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Transformer (T1) Division

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NABL NO.T1620

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Final Inspection

W.O.No :	:	**ET10335**
Serial No :	:	**ET10335/1A**
Customer :	:	**ZETDC**

JOB RATING	:	**3P2WDualHV**
REFERENCE STANDARD	:	**IEC:60076**
CUSTOMER REFERENCE	:	**-**
SCHEDULE OF TESTS	:	**AS PER SHEET 3**
TESTING DATE	:	**05/06/2015 To 05/06/2015**
DATE OF ISSUE	:	**05/06/2015**

TESTED BY **CHECKED BY** **APPROVED BY**

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Date : 24/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

Voltage Class [kV]		
Phase	: Three	
Winding Designation	: HV	LV
Terminal Notations	: 1U1,1V1,1W1,N	2U1,2V1,2W1,N
Rated Capacity [MVA]		
ONAN	: 20	20
ONAF	: 30	30
Rated Voltage[kV]	: 132 - 88	11
Rated Current[A]	: 131.22 - 196.83	1574.64
Rated Frequency[Hz]	: 50	
Connections	: STAR	STAR
Vector Group	: YNyn0	
Type Of Tap Changer	: OLTC & OLTC	
% Voltage Variation On		
OLTC	: Taps Provided On HV Winding For Variation Of HV Voltage From 7% To -7% in 1% Steps in 14 Steps	
Transformer Type	: Power Transformer	
OLTC	: Taps Provided On HV Winding For Variation Of HV Voltage From 10.5% To -10.5% in 1.5% Steps in 14 Steps	
Temp. Rise. Of Oil/Wdg (°C)	: 60 / 65	

INSULATION LEVELS	LINE TERMINALS	NEUTRAL TERMINALS
HV	LI (FW/CW) - 650/950kVp SI : 750kVp	LI - 325kVp
LV	LI (FW/CW) - 95/95kVp	N.A.

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Date : 16/09/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA :30 **Customer :** ZETDC

Tests Performed

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Date : 24/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

MEASUREMENT OF VOLTAGE RATIO

HV/LV(132/11kV)/1

TAP NO.	VOLTAGES (kV)		CAL. RATIO	MEASURED RATIO					
	HV	LV		1U1-N 2U1-N	% Error	1V1-N 2V1-N	% Error	1W1-N 2W1-N	% Error
1	141.2400	11.0000	12.8400	12.8410	0.008	12.8360	-0.031	12.8330	-0.055
2	139.9200	11.0000	12.7200	12.7110	-0.071	12.7130	-0.055	12.7120	-0.063
3	138.6000	11.0000	12.6000	12.6060	0.048	12.6080	0.063	12.6010	0.008
4	137.2800	11.0000	12.4800	12.4690	-0.088	12.4670	-0.104	12.4720	-0.064
5	135.9600	11.0000	12.3600	12.3690	0.073	12.3630	0.024	12.3600	0.000
6	134.6400	11.0000	12.2400	12.2360	-0.033	12.2360	-0.033	12.2300	-0.082
7	133.3200	11.0000	12.1200	12.1250	0.041	12.1280	0.066	12.1210	0.008
8(Nor)	132.0000	11.0000	12.0000	11.9980	-0.017	11.9960	-0.033	11.9980	-0.017
9	130.6800	11.0000	11.8800	11.8850	0.042	11.8900	0.084	11.8870	0.059
10	129.3600	11.0000	11.7600	11.7580	-0.017	11.7580	-0.017	11.7600	0.000
11	128.0400	11.0000	11.6400	11.6500	0.086	11.6500	0.086	11.6480	0.069
12	126.7200	11.0000	11.5200	11.5160	-0.035	11.5210	0.009	11.5200	0.000
13	125.4000	11.0000	11.4000	11.4110	0.096	11.4080	0.070	11.4100	0.088
14	124.0800	11.0000	11.2800	11.2920	0.106	11.2920	0.106	11.2940	0.124
15	122.7600	11.0000	11.1600	11.1810	0.188	11.1810	0.188	11.1820	0.197

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Date : 24/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

