Test Set Model</b>		<b>Travel Time</b>	
<b>Purchase Order</b>		<b>Ins. Book #</b>		<b>Duration</b>	
<b>Copies</b>		<b>Sheet #</b>		<b>Crew Size</b>	

## Arrester Nameplate

Location	Serial #	Manufacturer	Overall Catalog	Unit Catalog	Type	Rated kV	Order
H0	C-6736	Ohio Brass	219542	215920-3001	VN	42	1
H1	C-6740	Ohio Brass	219542	215920-3001	VN	42	1
H2	C-6739	Ohio Brass	219542	215920-3001	VN	42	1
H3	C-6742	Ohio Brass	219542	215920-3001	VN	42	1
X1	D9968	Ohio Brass	217009		VLA	8.4	1
X2	D10628	Ohio Brass	217009		VLA	8.4	1
X3	D9479	Ohio Brass	217009		VLA	8.4	1

### Bushing Nameplate

Designation	Serial #	Manufacturer	Type	C1 %PF	C1 Cap	C2 %PF	C2 Cap	Rated kV	Amps
H0	87-91733	Lapp	PRC-A Post s/n 00- 189100	0.62	292	*	*	69	400
H1	1ZUA 18165372	ABB (ASEA-Brown Boveri)	O+C II	0.25	239	0.18	479	69	400
H2	87-92071	Lapp	PRC-A Post s/n 00- 189100	0.57	298	*	*	69	400
H3	87-92107	Lapp	PRC-A Post s/n 00- 189100	0.57	298	*	*	69	400
X0	87-91171	Lapp	NONE	*	*	*	*	15	1200
X1	87-91034	Lapp	NONE	*	*	*	*	15	1200
X2	87-91177	Lapp	NONE	*	*	*	*	15	1200
X3	87-91176	Lapp	NONE	*	*	*	*	15	1200

### Bushing Additional Details -H0

<b>Designation</b> H0	<b>Voltage</b> Primary	<b>Serial #</b> 87-91733	
<b>Catalog #</b> B-81594-57-70	<b>Amps</b> 400 A	<b>BIL</b> 350 kV	<b>Tap</b> Y
<b>Class</b>	<b>Year</b>	<b>Drawing</b>	
<b>Style</b>	<b>Other</b>	<b>S.O. Number</b>	
<b>Physical Dimensions</b>			
<b>Creep Distance</b> *	<b>Overall Length</b> *	<b>Inner Seal Dia.</b> *	<b>Eff. Gnd Sleeve</b> *
<b>Total Weight</b> *	<b>Recess Depth</b> *	<b>Outer Seal Dia.</b> *	<b>Slot Size</b> *
<b>Units</b>			
<b>Flange Dimensions</b>			
<b>To Bottom</b> *	<b># Bolts</b> *	<b>Max. Diameters</b>	<b>Draw Lead</b>
<b>To Top</b> *	<b>Bolt Size</b> *	<b>Below Flange</b> *	<b>Tube ID</b> *
	<b>Circle Diameter</b> *	<b>Above Flange</b> *	<b>To Pin</b> *

### Bushing Additional Details -H1

<b>Designation</b> H1	<b>Voltage</b> Primary	<b>Serial #</b> 1ZUA 18165372	
<b>Catalog #</b>	<b>Amps</b> 400 A	<b>BIL</b> 350 kV	<b>Tap</b> Y
<b>Class</b>	<b>Year</b> 2018	<b>Drawing</b>	
<b>Style</b> 069Z0412UC	<b>Other</b>	<b>S.O. Number</b>	
<b>Physical Dimensions</b>			
<b>Creep Distance *</b>	<b>Overall Length *</b>	<b>Inner Seal Dia. *</b>	<b>Eff. Gnd Sleeve *</b>
<b>Total Weight *</b>	<b>Recess Depth *</b>	<b>Outer Seal Dia. *</b>	<b>Slot Size *</b>
<b>Units</b>			
<b>Flange Dimensions</b>			
<b>To Bottom *</b>	<b># Bolts *</b>	<b>Max. Diameters</b>	<b>Draw Lead</b>
<b>To Top *</b>	<b>Bolt Size *</b>	<b>Below Flange *</b>	<b>Tube ID *</b>
	<b>Circle Diameter *</b>	<b>Above Flange *</b>	<b>To Pin *</b>

### Bushing Additional Details -H2

<b>Designation</b> H2	<b>Voltage</b> Primary	<b>Serial #</b> 87-92071	
<b>Catalog #</b> B-81594-57-70	<b>Amps</b> 400 A	<b>BIL</b> 350 kV	<b>Tap</b> Y
<b>Class</b>	<b>Year</b>	<b>Drawing</b>	
<b>Style</b>	<b>Other</b>	<b>S.O. Number</b>	
<b>Physical Dimensions</b>			
<b>Creep Distance *</b>	<b>Overall Length *</b>	<b>Inner Seal Dia. *</b>	<b>Eff. Gnd Sleeve *</b>
<b>Total Weight *</b>	<b>Recess Depth *</b>	<b>Outer Seal Dia. *</b>	<b>Slot Size *</b>
<b>Units</b>			
<b>Flange Dimensions</b>			
<b>To Bottom *</b>	<b># Bolts *</b>	<b>Max. Diameters</b>	<b>Draw Lead</b>
<b>To Top *</b>	<b>Bolt Size *</b>	<b>Below Flange *</b>	<b>Tube ID *</b>
	<b>Circle Diameter *</b>	<b>Above Flange *</b>	<b>To Pin *</b>

### Bushing Additional Details -H3

<b>Designation</b> H3	<b>Voltage</b> Primary	<b>Serial #</b> 87-92107	
<b>Catalog #</b> B-81594-57-70	<b>Amps</b> 400 A	<b>BIL</b> 350 kV	<b>Tap</b> Y
<b>Class</b>	<b>Year</b>	<b>Drawing</b>	
<b>Style</b>	<b>Other</b>	<b>S.O. Number</b>	
<b>Physical Dimensions</b>			
<b>Creep Distance *</b>	<b>Overall Length *</b>	<b>Inner Seal Dia. *</b>	<b>Eff. Gnd Sleeve *</b>
<b>Total Weight *</b>	<b>Recess Depth *</b>	<b>Outer Seal Dia. *</b>	<b>Slot Size *</b>
<b>Units</b>			
<b>Flange Dimensions</b>			
<b>To Bottom *</b>	<b># Bolts *</b>	<b>Max. Diameters</b>	<b>Draw Lead</b>
<b>To Top *</b>	<b>Bolt Size *</b>	<b>Below Flange *</b>	<b>Tube ID *</b>
	<b>Circle Diameter *</b>	<b>Above Flange *</b>	<b>To Pin *</b>

