Preliminary Test Report

Three Phase Autotransformer

448 MVA

345±2x2.5% / 115 / 24kV

Customer:

National Grid USA Service Company

Sandy Pond Substation

References:

Customer PO no: C101629-000-001-00

ABB: 12101-01

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1.0 TECHNICAL DATA

WINDINGS					
NO	TERMINALS	VOLTAGE (KV)	POWER (MVA)	CURRENT (A)	CONNECTION
1	H1, H2, H3	345±2x 2.5%	448	714 / 750 / 789	Y/A
2	X1, X2, X3	115	448	2249	Y/A
3	Y1, Y2, Y3	24	41.8	1006	D
-	H0X0	-	-	-	-

BUSHINGS				
TERMINALS	Type	BIL	Current	Serial number
H1, H2, H3	ABB Alamo	1175	1600	3C05729203, 3C05729201, 3C05729202
X1, X2, X3	ABB Alamo	550	3000	3C05815901, 3C05815902, 3C05815903,
Y1, Y2, Y3	ABB Alamo	150	1200	3S06005620, 3S06005619, 3S06005622
H0X0	ABB Alamo	150	1200	3S06005614

COOLING EQUIPMENT (OA, FA)		
NUMBER	TYPE	SPECIFICATIONS
25	Fans	Krenz, 208 VAC, 3ph., 60Hz, 850RPM
18	Radiators	Menk, 32 sections, 2900mm height

TAP CHANGER	
TYPE	SERIAL NUMBER
DTW 600 kV BIL / 1000A	N/A

End of the tests: 2004-03-21

2.0 RATIOS

HV TERMINALS		XV TERMINALS	RATIO	MEASURED RATIO		
VOLTAGE (KV)	POSITION	VOLTAGE (KV)	THEORETICAL	PHASE A	PHASE B	PHASE C
362.250	1	115.0	3.150	3.156	3.153	3.151
353.625	2	115.0	3.075	3.078	3.076	3.075
345.000	3	115.0	3.000	3.002	3.001	2.999
336.375	4	115.0	2.925	2.925	2.923	2.922
327.750	5	115.0	2.850	2.848	2.846	2.844

HV TERMINALS		YV TERMINALS		RATIO	MEASURED RATIO		
VOLTAGE/√3 (KV)	POSITION	VOLTAGE (KV)	POSITION	THEORETICAL	PHASE A	PHASE B	PHASE C
345.0	3	24.0	-	8.299	8.326	8.320	8.320

XV TERMINALS		YV TERMINALS		RATIO	MEASURED RATIO		
VOLTAGE /√3 (KV)	POSITION	VOLTAGE (KV)	POSITION	THEORETICAL	PHASE A	PHASE B	PHASE C
115.0	-	24.0	-	2.766	2.770	2.769	2.770

3.0 RESISTANCE

WINDING HV		RESISTANCE AT 85°C		
VOLTAGE (KV)	POSITION	PHASE A (Ω)	PHASE B (Ω)	PHASE C (Ω)
362.250	1	0.19871	0.19865	0.19865
345.000	3	0.18406	0.18419	0.18428
327.750	5	0.16989	0.17009	0.17014

WINDING XV		RESISTANCE AT 85°C		
VOLTAGE (KV)	POSITION	PHASE A (Ω)	PHASE B (Ω)	PHASE C (Ω)
115.0	-	0.03704	0.03719	0.03726

WINDING YV		RESISTANCE AT 85°C		
VOLTAGE (KV)	POSITION	PHASE A (Ω)	PHASE B (Ω)	PHASE C (Ω)
24.0	-	0.03298	0.03289	0.03302

4.0 NO LOAD LOSSES & MAGNETIZING CURRENT

MEASUREMENTS BEFORE DIELECTRICS							
APPLIED VOLTAGE			RMS CURRENT		NO LOAD LOSSES		
% OF RATED VOLTAGE	RMS (KV)	MEAN (KV)	MEASURED (% OF RATED I)	GUARANTEED (% OF RATED I)	MEASURED (KW)	CORRECTED (KW)	GUARANTEED (KW)
70	16.9	16.8	0.017	-	44.8	45.0	-
80	19.2	19.2	0.019	-	58.1	58.4	-
90	21.7	21.6	0.021		75.3	75.7	
100	24.1	24.0	0.024	0.14	97.3	97.5	107
110	26.7	26.4	0.054	0.38	132.2	131.4	

DETC in pos. 3

5.0 LOAD LOSSES, IMPEDANCE

LOAD LOSSES MEASURED AT 448 MVA H / X								
WINDINGS				MEAN CURRENT (A)	MEAN WINDING TEMPERATURE °C	LOAD LOSSES		
kV	POS	kV	POS			MEASURED (kW)	CORRECTED (kW)	GUARANTEED (kW)
362.250	1	115.0	-	715.6	18.7	609.6	-	-
353.625	2	115.0	-	732.1	18.7	603.5	-	-
345.000	3	115.0	-	751.7	18.7	603.0	-	-
336.375	4	115.0	-	769.6	18.7	602.6	-	-
327.750	5	115.0	-	788.2	18.7	599.3	-	-