MEASUREMENT OF VOLTAGE RATIO

HV/LV(88/11kV)/2

TAP NO.	VOLTAGES (kV)		CAL. RATIO	MEASURED RATIO					
	HV	LV		1U1-N 2U1-N	% Error	1V1-N 2V1-N	% Error	1W1-N 2W1-N	% Error
1	97.2400	11.0000	8.8400	8.8350	-0.057	8.8330	-0.079	8.8350	-0.057
2	95.9200	11.0000	8.7200	8.7060	-0.161	8.7090	-0.126	8.7070	-0.149
3	94.6000	11.0000	8.6000	8.6000	0.000	8.5980	-0.023	8.5970	-0.035
4	93.2800	11.0000	8.4800	8.4700	-0.118	8.4690	-0.130	8.4780	-0.024
5	91.9600	11.0000	8.3600	8.3610	0.012	8.3610	0.012	8.3610	0.012
6	90.6400	11.0000	8.2400	8.2340	-0.073	8.2330	-0.085	8.2360	-0.049
7	89.3200	11.0000	8.1200	8.1120	-0.099	8.1230	0.037	8.1250	0.062
8(Nor)	88.0000	11.0000	8.0000	7.9950	-0.062	7.9960	-0.050	7.9950	-0.062
9	86.6800	11.0000	7.8800	7.8848	0.061	7.8840	0.051	7.8850	0.063
10	85.3600	11.0000	7.7600	7.7590	-0.013	7.7560	-0.052	7.7590	-0.013
11	84.0400	11.0000	7.6400	7.6470	0.092	7.6470	0.092	7.6470	0.092
12	82.7200	11.0000	7.5200	7.5200	0.000	7.5200	0.000	7.5190	-0.013
13	81.4000	11.0000	7.4000	7.4100	0.135	7.4090	0.122	7.4100	0.135
14	80.0800	11.0000	7.2800	7.2830	0.041	7.2810	0.014	7.2820	0.027
15	78.7600	11.0000	7.1600	7.1700	0.140	7.1690	0.126	7.1690	0.126

Results : All measured values are within ± 0.5 % tolerance of the specified values

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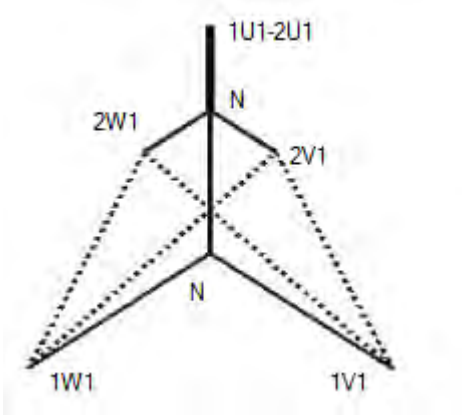
Date : 24/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

VECTOR GROUP VERIFICATION

Shorted : 1U1-2U1

3-Phase Supply : 1U1-1V1-1W1



Measured		
1U1-1V1	429	Volts
1V1-1W1	428	Volts
1W1-1U1	435	Volts
1W1-2W1	389	Volts
1V1-2V1	393	Volts
1W1-2V1	406	Volts
1V1-2W1	409	Volts

(1W1-2W1) ≈(1V1-2V1)	389 ≈ 393
(1W1-2V1) ≈(1V1-2W1)	406 ≈ 409

Hence, Vector Group <u>YNyn0</u> is confirmed.

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Date : 16/07/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

MEASUREMENT OF WINDING RESISTANCE

HV (88 kV) Winding Resistance in Ohms

Top Oil Temp. : 42.6ºC	Bottom Oil Temp. : 39.8ºC	Avg. Oil Temp. : 41.2ºC			
TAP NO.	**1U1-N**	**1V1-N**	**1W1-N**	**Avg. Resistance @ 41.2ºC**	**Total Resistance @ 75 ºC**
1	0.478940	0.479260	0.480180	0.479460	1.614402
2	0.469860	0.470160	0.471200	0.470407	1.583919
3	0.461800	0.462220	0.463100	0.462373	1.556868
4	0.452820	0.453180	0.454220	0.453407	1.526678
5	0.444680	0.445240	0.446140	0.445353	1.499559
6	0.434980	0.435460	0.436460	0.435633	1.466831
7	0.426840	0.427460	0.428320	0.427540	1.439581
8(Nor)	0.416180	0.415900	0.416060	0.416047	1.400882
9	0.426340	0.427080	0.427940	0.427120	1.438167
10	0.435680	0.436320	0.437260	0.436420	1.469481
11	0.443680	0.444420	0.445200	0.444433	1.496462
12	0.452980	0.453640	0.454580	0.453733	1.527776
13	0.460900	0.461780	0.462440	0.461707	1.554625
14	0.469500	0.470300	0.471000	0.470267	1.583448
15	0.477560	0.478380	0.478980	0.478307	1.610520

HV (132 kV) Winding Resistance in Ohms

Top Oil Temp. : 42.6ºC	Bottom Oil Temp. : 39.8ºC	Avg. Oil Temp. : 41.2ºC			
TAP NO.	**1U1-N**	**1V1-N**	**1W1-N**	**Avg. Resistance @ 41.2ºC**	**Total Resistance @ 75 ºC**
1	1.105500	1.106300	1.106800	1.106200	3.724713
2	1.096100	1.096900	1.097500	1.096833	3.693174
3	1.087800	1.088600	1.089200	1.088533	3.665226
4	1.078400	1.079200	1.079900	1.079167	3.633690
5	1.070100	1.070900	1.071500	1.070833	3.605628
6	1.060000	1.060800	1.061500	1.060767	3.571734
7	1.051600	1.052400	1.053100	1.052367	3.543453
8(Nor)	1.040500	1.040500	1.040400	1.040467	3.503382
9	1.051100	1.052000	1.052700	1.051933	3.541989
10	1.060800	1.061600	1.062400	1.061600	3.574539
11	1.069100	1.070000	1.070600	1.069900	3.602487
12	1.078700	1.079600	1.080300	1.079533	3.634923
13	1.087000	1.088000	1.088600	1.087867	3.662985
14	1.095900	1.096900	1.097500	1.096767	3.692952
15	1.104300	1.105200	1.105700	1.105067	3.720900