### Bushing Additional Details -X0

<b>Designation</b> X0	<b>Voltage</b> Secondary	<b>Serial #</b> 87-91171	
<b>Catalog #</b> B-82015-70	<b>Amps</b> 1200 A	<b>BIL</b> 110 kV	<b>Tap</b> N
<b>Class</b>	<b>Year</b>	<b>Drawing</b>	
<b>Style</b>	<b>Other</b>	<b>S.O. Number</b>	
<b>Physical Dimensions</b>			
<b>Creep Distance *</b>	<b>Overall Length *</b>	<b>Inner Seal Dia. *</b>	<b>Eff. Gnd Sleeve *</b>
<b>Total Weight *</b>	<b>Recess Depth *</b>	<b>Outer Seal Dia. *</b>	<b>Slot Size *</b>
<b>Units</b>			
<b>Flange Dimensions</b>			
<b>To Bottom *</b>	<b># Bolts *</b>	<b>Max. Diameters</b>	<b>Draw Lead</b>
<b>To Top *</b>	<b>Bolt Size *</b>	<b>Below Flange *</b>	<b>Tube ID *</b>
	<b>Circle Diameter *</b>	<b>Above Flange *</b>	<b>To Pin *</b>

### Bushing Additional Details -X1

<b>Designation</b> X1	<b>Voltage</b> Secondary	<b>Serial #</b> 87-91034	
<b>Catalog #</b> B-82015-70	<b>Amps</b> 1200 A	<b>BIL</b> 110 kV	<b>Tap</b> N
<b>Class</b>	<b>Year</b>	<b>Drawing</b>	
<b>Style</b>	<b>Other</b>	<b>S.O. Number</b>	
<b>Physical Dimensions</b>			
<b>Creep Distance *</b>	<b>Overall Length *</b>	<b>Inner Seal Dia. *</b>	<b>Eff. Gnd Sleeve *</b>
<b>Total Weight *</b>	<b>Recess Depth *</b>	<b>Outer Seal Dia. *</b>	<b>Slot Size *</b>
<b>Units</b>			
<b>Flange Dimensions</b>			
<b>To Bottom *</b>	<b># Bolts *</b>	<b>Max. Diameters</b>	<b>Draw Lead</b>
<b>To Top *</b>	<b>Bolt Size *</b>	<b>Below Flange *</b>	<b>Tube ID *</b>
	<b>Circle Diameter *</b>	<b>Above Flange *</b>	<b>To Pin *</b>

### Bushing Additional Details -X2

<b>Designation</b> X2	<b>Voltage</b> Secondary	<b>Serial #</b> 87-91177	
<b>Catalog #</b> B-82015-70	<b>Amps</b> 1200 A	<b>BIL</b> 110 kV	<b>Tap</b> N
<b>Class</b>	<b>Year</b>	<b>Drawing</b>	
<b>Style</b>	<b>Other</b>	<b>S.O. Number</b>	
<b>Physical Dimensions</b>			
<b>Creep Distance *</b>	<b>Overall Length *</b>	<b>Inner Seal Dia. *</b>	<b>Eff. Gnd Sleeve *</b>
<b>Total Weight *</b>	<b>Recess Depth *</b>	<b>Outer Seal Dia. *</b>	<b>Slot Size *</b>
<b>Units</b>			
<b>Flange Dimensions</b>			
<b>To Bottom *</b>	<b># Bolts *</b>	<b>Max. Diameters</b>	<b>Draw Lead</b>
<b>To Top *</b>	<b>Bolt Size *</b>	<b>Below Flange *</b>	<b>Tube ID *</b>
	<b>Circle Diameter *</b>	<b>Above Flange *</b>	<b>To Pin *</b>

### Bushing Additional Details -X3

<b>Designation</b> X3	<b>Voltage</b> Secondary	<b>Serial #</b> 87-91176	
<b>Catalog #</b> B-82015-70	<b>Amps</b> 1200 A	<b>BIL</b> 110 kV	<b>Tap</b> N
<b>Class</b>	<b>Year</b>	<b>Drawing</b>	
<b>Style</b>	<b>Other</b>	<b>S.O. Number</b>	
<b>Physical Dimensions</b>			
<b>Creep Distance *</b>	<b>Overall Length *</b>	<b>Inner Seal Dia. *</b>	<b>Eff. Gnd Sleeve *</b>
<b>Total Weight *</b>	<b>Recess Depth *</b>	<b>Outer Seal Dia. *</b>	<b>Slot Size *</b>
<b>Units</b>			
<b>Flange Dimensions</b>			
<b>To Bottom *</b>	<b># Bolts *</b>	<b>Max. Diameters</b>	<b>Draw Lead</b>
<b>To Top *</b>	<b>Bolt Size *</b>	<b>Below Flange *</b>	<b>Tube ID *</b>
	<b>Circle Diameter *</b>	<b>Above Flange *</b>	<b>To Pin *</b>

**Overall Tests [M4100 Serial: 91932945]**

	Insulation	Test kV	mA	Watts	PF*TCF [%]	Corr Fctr	Cap (pF)	FRANK™	Manual
1	CH+CHL	10.001	38.591	1.021	0.252	0.952	10237		
2	CH	10.000	11.735	0.334	0.271	0.952	3112.945	Good	
3	CHL (Measured)	10.000	26.839	0.666	0.236	0.952	7119.575	Good	
4	CHL	*	26.856	0.687	0.243	0.952	7124.055	Good	
5	CL+CHL	10.000	58.502	2.322	0.378	0.952	15518.200		
6	CL	10.000	31.648	1.638	0.493	0.952	8394.935	Good	
7	CHL (Measured)	10.000	26.841	0.673	0.239	0.952	7119.910	Good	
8	CHL	*	26.854	0.683	0.242	0.952	7123.265	Good	

Winding without Attached Bushing Calculation									
	CH-C1	CH'	11.735	0.334	0.271	0.952	3112.945		
	CL-C1	CL'	31.648	1.638	0.493	0.952	8394.935		

**Bushing Test (C1) [M4100 Serial: 91932945]**

ID	Serial #	Test kV	mA	Watts	Corr Fctr	PF*TCF [%]	NP %PF	Cap (pF)	NP Cap	FRANK™	Manual
H0	87-91733	10.001	1.110	0.057	1.064	0.550	0.62	294.331	292	Good	
H1	1ZUA 18165372	10.000	0.896	0.020	1.032	0.226	0.25	237.762	239	Good	
H2	87-92071	10.001	1.130	0.060	1.064	0.567	0.57	299.642	298	Good	
H3	87-92107	10.001	1.096	0.058	1.064	0.566	0.57	290.604	298	Good	

**Bushing Test (C2) [M4100 Serial: 91932945]**

ID	Serial #	Test kV	mA	Watts	Corr Fctr	PF*TCF [%]	NP %PF	Cap (pF)	NP Cap	FRANK™	Manual
H0	87-91733	0.500	3.561	2.776	1	7.796	*	941.720	*	Investigate	
H1	1ZUA 18165372	0.499	1.796	0.018	1	0.102	0.18	476.472	479	Good	
H2	87-92071	0.500	3.502	3.183	1	9.089	*	925.370	*	Bad	
H3	87-92107	0.500	3.947	4.161	1	10.541	*	1041.295	*	Bad	

**FRANK™ Message**

1 (Investigate) - The C2 upper limit for a "G" rating is1%  
 The C2 lower limit for a "G" rating is0.1%  
 The C2 Power Factor is very high compared to limit.

3 (Bad) - The C2 upper limit for a "G" rating is1%  
 The C2 lower limit for a "G" rating is0.1%  
 The C2 Power Factor is 3 times greater than the very high limit. The apparatus should not be placed in operation. Contact your supervisor or Doble.