LOAD LOSSES MEASURED AT 268.8 MVA H / X								
WINDINGS				MEAN CURRENT (A)	MEAN WINDING TEMPERATURE °C	LOAD LOSSES		
kV	POS	kV	POS			MEASURED (kW)	CORRECTED (kW)	GUARANTEED (kW)
362.250	1	115.0	-	427.5	18.7	216.5	-	-
353.625	2	115.0	-	439.8	18.7	216.6	-	-
345.000	3	115.0	-	449.7	18.7	213.3	244.4	257
336.375	4	115.0	-	462.0	18.7	214.9	-	-
327.750	5	115.0	-	473.3	18.7	214.5	-	-

LOAD LOSSES MEASURED AT 24 MVA H / Y								
WINDINGS				MEAN CURRENT (A)	MEAN WINDING TEMPERATURE °C	LOAD LOSSES		
kV	POS	kV	POS			MEASURED (kW)	CORRECTED (kW)	GUARANTEED (kW)
345.0	3	24.0	-	70.5	19.0	50.2	-	-

LOAD LOSSES MEASURED AT 24 MVA X/ Y								
WINDINGS				MEAN CURRENT (A)	MEAN WINDING TEMPERATURE °C	LOAD LOSSES		
KV	POS	KV	POS			MEASURED (KW)	CORRECTED (KW)	GUARANTEED (KW)
115	-	24	-	210.5	19.1	49.4	-	-

IMPEDANCE H / X						
WINDINGS				MEASURED VOLTAGE (KV)	IMPEDANCE (BASE 268.8 MVA)	
KV	POS	KV	POS		MEASURED (%)	GUARANTEED (%)
362.250	1	115.0	-	28.5	7.9	-
353.625	2	115.0	-	27.4	7.7	-
345.000	3	115.0	-	26.1	7.6	7.45
336.375	4	115.0	-	25.1	7.4	-
327.750	5	115.0	-	24.0	7.3	-

IMPEDANCE H / Y						
WINDINGS				MEASURED VOLTAGE (KV)	IMPEDANCE (268.8 MVA BASE)	
KV	POS	KV			MEASURED (%)	GUARANTEED (%)
345.0	3	24.0	-	14.5	44.9	44.8

IMPEDANCE X / Y						
WINDINGS				MEASURED VOLTAGE (KV)	IMPEDANCE (268.8 MVA BASE)	
KV	POS	KV			MEASURED (%)	GUARANTEED (%)
115.0	-	24..0	-	3.8	35.6	35.2

6.0 X TO R RATIO & VOLTAGE REGULATION

X TO R RATIO (OLTC IN POSITION N)			
CONNECTION	X % (448 MVA)	R% (85°C)	X/R
H / X	12.669	0.174	72.578

VOLTAGE REGULATION CALCULATED H/X			
	POWER FACTOR LAGGING (%)		
MVA	100	90	80
448	0.972	6.284	8.207
358.4	0.661	4.944	6.503
268.8	0.416	3.651	4.835

7.0 ZERO SEQUENCE IMPEDANCE

ZERO SEQUENCE IMPEDANCE					
VOLTAGE APPLIED	TERMINAL SHORT CIRCUITED	VOLTAGE kV	CURRENT A	IMPEDANCE %MEASURED (BASE 268.8 MVA)	POSITION
H1, H2, H3	X1, X2, X3, H0X0, Y3	2.1	202.7	7.0	3
H1, H2, H3	-	9.96	200.3	33.7	3
X1, X2, X3	H1, H2, H3, H0X0, Y3	0.287	299.7	5.8	3
X1, X2, X3	-	2.3	506.1	27.9	3

8.0 HEAT RUN

CONDITION		HEAT RUN (°C)											
COOLING TYPE	LOAD (MVA)	OIL RISE		WINDING RISE									GUARANTEED OIL / WINDING
		TOP	MEAN	HV			XV			YV			
				H1	H2	H3	X1	X2	X3	Y1	Y2	Y3	
ONAF	448	48.1	35.6	53.1	51.9	50.9	51.2	50.9	50.8	40.4	42.0	43.0	65/65
ONAF	390	40.5	29.5	-	44.3	-	-	42.6	-	-	33.3	-	65/65
ONAF	314	32.0	22.5	-	36.4	-	-	33.6	-	-	24.1	-	65/65
ONAN	269	46.7	38.8	51.5	50.2	50.5	48.5	47.8	48.4	-	41.2	-	65/65

HOT SPOT TEMPERATURE RISE (°C)			
LOAD (MVA)	HV	LV	TV
448	**69.1**	**72.2**	**56.2**

9.0 SOUND LEVEL

APPLIED VOLTAGE		MEAN OIL	TYPE	NOISE PRESSURE LEVEL	
% OF RATED kV	RMS (kV)	TEMPERATURE (°C)		MEASURED (dB)	GUARANTEED (dB)
100	24	26.1	ONAN	68.4	72
100	24	26.1	ONAF I	66.9	74
100	24	26.1	ONAF II	66.7	75