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Date : 16/07/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

MEASUREMENT OF WINDING RESISTANCE

LV (11 kV) Winding Resistance in Ohms

Top Oil Temp. : 42.6°C	Bottom Oil Temp. : 39.8°C	Avg. Oil Temp. : 41.2°C			
TAP NO.	**2U1-N**	**2V1-N**	**2W1-N**	**Avg. Resistance @ 41.2°C**	**Total Resistance @ 75 °C**
-	0.005980	0.005980	0.006020	0.005993	0.020178

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Date : 24/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

MEASUREMENT OF INSULATION RESISTANCE OF WINDING

Top Oil Temp. : 42.60°C	Bottom Oil Temp. : 39.80°C	Avg. Oil Temp. : 41.2°C

Insulation Resistance in MegaOhms

Measured Between	HV / LV + E	LV / HV + E	HV / LV
Test Voltage[Volts]	5000	5000	5000
After Dielectric Tests			
15 Seconds	8740	5930	8250
60 Seconds	12200	11000	13100
600 Seconds	18900	20200	29300
Absorption Index(60/15)	1.4	1.85	1.59
Polarisation Index(600/60)	1.55	1.84	2.24
Before Dielectric Tests			
15 Seconds	13900	8830	12600
60 Seconds	18600	16000	18700
600 Seconds	27900	35000	45200
Absorption Index(60/15)	1.34	1.81	1.48
Polarisation Index(600/60)	1.5	2.19	2.42

Insulation Resistance in MegaOhms

Terminal No.	Measured Between / Test Voltage[Volts]	Core/Frame 2500	Core/Tank 2500	Frame/Tank 2500
Before Dielectric Tests				
1	60 Seconds	200	22	2
2	60 Seconds	50	55	5
After Dielectric Tests				
1	60 Seconds	200	2	22

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Date : 03/07/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA: 30 **Customer :** ZETDC

MEASUREMENT OF NO LOAD LOSS AND NO LOAD CURRENT

Base MVA for % No-load Current (MVA) : 30

Tap Position No. : 8-8

Transformer Energised from : LV

After Dielectric Tests Date : 03/07/2015

% kV	Freq. [Hz]	C.T. Ratio / P.T. Ratio	R.M.S. Volt (kV) / Avg. Volt (kV)	Current Reading (Amp) U	V	W	Avg.	Power Reading (kW) W1	W2	W3	Total	No Load Loss (kW)	No Load Current as % of rated Current	Corr. Losses (kW)
90	50.00	30/1	9.906	1.474	0.941	1.545	1.320					17.160	0.084	17.153
		33000/110	9.902	7.276	4.013	5.867	17.156							
100	50.00	30/1	11.030	2.785	1.856	2.891	2.511					24.110	0.159	24.049
		33000/110	11.002	11.576	5.598	6.931	24.105							
110	50.00	30/1	12.427	23.218	18.501	23.762	21.827					42.060	1.386	40.934
		33000/110	12.103	42.362	10.850	-11.150	42.062							

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Date : 25/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

MEASUREMENT OF LOAD LOSS AND IMPEDANCE VOLTAGE

Combination Name : HV (132 kV)/LV

Supplied Winding : HV (132 kV)	**Shorted Winding : LV**	**Base MVA : 30**
C.T.Ratio : 500/1	**P.T.Ratio : 22000/110**	
Top Oil Temp : 35.30 °C	**Bottom Oil Temp : 32.80 °C**	**Avg Oil Temp : 34.05 °C**

Tap Pos	Rated Parameters		Measured Voltage & Current		% of Rated Curr.	Measured Load Loss			Total Load Loss	Freq
	Volt.	Curr.	Volt.	Curr.		W1	W2	W3		
HV	[kV]	[A]	[V]	[A]		[W]	[W]	[W]	[kW]	[Hz]
1	141.240	122.640	16419.60	125.8900	102.65	46350	43350	37500	127.20	49.98
8	132.000	131.220	14468.90	131.3900	100.13	43950	39600	37050	120.60	50.02
15	122.760	141.100	13247.20	142.1200	100.72	47700	43800	42150	133.65	50.02

Calculations

Supply Side : HV (132 kV) **Short Circuit : LV** **Temperature [°C] : 34.05 °C**

Measurement

Cooling Type : ONAF [30 MVA] **Combination Name : HV (132 kV)/LV**

Tap Position		1	8	15						
Measured Impedance voltage [Vm]	[V]	16419.60	14468.90	13247.20						
Corrected Impedance Voltage at Rated Current	[V]	15995.71	14450.18	13152.12						
Applied Current [ISc]	A	125.89	131.39	142.12						
Rated Current [IHR]	A	122.64	131.22	141.10						
Measured Load Loss [LLM]	[W]	127200.00	120600.00	133650.00						
Corrected Load Loss At Rated Current [LLC]	[W]	120717.14	120288.12	131738.46						