4 (Bad) - The C2 upper limit for a "G" rating is1%  
 The C2 lower limit for a "G" rating is0.1%  
 The C2 Power Factor is 3 times greater than the very high limit. The apparatus should not be placed in operation. Contact your supervisor or Doble.

**Surge Arrester Tests [M4100 Serial: 91932945]**

Location	Test Mode	Test kV	mA	Watts	FRANK™	Manual
H0	GAR RB	10.000	0.325	0.115	Good	
H1	GAR RB	10.000	0.303	0.120	Good	
H2	GAR RB	10.001	0.305	0.120	Good	
H3	GAR RB	10.001	0.305	0.124	Good	
X1	GAR RB	2.499	0.833	0.534	Good	
X2	GAR RB	2.500	0.796	0.432	Good	
X3	GAR RB	2.500	0.819	0.517	Good	

**Excitation Current & Loss [M4100 Serial: 91932945]**

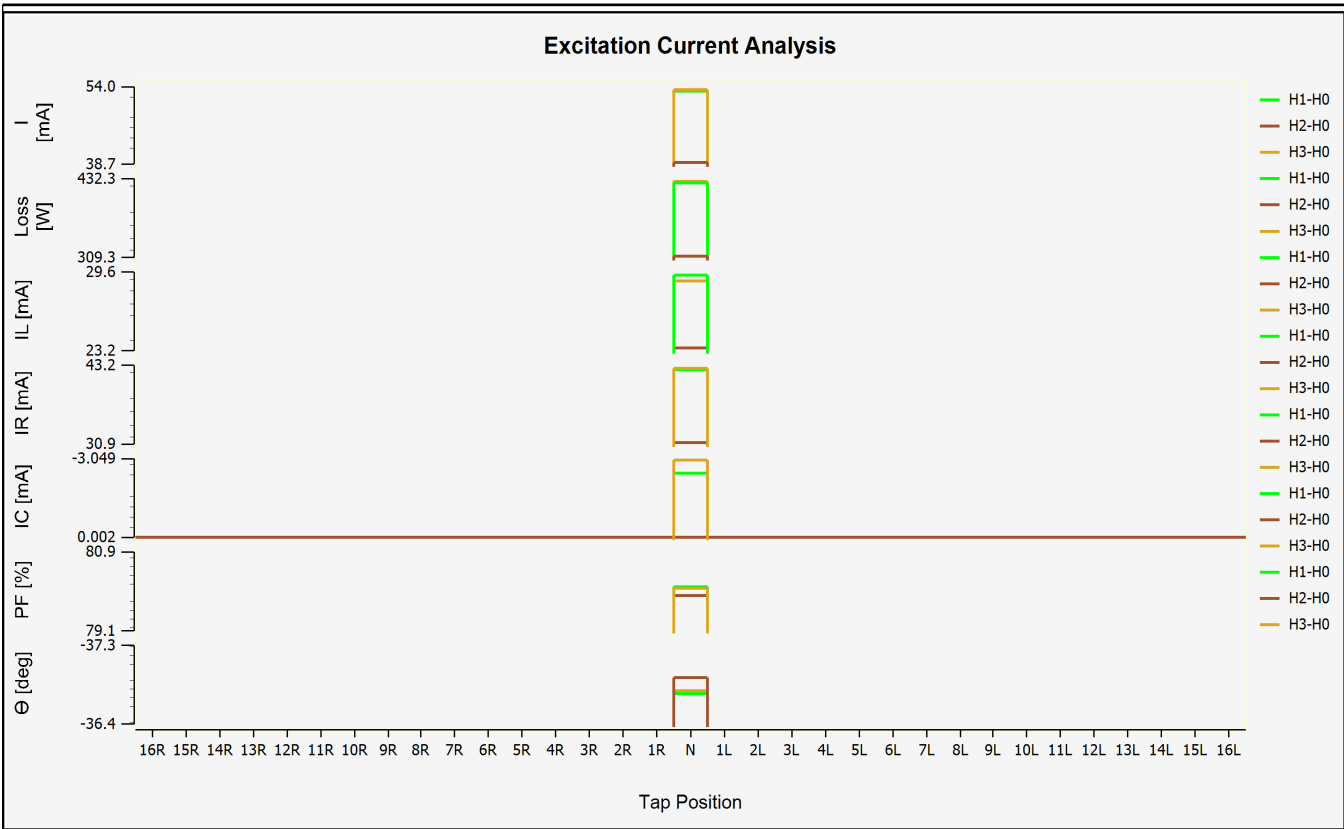
Ref. To 10kV: Yes Components: Yes

Manufacturer	Type	Steps	Increase %	Decrease %	Oil Volume
DETC-1		5	*	*	*
OLTC-1		33	*	*	*

Winding : Tap	Test kV	H1 H0			H2 H0			H3 H0			FRANK™	Manual
		mA	Watts	X	mA	Watts	X	mA	Watts	X		
HV: B LV: N	10	53.219	426.374	L	39.100	312.474	L	53.447	428.000	L	Good	

Winding : Tap	Connections	I <sub>L</sub>	I <sub>R</sub>	I <sub>C</sub>	PF	θ
		[mA]	[mA]	[mA]	[%]	[deg]
HV: B LV: N	H1 H0	29.267	42.637	-2.466	80.116	-36.759
HV: B LV: N	H2 H0	23.464	31.247	0.002	79.917	-36.949
HV: B LV: N	H3 H0	28.845	42.800	-3.019	80.079	-36.794

Excitation Current Plot [M4100 Serial: 91932945]



**EQUIPMENT INFORMATION**

Owner:	<b>TRAVERSE CITY</b>	Manufacturer:	<b>KUHLMAN</b>	Region:	<b>TRAVERSE CITY, MI</b>
Location:	<b>PARSONS RD</b>	Year Manufactured:	<b>1987</b>	Model:	<b>TLC-21</b>
Equipment Type:	<b>LTC</b>	Voltage Rating:	<b>67 kV</b>	Oil Pressure:	<b>INERT GAS-PRESSURE</b>
Designation:	<b>T-1</b>	Apparent Power Rating:	<b>17.92 MVA</b>	Fluid Type:	<b>MINERAL OIL</b>
Equipment #:	<b>272700871-LTC</b>	Phase:	<b>SINGLE PHASE</b>	Fluid Volume:	<b>733.0 gal</b>
Serial #:	<b>9261013</b>				

**TESTING DATA**

SAMPLE INFORMATION						Limits	Units
Sample Date:	2021-Jun-07	2022-Apr-25	2023-May-18	2024-Jun-27	2024-Jul-16		
Job Number:	n/a	n/a	GRB23075-350	GRB24187-350	GRB24091-350		
Sampled By:	n/a	n/a	n/a	n/a	n/a		
Container ID:	n/a	n/a	IAG566	GO931	FR492		
Fluid Temperature:	n/a	28.0	25.0	n/a	54.0		°C
Reason For Sampling:	IMPORT	IMPORT	ROUTINE	ROUTINE	ROUTINE		