10.0 LIGHTNING IMPULSE

SPECIFICATION		H1		H2		H3	
		WAVE SHAPE µSEC : 1.34/47					
WAVE TYPE	VOLTAGE (KV)	FIGURE #	TEST (KV)	FIGURE #	TEST (KV)	FIGURE #	TEST (KV)
RFW	662	7	662	26	661	34	663
CW	1155	10	1159	29	1159	37	1161
CW	1155	11	1157	30	1156	38	1155
FW	1050	13	1051	31	1050	39	1051

DETC IN POSITION 5

SPECIFICATION		X1		X2		X3	
		WAVE SHAPE µSEC : 1.45/59					
WAVE TYPE	VOLTAGE(KV)	FIGURE #	TEST (KV)	FIGURE #	TEST (KV)	FIGURE #	TEST (KV)
RFW	284	47	283	55	280	63	285
CW	495	51	495	59	497	67	495
CW	495	52	494	60	497	68	496
FW	450	53	450	61	452	69	450

DETC IN POSITION 5

SPECIFICATION		Y1		Y2		Y3	
		WAVE SHAPE µSEC : 1.76/48					
WAVE TYPE	VOLTAGE(KV)	FIGURE #	TEST (KV)	FIGURE #	TEST (KV)	FIGURE #	TEST (KV)
RFW	69	87	70	95	70	101	69
CW	120	91	118	97	121	103	120
CW	120	92	120	98	120	104	119
FW	110	93	109	99	110	105	110

DETC IN POSITION 5

SPECIFICATION		H0X0	
		WAVE SHAPE µSEC : 2.51/41	
WAVE TYPE	VOLTAGE(KV)	FIGURE #	TEST (KV)
RFW	66	76	66
FW	110	78	110
FW	110	79	110

DETC IN POSITION 5

11.0 SWITCHING SURGE

SPECIFICATION		H1		H2		H3	
		WAVE SHAPE µSEC :122/234/>3700					
WAVE TYPE	VOLTAGE(KV)	FIGURE #	TEST (KV)	FIGURE #	TEST (KV)	FIGURE #	TEST (KV)
RSW	548	136	551	123	540	110	549
FSW	870	142	875	129	872	116	872
FSW	870	146	874	133	874	120	873

DETC IN POSITION 1

12.0 APPLIED TEST

APPLIED TEST			
TERMINALS		VOLTAGE	TIME
APPLIED	GROUNDED	(KV)	(SEC.)
H1, H2, H3, H0X0, X1, X2, X3	Y1, Y2, Y3, Tank	34	60
Y1, Y2, Y3	H1, H2, H3, H0X0, X1, X2, X3, Tank	34	60

13.0 INDUCED VOLTAGE TEST

INDUCED VOLTAGE (180 HZ)			
VOLTAGE (KV PHASE-GND)		OVER VOLTAGE FACTOR	TIME
Y1,Y2, Y3	H1, H2, H3	(%)	(--)
24.0	199.2	100	-
43.4	360.0	181	7200 Cycles
37.9	315.0	158	60 minutes
24.0	199.2	100	20 minutes

DETC in position 3
PD< 500pC and RIV< 100μV during one hour

14.0 ACCESSORIES & OTHER TESTS

Accessories	Verification	
Cooling	Motors	
Current Transformers	Polarity Check Ratio Check	
FRA	Sweep Frequency Response Analysis done	
Auxiliaries	All the auxiliaries were checked for proper operation.	
Wiring Hi-Pot	Accessories:	1.5 kV at 60 Hz for 60 seconds
	Current Transformer:	2.5 kV at 60 Hz for 60 seconds
	Motors:	1.5 kV at 60 Hz for 60 seconds
Leak Test	No leaks were detected on the unit at 5 PSI for 24 hours at a minimum temperature of 20 °C	

WINDINGS TEMPERATURE INDICATOR		
WINDING	HOT SPOT TEMPERATURE OVER TOP OIL (°C)	RESISTOR ADJUSTMENT (Ω)
HV	21.0	1.32
XV	24.0	1.41
YV	8.1	0.82

MOTOR LOSSES (KW)	
MEASURED (KW)	GUARANTEED
5.2	15

15.0 INSULATION RESISTANCE - TANG δ

INSULATION RESISTANCE (M OHM) AT 5 000 VDC	
APPLY	RESULTS
HV, XV==> YV, TANK	2 000
HV, XV, YV==> TANK	1 400
YV==>HV, XV, TANK	700

TANG δ AT 10 kV (AT 22.0°C)				
APPLY	GROUNDED	GUARDED	% POWER FACTOR	CAPACITANCE pF
HV, XV	-	YV	0.23	7342
HV, XV	YV	-	0.20	22272
YV	-	HV, XV	0.16	25280
YV	HV, XV	-	0.17	40199