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MVA : 30 **Customer :** ZETDC

MEASUREMENT OF LOAD LOSS AND IMPEDANCE VOLTAGE

Cooling Type : ONAF [30 MVA] **Combination Name : HV (132 kV)/LV**

Tap Position				1	8	15						
Rated Current [IHR]	[HV]		A	122.64	131.22	141.10						
Rated Current [ILR]	[LV]		A	1574.64	1574.64	1574.64						
Avg. Resistance [RhAvg]	[HV]	at 41.2 °C	Ohms	1.106200	1.040467	1.105067						
Avg. Resistance [RlAvg]	[LV]	at 41.2 °C	Ohms	0.0059933	0.0059933	0.0059933						
Copper Loss[I²R] [CLh]	[HV]	at 41.2 °C	[W]	49913.63	53746.43	66003.03						
Copper Loss[I²R] [CLl]	[LV]	at 41.2 °C	[W]	44581.00	44581.00	44581.00						
Total Loss[I²R]		at 41.2 °C	[W]	94494.63	98327.43	110584.03						
Total Loss[I²R] [TCL]		at 34.05 °C	[W]	92031.34	95764.22	107701.32						
Corrected Load Loss [LLC]		at 34.05 °C	[W]	120717.14	120288.12	131738.46						
Stray Loss [SL =LLC - TCL]		at 34.05 °C	[W]	28685.80	24523.90	24037.14						
% Z		at 34.05 °C	%	11.33	10.94	10.71						
% R		at 34.05 °C	%	402.39	400.96	439.13						
% X		at 34.05 °C	%	402.23	400.81	439.00						
Total Copper Loss[I²R]		at 75 °C	[W]	106058.42	110360.25	124116.76						
Stray Loss		at 75 °C	[W] At Test Freq	24891.87	21280.42	20858.03						
Stray Loss		at 75 °C	[W] @ 50 Hz	24911.80	21263.40	20841.36						
Load Loss		at 75 °C	[W] At Test Freq	130950.29	131640.67	144974.79						
Load Loss at [30 KVA]		at 75 °C	[W] @ 50 Hz	130970.22	131623.65	144958.12						
% X		at 75 °C	%	402.23	400.81	439.00						
% R		at 75 °C	%	436.50	438.80	483.25						
% Z at [30 KVA] at 50 Hz		at 75 °C	%	593.57	594.30	652.88						

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Date : 25/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

MEASUREMENT OF LOAD LOSS AND IMPEDANCE VOLTAGE

Combination Name : HV (88 kV)/LV

Supplied Winding : HV (88 kV)	**Shorted Winding : LV**	**Base MVA : 30**
C.T.Ratio : 500/1	**P.T.Ratio : 33000/110**	
Top Oil Temp : 32.40 °C	**Bottom Oil Temp : 30.50 °C**	**Avg Oil Temp : 31.45 °C**

Tap Pos	Rated Parameters		Measured Voltage & Current		% of Rated Curr.	Measured Load Loss			Total Load Loss	Freq
	Volt.	Curr.	Volt.	Curr.		W1	W2	W3		
HV	[kV]	[A]	[V]	[A]		[W]	[W]	[W]	[kW]	[Hz]
1	97.240	178.130	7472.50	138.5900	77.80	23940	22260	19970	66.17	49.96
8	88.000	196.830	7295.80	177.1500	90.00	30860	29940	27350	88.15	49.88
15	78.760	219.920	6064.80	189.5000	86.17	32240	32510	30530	95.28	49.81

Calculations

Supply Side : HV (88 kV) **Short Circuit : LV** **Temperature [°C] : 31.45 °C**

Measurement

Cooling Type : ONAF [30 MVA] **Combination Name : HV (88 kV)/LV**

Tap Position		1	8	15						
Measured Impedance voltage [Vm]	[V]	7472.50	7295.80	6064.80						
Corrected Impedance Voltage at Rated Current	[V]	9604.42	8106.31	7038.37						
Applied Current [ISc]	A	138.59	177.15	189.50						
Rated Current [IHR]	A	178.13	196.83	219.92						
Measured Load Loss [LLM]	[W]	66170.00	88150.00	95280.00						
Corrected Load Loss At Rated Current [LLC]	[W]	109312.92	108823.47	128325.44						

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Date : 25/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