DISSOLVED GAS ANALYSIS						Limits	Units	
ASTM D3612	Carbon Monoxide (CO):	51	28	21	79	62	400	ppm
	Carbon Dioxide (CO2):	474	450	438	553	429		ppm
	Hydrogen (H2):	2	2	5	23	21	300	ppm
	Methane (CH4):	1.3	1.7	21.9	92.9	<b>108 ▲</b>	100	ppm
	Ethane (C2H6):	0.1	0.1	14.3	70.1	92.2		ppm
	Ethylene (C2H4):	2.9	2.6	<b>85.5</b>	<b>497.7 ▲</b>	<b>653.6 ▲</b>	200	ppm
	Acetylene (C2H2):	11.2	10.6	16.1	<b>78.3</b>	55.8	1000	ppm
	TDCG:	69	45	162.9	840.5	992.4999999999999		ppm
	Oxygen (O2):	14100	23200	25600	43600	27300		ppm
	Nitrogen (N2):	59100	61100	64000	124500	81300		ppm

FLUID QUALITY						Limits	Units	
ASTM D1816 (1mm)	Dielectric Breakdown:	n/a	n/a	n/a	n/a	<b>12 ▲</b>	25	kV
ASTM D974	Neutralization Number:	n/a	n/a	n/a	n/a	0.02	0.2	mgKOH/g
ASTM D971	Interfacial Tension:	n/a	n/a	n/a	n/a	27.1	25	mN/m
ASTM D1298/D4058	Specific Gravity:	n/a	n/a	n/a	n/a	0.872		
ASTM D1500	Color:	n/a	n/a	n/a	n/a	1.5	2	
ASTM D1524	Visual:	n/a	n/a	n/a	n/a	CLEAR		
ASTM D924	Power Factor (25C):	n/a	n/a	n/a	n/a	n/a		%
ASTM D924	Power Factor (100C):	n/a	n/a	n/a	n/a	n/a	3	%
ASTM D1533	Moisture:	n/a	n/a	n/a	n/a	<b>40 ▲</b>	25	ppm
ASTM D1533	Relative Saturation:	n/a	n/a	n/a	n/a	19		%
ASTM D1533	Dew Point:	n/a	n/a	n/a	n/a	13.0		°C

**TESTING ANALYTICS**

Dissolved Gas Analysis:	Abnormal or high gas levels (*). Severe contact heating. Use a short sampling interval. Based on limits established in the analysis norms, a potential diagnosis could be a T3 fault.
Fluid Quality:	Low breakdown kV. There may be polar contaminants or excessive moisture.
Moisture:	The water content of the oil may be too high. Consider drying the oil.
Suggested Retest Date:	2024-Aug-15
Analysis Basis:	Allis-Chalmers LTC - TLH, TLS, SJ - IEEE C57.139-2015, C57.106-2015

**EQUIPMENT INFORMATION**

Owner:	<b>TRAVERSE CITY LIGHT AND POWER</b>	Manufacturer:	<b>KUHLMAN</b>	Region:	<b>TRAVERSE CITY, MI</b>
Location:	<b>PARSONS RD</b>	Year Manufactured:	<b>1987</b>	Model:	
Equipment Type:	<b>TRN</b>	Voltage Rating:	<b>70.35 kV</b>	Oil Pressure:	<b>INERT GAS-PRESSURE</b>
Designation:	<b>T-1</b>	Apparent Power Rating:	<b>17.92 MVA</b>	Fluid Type:	<b>MINERAL OIL</b>
Equipment #:	<b>272700871</b>	Phase:	<b>THREE PHASE</b>	Fluid Volume:	<b>3522.0 gal</b>
Serial #:	<b>272700871</b>				

**TESTING DATA**

SAMPLE INFORMATION					Limits	Units
Sample Date:	2021-Jun-07	2022-Apr-25	2023-May-18	2024-Jun-27		
Job Number:	n/a	n/a	GRB23075-350	GRB24187-350		
Sampled By:	n/a	n/a	n/a	n/a		
Container ID:	n/a	n/a	GQ828	ER594		
Fluid Temperature:	52.0	28.0	10.0	n/a		°C
Reason For Sampling:	IMPORT	IMPORT	ROUTINE	ROUTINE		

DISSOLVED GAS ANALYSIS					Limits	Units
ASTM D3612	Carbon Monoxide (CO):	23	33	8	44	900 ppm
	Carbon Dioxide (CO2):	642	536	547	814	10000 ppm
	Hydrogen (H2):	1	2	0	0	100 ppm
	Methane (CH4):	28.7	37.4	19.3	32.2	110 ppm
	Ethane (C2H6):	193.5 ▲	206.8 ▲	173.4 ▲	256 ▲	150 ppm
	Ethylene (C2H4):	7.2	7	6.8	11.1	90 ppm
	Acetylene (C2H2):	0	0	1.6 ▲	0	1 ppm
	TDCG:	253	286	208.70000000000002	343.2	ppm
	Oxygen (O2):	0	100	800	1100	ppm
	Nitrogen (N2):	72400	76900	62600	158100	ppm

FLUID QUALITY					Limits	Units
ASTM D974	Neutralization Number:	n/a	n/a	n/a	n/a	0.1 mgKOH/g
ASTM D971	Interfacial Tension:	n/a	n/a	n/a	n/a	30 mN/m
ASTM D1298/D4058	Specific Gravity:	n/a	n/a	n/a	n/a	
ASTM D1500	Color:	n/a	n/a	n/a	n/a	
ASTM D1524	Visual:	n/a	n/a	n/a	n/a	
ASTM D924	Power Factor (25C):	n/a	n/a	n/a	n/a	0.5 %
ASTM D924	Power Factor (100C):	n/a	n/a	n/a	n/a	5 %
ASTM D1533	Moisture:	n/a	n/a	n/a	n/a	25 ppm
ASTM D1533	Relative Saturation:	n/a	n/a	n/a	n/a	20 %
ASTM D1533	Dew Point:	n/a	n/a	n/a	n/a	°C

**TESTING ANALYTICS**

Dissolved Gas Analysis: One or more combustible gases have a positive long-term average rate (C2H4). Sharp jump (!). Significant increase (^). High level (\*). Thermal fault (300 to 700°C). Consider investigative sampling.

Fluid Quality:

Moisture:

Suggested Retest Date: 2024-Jul-27

Date:

Analysis Basis: In-service transformer norms based on IEEE C57.104-2019 (+ estimated Extreme DGA) and C57.106-2015

Insulation Fluid Test Report

Doc# 1553463716

Report 20243205001



Filename: Transformer #1 High Side Winding Resistance      Manufacturer: Kuhlman  
Date/Time: May 17, 2023 11:40:28      Model: OA/FA  
Company: Traverse City Light & Power      S/N: 272700-87-1  
Station: Parsons Substation      Operator: ZLB  
Report Type: 3-Phase Y With Neutral Res Test      Circuit: Transformer #1  
KVA: 12,000  
Measure Temp: 25.0 C      Reference Temp 75.0 C      Temp Constant: 234.5

Test	Time	I	Rm	Rs	Notes
1 A H/X1 - H/X0	11:41:51	9.994 A	481.44 m-Ohm	577.72 m-Ohm	
1 B H/X2 - H/X0	11:42:50	9.996 A	481.78 m-Ohm	578.13 m-Ohm	
1 C H/X3 - H/X0	11:43:40	10.009 A	481.53 m-Ohm	577.83 m-Ohm	