MEASUREMENT OF LOAD LOSS AND IMPEDANCE VOLTAGE

Cooling Type : ONAF [30 MVA] **Combination Name : HV (88 kV)/LV**

Tap Position				1	8	15						
Rated Current [IHR]	[HV]		A	178.13	196.83	219.92						
Rated Current [ILR]	[LV]		A	1574.64	1574.64	1574.64						
Avg. Resistance [RhAvg]	[HV]	at 41.2 °C	Ohms	0.479460	0.416047	0.478307						
Avg. Resistance [RlAvg]	[LV]	at 41.2 °C	Ohms	0.0059933	0.0059933	0.0059933						
Copper Loss[I²R] [CLh]	[HV]	at 41.2 °C	[W]	45640.22	48355.54	69399.68						
Copper Loss[I²R] [CLl]	[LV]	at 41.2 °C	[W]	44581.00	44581.00	44581.00						
Total Loss[I²R]		at 41.2 °C	[W]	90221.22	92936.54	113980.68						
Total Loss[I²R] [TCL]		at 31.45 °C	[W]	87020.03	89639.01	109936.47						
Corrected Load Loss [LLC]		at 31.45 °C	[W]	109312.92	108823.47	128325.44						
Stray Loss [SL =LLC - TCL]		at 31.45 °C	[W]	22292.89	19184.46	18388.97						
% Z		at 31.45 °C	%	9.88	9.23	8.97						
% R		at 31.45 °C	%	364.38	362.74	427.75						
% X		at 31.45 °C	%	364.25	362.62	427.66						
Total Copper Loss[I²R]		at 75 °C	[W]	101262.05	104309.66	127929.08						
Stray Loss		at 75 °C	[W] At Test Freq	19157.50	16486.26	15802.65						
Stray Loss		at 75 °C	[W] @ 50 Hz	19188.19	16565.68	15923.44						
Load Loss		at 75 °C	[W] At Test Freq	120419.55	120795.92	143731.73						
Load Loss at [30 KVA]		at 75 °C	[W] @ 50 Hz	120450.24	120875.34	143852.52						
% X		at 75 °C	%	364.25	362.62	427.66						
% R		at 75 °C	%	401.40	402.65	479.11						
% Z at [30 KVA] at 50 Hz		at 75 °C	%	542.03	541.87	642.21						

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Date : 27/07/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

APPLIED VOLTAGE TEST

Winding's Under Test	*Ur[kV]	Test volt [kV]	Test Time(Sec)	Freq.[Hz]	Remarks
HV wdg to other wdg and Tank	132	38	60	50	WITHSTOOD OK
HV wdg to other wdg and Tank	88	38	60	50	WITHSTOOD OK
LV wdg to other wdg and Tank	11	38	60	50	WITHSTOOD OK

***Ur: Rated Line Voltage**

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Date : 29/07/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

MAGNETIC BALANCE AND EXCITATION CURRENT

For Before Dielectric Tests

Magnetic Balance & Excitation Current for Tap 8 From HV(88 kV) Side.				
Applied Voltage ☐	**1U1 - N [V]**	**1V1 - N [V]**	**1W1 - N [V]**	**Current (mA)**
1U1 - N	**244.4**	220.4	23.2	4.53
1V1 - N	123.5	**244.1**	120.5	3.15
1W1 - N	18.92	225.2	**244.3**	4.58

Magnetic Balance & Excitation Current From LV Side.				
Applied Voltage ☐	**2U1 - N [V]**	**2V1 - N [V]**	**2W1 - N [V]**	**Current (mA)**
2U1 - N	**244.8**	188.9	55.4	171.40
2V1 - N	122.8	**244.9**	121.7	122.50
2W1 - N	55.4	188.8	**244.7**	170.70

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MVA : 30 **Customer :** ZETDC

MAGNETIC BALANCE AND EXCITATION CURRENT

Magnetic Balance & Excitation Current for Tap 8 From HV(132 kV) Side.				
Applied Voltage ☐	**1U1 - N [V]**	**1V1 - N [V]**	**1W1 - N [V]**	**Current (mA)**
1U1 - N	**234.2**	231.7	10.76	2.47
1V1 - N	121.1	**234.4**	113.1	1.74
1W1 - N	9.68	228.4	**234.6**	2.38

Magnetic Balance & Excitation Current From LV Side.				
Applied Voltage ☐	**2U1 - N [V]**	**2V1 - N [V]**	**2W1 - N [V]**	**Current (mA)**
2U1 - N	**233.6**	184.7	47.4	171.40
2V1 - N	117	**232.6**	116.5	122.50
2W1 - N	47.8	184	**234.2**	170.70

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MVA : 30 **Customer :** ZETDC

MEASUREMENT OF POWER TAKEN BY COOLER CIRCUIT

Average voltage L-L	**412.5 V**
Total Current	**4.11 A**
Measured Loss	**2.91 kW**
Guaranteed Loss	**3 kW**

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Date : 24/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

OIL LEAKAGE TEST

- Transformer was subjected to oil leakage test at pressure of 12 PSI measured at bottom of tank.The pressure was sustained for a period of 12 hours and observations were made. No drop in pressure or no leaks observed during the sustained period.

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Date : 24/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA :30 **Customer :** ZETDC

MEASUREMENT OF ACOUSTIC NOISE LEVEL

Noise level measured in accordance with specification : NEMA-TR1

Test Conditions

Excitation voltage[kV] : 132 **Tap position** : 8

Test Frequency[Hz] : 50 **Guaranteed Noise Level [dB]** : 76

Transformer Energised at Rated Voltage				
	Before Energising Transformer Ambient (dB)		Cooling	
			ONAF (dB)	
Point No	1/3 rd Height	2/3 rd Height	1/3 rd Height	2/3 rd Height
1	67.20	67.50	74.30	73.60
2			74.90	73.80
3			74.80	73.90
4	67.10	67.30	75.60	74.40
5			75	76.60
6			75.40	75.70
7	67	67	76	75.80
8			75.40	76.10
9			76.20	74.20
10	67.20	67.20	74.60	73.80
11			73.80	72.70
12			74.20	74
13			73.80	74.20
14	67.30	67.10	76.30	73
15			73.80	73.60
16			73.90	74.20
17			74.80	72.60

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Date : 24/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA :30 **Customer :** ZETDC

MEASUREMENT OF ACOUSTIC NOISE LEVEL

Transformer Energised at Rated Voltage				
	Before Energising Transformer Ambient (dB)		Cooling ONAF (dB)	
Point No	1/3 rd Height	2/3 rd Height	1/3 rd Height	2/3 rd Height
18			74.60	75.40
19	67.40	67.10		
Mean:-	**67.20**	**67.20**	**74.93**	**74.46**
Mean Avg:-	**67.20**		**74.70**	

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MVA : 30 **Customer :** ZETDC

LIGHTNING IMPULSE VOLTAGE WITHSTAND TEST

Rated Voltage	Test Voltage [kVp]			Standard Waveform	Polarity
[kV]	FW	-	-	T1/T2/Tc	
132	650	-	-	[1.2 ± 0.36 / 50 ± 10/2-6] µS	[-] Negative

Phase Applied	Phase - 1U1	Phase - 1V1	Phase - 1W1
Terminal	HV(132) - 1U1	HV(132) - 1V1	HV(132) - 1W1
Tap Position	1	8	15
WaveShape	1.17 / 55.74 / NA µs	1.32 / 47.30 / NA µs	1.27 / 47.45 / NA µs

Test Sequence	Wave No.	Voltage		Wave No.	Voltage		Wave No.	Voltage	
		[%]	[kVp]		[%]	[kVp]		[%]	[kVp]
RFW	1	61.60	400.40	1	61.88	402.2	1	61.75	401.4
FW	2	100.00	650	2	100.42	652.7	2	100.12	650.8
FW	3	100.03	650.2	3	100.00	650	3	101.35	658.8
FW	4	100.18	651.2	4	99.97	649.8	4	99.29	645.4

RFW : Reduced Full Wave / FW : Full Wave / RCW : Reduced Chopped Wave / CW : Chopped Wave

Result : Transformer withstood the Test Satisfactory.

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MVA : 30 **Customer :** ZETDC

LIGHTNING IMPULSE VOLTAGE WITHSTAND TEST

Rated Voltage	Test Voltage [kVp]			Standard Waveform	Polarity
[kV]	FW	-	-	T1/T2/Tc	
11	95	-	-	[1.2 ± 0.36 / 50 ± 10/2-6] µS	[-] Negative

Phase Applied	Phase - 2U1	Phase - 2V1	Phase - 2W1
Terminal	LV - 2U1	LV - 2V1	LV - 2W1
Tap Position	-	-	-
WaveShape	1.28 / 42.56 / NA µs	1.28 / 42.93 / NA µs	1.29 / 42.70 / NA µs

Test Sequence	Wave No.	Voltage		Wave No.	Voltage		Wave No.	Voltage	
		[%]	[kVp]		[%]	[kVp]		[%]	[kVp]
RFW	1	53.09	50.44	1	52.11	49.5	1	52.00	49.4
FW	2	100.53	95.5	2	101.37	96.3	2	101.16	96.1
FW	3	100.11	95.1	3	99.79	94.8	3	99.89	94.9
FW	4	99.89	94.9	4	100.00	95.	4	100.11	95.1

RFW : Reduced Full Wave / FW : Full Wave / RCW : Reduced Chopped Wave / CW : Chopped Wave

Result : Transformer withstood the Test Satisfactory.

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MVA : 30 **Customer :** ZETDC

LIGHTNING IMPULSE VOLTAGE WITHSTAND TEST

Rated Voltage	Test Voltage [kVp]			Standard Waveform	Polarity
[kV]	FW	CW	-	T1/T2/Tc	
132	950	950	-	[1.2 ± 0.36 / 50 ± 10/2-6] µS	[-] Negative

Phase Applied	Phase - 1U1	Phase - 1V1	Phase - 1W1
Terminal	HV(132) - 1U1	HV(132) - 1V1	HV(132) - 1W1
Tap Position	1	8	15
WaveShape	1.17 / 55.74 / NA µs	1.32 / 47.30 / NA µs	1.27 / 47.45 / NA µs

Test Sequence	Wave No.	Voltage		Wave No.	Voltage		Wave No.	Voltage	
		[%]	[kVp]		[%]	[kVp]		[%]	[kVp]
RFW	1	42.15	400.40	1	42.34	402.2	1	42.25	401.4
FW	2	68.42	650.0	2	68.71	652.7	2	68.51	650.8
RCW	3	67.53	641.50	3	67.61	642.3	3	67.45	640.8
FCW	4	109.98	1044.8	4	109.92	1044.2	4	109.56	1040.8
FCW	5	109.60	1041.2	5	109.72	1042.3	5	109.65	1041.7
FW	6	68.44	650.2	6	68.42	650.0	6	69.35	658.8
FW	7	68.55	651.2	7	68.40	649.8	7	67.94	645.4

RFW : Reduced Full Wave / FW : Full Wave / RCW : Reduced Chopped Wave / CW : Chopped Wave

Result : Transformer withstood the Test Satisfactory.