Filename: Transformer #1 Low Side Winding Resistance      Manufacturer: Kuhlman  
 Date/Time: May 17, 2023 09:39:52      Model: OA/FA  
 Company: Traverse City Light & Power      S/N: 272700-87-1  
 Station: Parsons Substation      Operator: ZLB  
 Report Type: 3-Phase Y with Neutral Res LTC      Circuit: Transformer #1  
 KVA: 12,000

Measure Temp: 25.0 C      Reference Temp 75.0 C      Temp Constant: 234.5

Test	Time	I	Rm	Rs	Notes
1L A H/X1 - H/X0	09:42:59	39.996 A	17.826 m-Ohm	21.391 m-Ohm	
1L B H/X2 - H/X0	09:44:03	39.997 A	18.222 m-Ohm	21.866 m-Ohm	
1L C H/X3 - H/X0	09:45:04	39.997 A	18.043 m-Ohm	21.651 m-Ohm	
N A H/X1 - H/X0	09:46:52	39.996 A	18.825 m-Ohm	22.590 m-Ohm	
N B H/X2 - H/X0	09:48:22	39.995 A	18.926 m-Ohm	22.711 m-Ohm	
N C H/X3 - H/X0	09:49:33	39.995 A	19.045 m-Ohm	22.854 m-Ohm	
1R A H/X1 - H/X0	09:50:56	39.995 A	18.935 m-Ohm	22.722 m-Ohm	
1R B H/X2 - H/X0	09:51:49	39.993 A	19.195 m-Ohm	23.034 m-Ohm	
1R C H/X3 - H/X0	09:53:40	39.994 A	19.267 m-Ohm	23.120 m-Ohm	
2R A H/X1 - H/X0	09:54:47	39.995 A	19.700 m-Ohm	23.640 m-Ohm	
2R B H/X2 - H/X0	09:55:40	39.993 A	21.933 m-Ohm	26.319 m-Ohm	
2R C H/X3 - H/X0	09:56:52	39.993 A	20.456 m-Ohm	24.547 m-Ohm	
3R A H/X1 - H/X0	09:58:07	39.990 A	19.650 m-Ohm	23.580 m-Ohm	
3R B H/X2 - H/X0	09:59:01	39.987 A	21.804 m-Ohm	26.164 m-Ohm	
3R C H/X3 - H/X0	09:59:59	39.993 A	20.348 m-Ohm	24.417 m-Ohm	
4R A H/X1 - H/X0	10:01:32	39.991 A	19.950 m-Ohm	23.940 m-Ohm	
4R B H/X2 - H/X0	10:02:39	39.993 A	22.246 m-Ohm	26.695 m-Ohm	
4R C H/X3 - H/X0	10:03:35	39.992 A	20.757 m-Ohm	24.908 m-Ohm	
5R A H/X1 - H/X0	10:04:41	39.992 A	19.973 m-Ohm	23.967 m-Ohm	
5R B H/X2 - H/X0	10:06:17	39.995 A	22.303 m-Ohm	26.763 m-Ohm	
5R C H/X3 - H/X0	10:07:22	39.991 A	20.710 m-Ohm	24.852 m-Ohm	
6R A H/X1 - H/X0	10:08:34	39.988 A	20.600 m-Ohm	24.720 m-Ohm	
6R B H/X2 - H/X0	10:09:50	39.990 A	22.844 m-Ohm	27.412 m-Ohm	



Test	Time	I	Rm	Rs	Notes
6R C H/X3 - H/X0	10:11:14	39.986 A	21.319 m-Ohm	25.582 m-Ohm	
7R A H/X1 - H/X0	10:12:48	39.989 A	20.493 m-Ohm	24.591 m-Ohm	
7R B H/X2 - H/X0	10:13:59	39.986 A	22.652 m-Ohm	27.182 m-Ohm	
7R C H/X3 - H/X0	10:15:10	39.987 A	21.107 m-Ohm	25.328 m-Ohm	
8R A H/X1 - H/X0	10:16:27	39.984 A	20.807 m-Ohm	24.968 m-Ohm	
8R B H/X2 - H/X0	10:17:43	39.986 A	23.023 m-Ohm	27.627 m-Ohm	
8R C H/X3 - H/X0	10:18:53	39.985 A	21.532 m-Ohm	25.838 m-Ohm	
9R A H/X1 - H/X0	10:20:25	39.985 A	20.674 m-Ohm	24.808 m-Ohm	
9R B H/X2 - H/X0	10:21:49	39.982 A	22.904 m-Ohm	27.484 m-Ohm	
9R C H/X3 - H/X0	10:23:25	39.985 A	21.320 m-Ohm	25.584 m-Ohm	
10R A H/X1 - H/X0	10:24:44	39.985 A	20.889 m-Ohm	25.066 m-Ohm	
10R B H/X2 - H/X0	10:25:52	39.986 A	23.244 m-Ohm	27.892 m-Ohm	
10R C H/X3 - H/X0	10:27:26	39.986 A	21.625 m-Ohm	25.950 m-Ohm	
11R A H/X1 - H/X0	10:29:05	39.984 A	20.794 m-Ohm	24.952 m-Ohm	
11R B H/X2 - H/X0	10:30:30	39.984 A	23.117 m-Ohm	27.740 m-Ohm	
11R C H/X3 - H/X0	10:31:35	39.986 A	21.486 m-Ohm	25.783 m-Ohm	
12R A H/X1 - H/X0	10:33:22	39.986 A	21.150 m-Ohm	25.380 m-Ohm	
12R B H/X2 - H/X0	10:34:28	39.985 A	23.397 m-Ohm	28.076 m-Ohm	
12R C H/X3 - H/X0	10:35:30	39.985 A	21.862 m-Ohm	26.234 m-Ohm	
13R A H/X1 - H/X0	10:36:45	39.986 A	21.202 m-Ohm	25.442 m-Ohm	
13R B H/X2 - H/X0	10:38:42	39.984 A	23.398 m-Ohm	28.077 m-Ohm	
13R C H/X3 - H/X0	10:39:54	39.984 A	21.871 m-Ohm	26.245 m-Ohm	
14R A H/X1 - H/X0	10:41:21	39.985 A	21.690 m-Ohm	26.028 m-Ohm	
14R B H/X2 - H/X0	10:43:06	39.985 A	23.993 m-Ohm	28.791 m-Ohm	
14R C H/X3 - H/X0	10:44:13	39.985 A	22.402 m-Ohm	26.882 m-Ohm	
15R A H/X1 - H/X0	10:45:19	39.985 A	21.675 m-Ohm	26.010 m-Ohm	
15R B H/X2 - H/X0	10:46:05	39.986 A	24.019 m-Ohm	28.822 m-Ohm	
15R C H/X3 - H/X0	10:46:53	39.986 A	22.298 m-Ohm	26.757 m-Ohm	



Test	Time	I	Rm	Rs	Notes
16R A H/X1 - H/X0	10:48:03	39.984 A	21.974 m-Ohm	26.368 m-Ohm	
16R B H/X2 - H/X0	10:48:49	39.989 A	24.514 m-Ohm	29.416 m-Ohm	
16R C H/X3 - H/X0	10:49:28	39.986 A	22.721 m-Ohm	27.265 m-Ohm	