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MVA : 30 **Customer :** ZETDC

LIGHTNING IMPULSE VOLTAGE WITHSTAND TEST

Rated Voltage	Test Voltage [kVp]			Standard Waveform	Polarity
[kV]	FW	CW	-	T1/T2/Tc	
11	95	95	-	[1.2 ± 0.36 / 50 ± 10/2-6] µS	[-] Negative

Phase Applied	Phase - 2U1	Phase - 2V1	Phase - 2W1
Terminal	LV - 2U1	LV - 2V1	LV - 2W1
Tap Position	-	-	-
WaveShape	1.28 / 42.56 / NA µs	1.28 / 42.93 / NA µs	1.29 / 42.70 / NA µs

Test Sequence	Wave No.	Voltage		Wave No.	Voltage		Wave No.	Voltage	
		[%]	[kVp]		[%]	[kVp]		[%]	[kVp]
RFW	1	53.09	50.44	1	52.11	49.5	1	52.00	49.4
FW	2	100.53	95.5	2	101.37	96.3	2	101.16	96.1
RCW	3	66.11	62.80	3	64.95	61.7	3	66.42	63.1
FCW	4	107.79	102.4	4	108.53	103.1	4	108.84	103.4
FCW	5	107.16	101.8	5	108.21	102.8	5	108.11	102.7
FW	6	100.11	95.1	6	99.79	94.8	6	99.89	94.9
FW	7	99.89	94.9	7	100.00	95.0	7	100.11	95.1

RFW : Reduced Full Wave / FW : Full Wave / RCW : Reduced Chopped Wave / CW : Chopped Wave

Result : Transformer withstood the Test Satisfactory.

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MVA : 30 **Customer :** ZETDC

LIGHTNING IMPULSE VOLTAGE WITHSTAND TEST ON NEUTRAL TERMINAL

Winding	HV-N
Test Circuit	Neutral
Impulse On	Neutral (N)
Tap Position	
Wave Shape	µs
Test Voltage	250
Standard Waveform	[1.2 ± 0.36 / 50 ± 10] µS
Polarity	[-] Negative

Test Sequence	Wave No.	Voltage [%]	Voltage [kVp]
RFW	1	64.28	160.7
FW	2	99.12	247.8
FW	3	100.36	250.9
FW	4	99.92	249.8

RFW : Reduced Full Wave / FW : Full Wave

Result : Transformer withstood the Test Satisfactory.

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Date : 26/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

MEASUREMENT OF ZERO PHASE SEQUENCE IMPEDANCE

Cooling Type : **ONAF [30 MVA]** Frequency : **50.01** Hz

Supply : **HV(132)** | Short Circuit : **-** | Open : **LV**

Supply given between 3-Phase terminals shorted together and Neutral terminal.
Another winding 3-Phase terminals and Neutral Kept open.

Tap No.	U Rated	I Rated	U Meas.	I Meas.	Ohms	%Z at 50 Hz	Frequency
	[kV]	[Amp]	[kV]	[Amp]	[3V/I]		(Hz)
8	132.0000	131.22	3.061	46.100	199.20	34.294	50.01

Cooling Type : **ONAF [30 MVA]** Frequency : **50.14** Hz

Supply : **HV(132)** | Short Circuit : **LV** | Open : **-**

Supply given between 3-Phase terminals shorted together and Neutral terminal.
Another winding 3-Phase terminals and Neutral Shorted.

Tap No.	U Rated	I Rated	U Meas.	I Meas.	Ohms	%Z at 50 Hz	Frequency
	[kV]	[Amp]	[kV]	[Amp]	[3V/I]		(Hz)
8	132.0000	131.22	0.880	45.200	58.407	10.026	50.14

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MVA : 30 **Customer :** ZETDC

SWITCHING IMPULSE VOLTAGE WITHSTAND TEST

Rated Voltage	Test Voltage [kVp]			Waveform	Polarity
[kV]	-	-	SI	Tp/Td/Tz	
132	-	-	750	[≥100/≥200/≥1000 µS]	[-] Negative

Phase Applied	Phase - 1U1		Phase - 1V1		Phase - 1W1		
Terminal	HV(132) - 1U1		HV(132) - 1V1		HV(132) - 1W1		
Tap Position	11		11		11		
WaveShape	259.20 / 208.10 / >1000 µS		255.60 / 204.20 / >1000 µS		257.10 / 206.80 / >1000 µS		
Test Sequence	Wave No.	Voltage		Wave No.	Voltage		Wave No.	Voltage	
		[%]	[kVp]		[%]	[kVp]		[%]	[kVp]
RFW	1	66.81	501.1	1	67.76	508.2	1	67.41	505.6
FW	2	100.83	756.2	2	101.09	758.2	2	100.81	756.1
FW	3	100.68	755.1	3	101.35	760.1	3	101.04	757.8
FW	4	100.32	752.4	4	100.55	754.1	4	101.21	759.1

RFW : Reduced Full Wave / FW : Full Wave

Result : Transformer withstood the Test Satisfactory.