# Transformer Liquid Filled 7.2.2 Maintenance Test Data

1361 Glory Road  
Green Bay, WI 54304  
Office 920 632 7929  
Fax 920 632 7928  
epsii.com



CLIENT Traverse City Light and Power

DATE 5/16/2023

SITE Parsons Substation

PROJECT # GRB23075-350

EQPT LOCATION Transformer #1

TEMPERATURE 18°C HUMIDITY 33%

## EQUIPMENT INFORMATION

No.	TYPE	MANUFACTURER	MODEL	SERIAL	SPECIAL IDENTIFICATION
1	Transformer	Kuhlman	OA/FA	272700-87-1	Transformer #1

## WORK SCOPE / INSTRUCTION

1. Perform appropriate visual and mechanical inspections along with appropriate electrical tests per NETA/EPS standards

## VISUAL AND MECHANICAL INSPECTION

STEP	MAINTENANCE OR INSPECTION ACTIVITY	As Left Condition	Note
1	Inspect physical and mechanical condition (Main and LTC)	SAT	
2	Inspect anchorage, alignment, and grounding (Main and LTC)	SAT	
3	Verify the presence of PCB content labeling	SAT	
4	Prior to cleaning the unit, perform as-found tests, if required	SAT	
5	Clean bushings and control cabinet	SAT	
6	*Verify operation of heaters, alarm, control, and trip circuits from temperature and level indicators, pressure relief device, gas accumulator and fault pressure relay within manufacturer's recommendations for their specified settings	SAT	
7	Verify fans and cooling pumps operational	SAT	
8	Verify correct liquid level in tanks and bushings within indicated tolerances (Main and LTC)	SAT	
9	Verify that a positive pressure is maintained on gas-blanked transformers per pressure gauge	SAT	
10	Perform inspections and tests as recommended by the manufacturer (Main and LTC)	SAT	
11	Verify the presence of surge arresters	SAT	
12	**Verify transformer/LTC desiccant dry	SAT	
13	Visually inspect wear/erosion indicators on LTC vacuum bottles within manufacturer's specified tolerances, if applicable.	SAT	
14	Verify correct auxiliary device operation of LTC in accordance of design intent	SAT	
15	Verify correct operation of motor and drive train and automatic motor cutoff at max raise and lower positions of LTC within manufacturer's design	SAT	
16	Verify appropriate lubrication on motor components of LTC	SAT	
17	Verify LTC operates through full range of taps	SAT	
18	*Perform LTC internal inspection and cleaning (19-23 completed only if LTC inspection performed)	SAT	
19	Inspect LTC contacts for wear and alignment and verify within manufacturer's recommended tolerances	SAT	1
20	Inspect all internal LTC electrical and mechanical connections for tightness	SAT	
21	Inspect LTC terminal board, contact support boards and insulated operating components for evidence of moisture, cracks, excessive wear, breakage and/or signs of electrical tracking	SAT	
22	Verify gaskets and seal compartment integrity	SAT	
23	Apply appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces	SAT	
24	Record as found and as left operations counter of LTC	SAT	



# Transformer Liquid Filled 7.2.2 Maintenance Test Data

1361 Glory Road  
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Fax 920 632 7928  
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STEP	MAINTENANCE OR INSPECTION ACTIVITY	As Left Condition	Note
25	Inspect bolted electrical connections for high resistance using one or more of the following: Use of a DLRO, calibrated torque wrench or thermographic survey	SAT	
26	Verify DETC position is left as specified	SAT	
27			

\* NETA Optional Inspection    \*\*Non-NETA, EPS Inspection

### ELECTRICAL TESTS (use next section to record test results)

STEP	TEST	As Left Condition	Note
1	Perform insulation resistance test, winding to winding and each winding to ground (LTC off neutral position) and calculate polarization index	SAT	
2	Perform turns ratio test on in service DETC tap and LTC	SAT	
3	Perform power factor on all windings (One off neutral)	SAT	
4	Perform power factor on each bushing equipped with a power factor/capacitance tap; if no power factor/capacitance tap, then perform hot-collar tests.	SAT	2
5	Perform power factor excitation test (In service DETC tap and LTC taps 1L, N, 1R, 8R and 16R)	SAT	
6	Perform power factor of surge arresters	SAT	
7	**Perform power factor on insulating oil (Main and LTC)	NA	
8	Perform winding resistance test of each winding (In service DETC tap and LTC taps 1L, N, 1R-16R)	SAT	
9	*Perform core ground insulation resistance test to ground at 500 volts	SAT	
10	*Measure percent oxygen in the gas blanket	NA	
11	Obtain oil quality and DGA sample and conduct appropriate tests (Main and LTC)	SAT	
12	**Perform dielectric test of insulating oil (Main and LTC)	NA	
13	Perform saturation, polarity, ratio, winding resistance and insulation resistance tests on current transformers	NA	
14	Perform test on transformer neutral grounding impedance device	NA	
15	Perform LTC vacuum bottle integrity test across each open vacuum bottle in the open position (If LTC inspection is conducted)	NA	
16	**Perform SFRA test (extreme raise position)	NA	
17			

\* NETA Optional Test    \*\*Non-NETA, EPS Test

### INSPECTION/TEST VALUES – VISUAL AND MECHANICAL

TEST	EXPECTED	AS FOUND	AS LEFT
Bolted electrical connections with calibrated torque-wrench	Manufacturer's published data or Table 100.12 of NETA MTS	SAT	SAT
Thermography survey of bolted electrical connections	In accordance with Section 9 of NETA MTS	NA	NA
LTC as-found/as-left counter reading	Functional	5,204	5,259

### TEST VALUES – ELECTRICAL

TEST	EXPECTED	AS FOUND	AS LEFT
DLRO of bolted electrical connections	Delta of $\leq 50\%$ of lowest value	NA	NA
Insulation resistance:			

# Transformer Liquid Filled

## 7.2.2 Maintenance Test Data

TEST	EXPECTED	AS FOUND	AS LEFT
High-to-Low	Within manufacturer's data or Table 100.5 of NETA MTS PI compare to previous and $\geq 1$	6 Giga-ohms	6 Giga-ohms
High-to-Ground	Within manufacturer's data or Table 100.5 of NETA MTS PI compare to previous and $\geq 1$	5.5 Giga-ohms	5.5 Giga-ohms
Low-to-Ground	Within manufacturer's data or Table 100.5 of NETA MTS PI compare to previous and $\geq 1$	5.1 Giga-ohms	5.1 Giga-ohms
Turns Ratio	$\leq .5\%$ deviation between phases	$\leq .5\%$ deviation between phases	$\leq .5\%$ deviation between phases
Power factor windings	Within manufacturer's data or Table 100.3 of NETA MTS	Table 100.3 of NETA MTS	Table 100.3 of NETA MTS
Power factor bushings	Within nameplate and/or Doble limits	Within Doble Limits	Within Doble Limits
Power factor excitation	Show appropriate pattern	Show appropriate pattern	Show appropriate pattern
Power factor surge arresters	Within Doble limits / Compare	Within Doble limits / Compare	Within Doble limits / Compare
Power factor insulating oil	$\leq .5\%$	NA	NA
Winding resistance	Temperature corrected values compare within 2.0% of previous results	Compare within 2.0% of adjacent windings	Compare within 2.0% of adjacent windings
Core ground insulation resistance	Compare to previous / $\geq 1$ Meg-ohm	NA	NA
Measure percent oxygen in gas blanket	Record percent oxygen present	NA	NA
Oil quality and DGA sample	Oil quality within parameters of Table 100.4 of NETA MTS / DGA ANSI/IEEE C57.104 or ASTM D 3612	See Lab Results	See Lab Results
Dielectric of insulating oil	Within parameters of Table 100.4 of NETA MTS	NA	NA
Current transformer tests:			
Saturation	Saturate	NA	NA
Polarity	Positive	NA	NA
Ratio	$\leq 10\%$ deviation	NA	NA
Winding resistance	Comparable to similar CT's	NA	NA
Insulation resistance	$\geq 100$ Meg-ohms	NA	NA
Transformer neutral grounding impedance device	Compare to previous results / Manufacturer's data	NA	NA
LTC vacuum bottle integrity test	Within manufacturer's data / No evidence of distress or insulation failure	NA	NA
SFRA	Show appropriate pattern	NA	NA

### SUMMARY

1. **Transformer #1:** Three stationary contacts were replaced during internal inspection. Stationary contact number 6 got replaced on each phase. C Phase moving contact "A" showing significant erosion.
2. **Transformer #1:** H0, H2, and H3 bushings C2 power factor results are satisfactory per Doble. Pre 2000 Lapp PRC bushings are allowed up to 15% PF for C2 test results.



# Transformer Liquid Filled 7.2.2 Maintenance Test Data

1361 Glory Road  
Green Bay, WI 54304  
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epsii.com



## ANALYSIS AND RECOMMENDATIONS

1. **Transformer #1:** Customer should consider replacing C phase moving contact "A" during next maintenance.
2. **Transformer #1** is satisfactory for normal operation based on the work and tests performed.

TECHNICIAN(S) Zach Bricker and Derek DeCaire

TEST EQUIPMENT ID(S) 197, 353, 632, 817



# Vanguard Instruments Company, Inc.

www.vanguard-instruments.com

Date: May 17, 2023  
 Filename: Transformer #1 TTR Plan.PLN  
 Company: Traverse City Light & Power  
 Location: Parsons Substation  
 Circuit: Transformer #1  
 Operator: ZLB  
 Comment:

Manufacturer: Kuhlman  
 Model: OA/FA  
 Serial #: 272700-87-1  
 Rating: 12 MVA  
 Test Voltage: 100V  
 Type: YNyn0  
 Device: Load Tap Changer  
 Max Deviation: 0.5  
 Step: 5/8 of 1%

HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	VECTOR GROUP	PHASE	INTERNAL JUMPER	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	MEAS RATIO	TURNS RATIO	NOTES
		YNyn0	A		H <sub>1</sub> - H <sub>0</sub>	X <sub>1</sub> - X <sub>0</sub>	$\frac{V_H}{V_x}$	$\frac{V_H}{V_x}$	
	B			H <sub>2</sub> - H <sub>0</sub>	X <sub>2</sub> - X <sub>0</sub>				
	C			H <sub>3</sub> - H <sub>0</sub>	X <sub>3</sub> - X <sub>0</sub>				

### Test Results

Test	H Voltage	H Tap	X Voltage	X Tap	C-RATIO	M-RATIO	DEV [%]	P/F	I [mA]	Angle	RES
1	68675		15180	16R	4.5240	+ 4.523	0.02	P	2.800	0.18	
						+ 4.523	0.02	P	2.200	0.09	
						+ 4.523	0.02	P	2.800	0.04	
2	68675		15094	15R	4.5498	+ 4.557	0.16	P	6.100	0.30	
						+ 4.556	0.14	P	5.300	0.12	
						+ 4.557	0.16	P	6.000	0.32	
3	68675		15008	14R	4.5759	+ 4.579	0.07	P	2.700	0.21	
						+ 4.579	0.07	P	2.200	0.20	
						+ 4.579	0.07	P	2.700	0.32	
4	68675		14921	13R	4.6026	+ 4.613	0.23	P	6.000	0.21	
						+ 4.611	0.18	P	5.200	359.99	
						+ 4.613	0.23	P	6.000	0.06	
5	68675		14835	12R	4.6293	+ 4.636	0.14	P	2.700	359.99	
						+ 4.635	0.12	P	2.200	0.06	
						+ 4.635	0.12	P	2.700	0.19	
6	68675		14749	11R	4.6562	+ 4.671	0.32	P	6.000	0.29	
						+ 4.670	0.30	P	5.300	0.23	
						+ 4.671	0.32	P	6.000	359.99	
7	68675		14663	10R	4.6836	+ 4.694	0.22	P	2.700	0.14	
						+ 4.694	0.22	P	2.200	0.07	
						+ 4.694	0.22	P	2.700	0.19	
8	68675		14576	9R	4.7115	+ 4.710	0.03	P	3.500	0.04	
						+ 4.710	0.03	P	2.900	0.25	
						+ 4.710	0.03	P	3.500	0.19	
9	68675		14490	8R	4.7395	+ 4.725	0.31	P	2.700	0.08	
						+ 4.724	0.33	P	2.200	0.21	
						+ 4.725	0.31	P	2.700	0.19	



**Vanguard Instruments Company, Inc.**  
www.vanguard-instruments.com

Date: May 17, 2023  
 Filename: Transformer #1 TTR Plan.PLN  
 Company: Traverse City Light & Power  
 Location: Parsons Substation  
 Circuit: Transformer #1  
 Operator: ZLB  
 Comment:

Manufacturer: Kuhlman  
 Model: OA/FA  
 Serial #: 272700-87-1  
 Rating: 12 MVA  
 Test Voltage: 100V  
 Type: YNyn0  
 Device: Load Tap Changer  
 Max Deviation: 0.5  
 Step: 5/8 of 1%

HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	VECTOR GROUP	PHASE	INTERNAL JUMPER	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	MEAS RATIO	TURNS RATIO	NOTES
		YNyn0	A		H <sub>1</sub> - H <sub>0</sub>	X <sub>1</sub> - X <sub>0</sub>	$\frac{V_H}{V_x}$	$\frac{V_H}{V_x}$	
	B			H <sub>2</sub> - H <sub>0</sub>	X <sub>2</sub> - X <sub>0</sub>				
	C			H <sub>3</sub> - H <sub>0</sub>	X <sub>3</sub> - X <sub>0</sub>				

Test Results

Test	H Voltage	H Tap	X Voltage	X Tap	C-RATIO	M-RATIO	DEV [%]	P/F	I [mA]	Angle	RES
10	68675		14404	7R	4.7678	+ 4.760	0.16	P	6.000	0.08	
						+ 4.759	0.18	P	5.200	0.00	
						+ 4.760	0.16	P	6.000	0.10	
11	68675		14318	6R	4.7964	+ 4.784	0.26	P	2.700	0.18	
						+ 4.784	0.26	P	2.200	0.03	
						+ 4.785	0.24	P	2.700	0.24	
12	68675		14231	5R	4.8257	+ 4.821	0.10	P	6.000	0.16	
						+ 4.821	0.10	P	5.200	0.06	
						+ 4.821	0.10	P	6.000	0.24	
13	68675		14145	4R	4.8551	+ 4.847	0.17	P	2.700	0.22	
						+ 4.847	0.17	P	2.200	0.15	
						+ 4.847	0.17	P	2.700	0.23	
14	68675		14059	3R	4.8848	+ 4.885	0.00	P	6.000	0.18	
						+ 4.885	0.00	P	5.200	0.16	
						+ 4.885	0.00	P	6.000	0.20	
15	68675		13973	2R	4.9148	+ 4.910	0.10	P	2.700	0.23	
						+ 4.910	0.10	P	2.200	0.07	
						+ 4.911	0.08	P	2.700	0.40	
16	68675		13886	1R	4.9456	+ 4.949	0.07	P	6.000	359.96	
						+ 4.949	0.07	P	5.200	0.22	
						+ 4.949	0.07	P	6.000	359.97	
17	68675		13800	N	4.9764	+ 4.976	0.01	P	2.700	0.05	
						+ 4.976	0.01	P	2.200	0.18	
						+ 4.977	0.01	P	2.700	0.00	
18	68675		13714	1L	5.0077	+ 5.014	0.13	P	5.600	0.26	
						+ 5.014	0.13	P	4.900	0.08	
						+ 5.014	0.13	P	5.600	0.26	



# Vanguard Instruments Company, Inc.

www.vanguard-instruments.com

Date: May 17, 2023  
 Filename: Transformer #1 TTR Plan.PLN  
 Company: Traverse City Light & Power  
 Location: Parsons Substation  
 Circuit: Transformer #1  
 Operator: ZLB  
 Comment:

Manufacturer: Kuhlman  
 Model: OA/FA  
 Serial #: 272700-87-1  
 Rating: 12 MVA  
 Test Voltage: 100V  
 Type: YNyn0  
 Device: Load Tap Changer  
 Max Deviation: 0.5  
 Step: 5/8 of 1%

HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	VECTOR GROUP	PHASE	INTERNAL JUMPER	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	MEAS RATIO	TURNS RATIO	NOTES
		YNyn0	A		H <sub>1</sub> - H <sub>0</sub>	X <sub>1</sub> - X <sub>0</sub>	$\frac{V_H}{V_x}$	$\frac{V_H}{V_x}$	
	B			H <sub>2</sub> - H <sub>0</sub>	X <sub>2</sub> - X <sub>0</sub>				
	C			H <sub>3</sub> - H <sub>0</sub>	X <sub>3</sub> - X <sub>0</sub>				

### Test Results

Test	H Voltage	H Tap	X Voltage	X Tap	C-RATIO	M-RATIO	DEV [%]	P/F	I [mA]	Angle	RES
19	68675		13628	2L	5.0393	+ 5.042	0.05	P	2.700	0.24	
						+ 5.043	0.07	P	2.200	0.12	
						+ 5.043	0.07	P	2.700	0.13	
20	68675		13541	3L	5.0716	+ 5.083	0.22	P	6.000	0.14	
						+ 5.084	0.24	P	5.200	0.08	
						+ 5.084	0.24	P	6.000	359.91	
21	68675		13455	4L	5.1041	+ 5.112	0.15	P	2.700	0.01	
						+ 5.111	0.14	P	2.200	0.05	
						+ 5.113	0.17	P	2.700	0.05	
22	68675		13369	5L	5.1369	+ 5.152	0.29	P	6.000	0.16	
						+ 5.153	0.31	P	5.200	0.06	
						+ 5.153	0.31	P	6.000	0.13	
23	68675		13283	6L	5.1701	+ 5.182	0.23	P	2.700	0.21	
						+ 5.183	0.25	P	2.200	0.01	
						+ 5.182	0.23	P	2.700	0.13	
24	68675		13196	7L	5.2042	+ 5.225	0.40	P	6.000	0.18	
						+ 5.226	0.42	P	5.200	0.10	
						+ 5.226	0.42	P	6.000	359.95	
25	68675		13110	8L	5.2384	+ 5.256	0.34	P	2.700	0.18	
						+ 5.257	0.36	P	2.200	0.06	
						+ 5.257	0.36	P	2.700	0.25	
26	68675		13024	9L	5.2730	+ 5.276	0.06	P	3.500	0.07	
						+ 5.276	0.06	P	2.900	0.22	
						+ 5.276	0.06	P	3.500	0.15	
27	68675		12938	10L	5.3080	+ 5.291	0.32	P	2.700	0.25	
						+ 5.292	0.30	P	2.200	0.34	
						+ 5.293	0.28	P	2.700	0.17	



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Manufacturer: Kuhlman  
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 Serial #: 272700-87-1  
 Rating: 12 MVA  
 Test Voltage: 100V  
 Type: YNyn0  
 Device: Load Tap Changer  
 Max Deviation: 0.5  
 Step: 5/8 of 1%

HIGH-VOLTAGE WINDING (H)	LOW-VOLTAGE WINDING (X)	VECTOR GROUP	PHASE	INTERNAL JUMPER	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	MEAS RATIO	TURNS RATIO	NOTES
		YNyn0	A		H <sub>1</sub> - H <sub>0</sub>	X <sub>1</sub> - X <sub>0</sub>	$\frac{V_H}{V_x}$	$\frac{V_H}{V_x}$	
	B			H <sub>2</sub> - H <sub>0</sub>	X <sub>2</sub> - X <sub>0</sub>				
	C			H <sub>3</sub> - H <sub>0</sub>	X <sub>3</sub> - X <sub>0</sub>				

Test Results

Test	H Voltage	H Tap	X Voltage	X Tap	C-RATIO	M-RATIO	DEV [%]	P/F	I [mA]	Angle	RES
28	68675		12851	11L	5.3439	+ 5.337	0.13	P	6.000	0.01	
						+ 5.338	0.11	P	5.200	0.07	
						+ 5.338	0.11	P	6.000	0.19	
29	68675		12765	12L	5.3799	+ 5.369	0.20	P	2.700	0.26	
						+ 5.369	0.20	P	2.200	0.08	
						+ 5.369	0.20	P	2.700	0.07	
30	68675		12679	13L	5.4164	+ 5.413	0.06	P	6.000	0.00	
						+ 5.413	0.06	P	5.200	0.12	
						+ 5.413	0.06	P	6.000	0.15	
31	68675		12593	14L	5.4534	+ 5.446	0.14	P	2.700	359.99	
						+ 5.446	0.14	P	2.200	0.32	
						+ 5.447	0.12	P	2.700	0.06	
32	68675		12506	15L	5.4914	+ 5.494	0.05	P	6.000	0.20	
						+ 5.494	0.05	P	5.200	359.98	
						+ 5.494	0.05	P	6.000	0.25	
33	68675		12420	16L	5.5294	+ 5.528	0.03	P	2.700	0.20	
						+ 5.528	0.03	P	2.200	0.02	
						+ 5.528	0.03	P	2.700	0.18	



Filename: Transformer #1 TTR Plan.PLN  
Company: Traverse City Light & Power  
Location: Parsons Substation  
Circuit: Transformer #1  
Model: OA/FA

Date/Time: May 17, 2023 07:27 AM  
Manufacturer: Kuhlman  
SN: 272700-87-1  
Operator: ZLB  
Test: Load Tap Changer - YNyn0