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MVA : 30 **Customer :** ZETDC

MEASUREMENT OF CAPACITANCE AND DISSIPATION FACTOR

For Bushing

Top Oil Temp. : 42.4ºC | Bottom Oil Temp. : 39.6ºC | Avg. Oil Temp. : 41ºC				
Terminal Connected	**Make / Sr. No.**	**Test voltage [kV]**	**Capacitance [pF]**	**Tan Delta in % @ 41 °C**
HV	HSP/EA20140040 4.1	10.00	255.570	0.366
HV	HSP/EA20140040 5.1	10.00	253.840	0.376
HV	HSP/EA20140040 6.1	10.00	250.260	0.375

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MVA :30 **Customer :** ZETDC

MEASUREMENT OF CAPACITANCE AND DISSIPATION FACTOR

For Winding/HV(132)

Top Oil Temp. : 42.4ºC	Bottom Oil Temp. : 39.6ºC	Avg. Oil Temp. : 41ºC		
Measured Between	Test Voltage [kV]	Capacitance pF	Tan Delta in % @	
			41 °C	20 °C
HV/LV + E	10.00	7035.840	0.375	0.236
LV/HV + E	10.00	11593.850	0.567	0.357
HV/LV + g	10.00	3359.070	0.381	0.240
LV/HV + g	10.00	7909.200	0.615	0.387
HV/LV	10.00	3674.470	0.376	0.236

For Winding/HV(88)

Top Oil Temp. : 42.4ºC	Bottom Oil Temp. : 39.6ºC	Avg. Oil Temp. : 41ºC		
Measured Between	Test Voltage [kV]	Capacitance pF	Tan Delta in % @	
			41 °C	20 °C
HV/LV + E	10.00	7047.260	0.321	0.202
LV/HV + E	10.00	11595.810	373.000	234.591
HV/LV + g	10.00	3361.410	0.322	0.203
LV/HV + g	10.00	7904.290	0.391	0.246
HV/LV	10.00	3684.290	0.329	0.207

tan delta @ 20ºC= Tan Delta @ Test Temp./ K, where K =0.6428 X e (0.0222x Avg. Temp.)

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Date : 26/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

INDUCED OVER VOLTAGE WITHSTAND TEST WITH PARTIAL DISCHARGE MEASUREMENT

IVPD

Ur = 132 kV

Calibration Signal :

Test Frequency : 1 Hz **All partial discharge measurements are in pC**

Test Volt. [kV]	Time in Mins		1U1	1V1	1W1
91.450	A	1	50	49	51
120.420	B	5	52	50	53
137.180	C	30 Sec	OK	OK	OK
120.420	D	5	51	52	55
120.420	D	10	53	54	54
120.420	D	15	52	55	54
120.420	D	20	54	55	56
120.420	D	25	53	54	57
120.420	D	30	55	54	56
120.420	D	35	54	55	56
120.420	D	40	532	56	54
120.420	D	45	55	56	54
120.420	D	50	54	57	55
120.420	D	55	55	55	53
120.420	D	60	53	56	52
91.450	E	1	52	51	52

	Background PD Level
Before Test	30.485
After Test	30.485
Guranteed Values	18
Background PD Level	16

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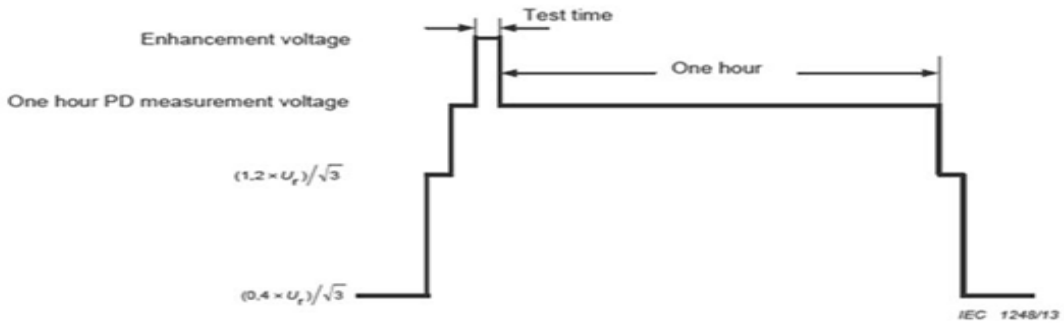
Date : 26/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

INDUCED OVER VOLTAGE WITHSTAND TEST WITH PARTIAL DISCHARGE MEASUREMENT



induced voltage test with partial discharge measurement (IVPD)

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Date : 15/07/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

CHECK OF CT RATIO AND POLARITY

All Bushing CT's Checked for Ratio & Polarity AS PER r & d PLATE DRAWING T0225552VFGHTC

Found to be OK

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Date : 26/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

SFRA MEASUREMENT

SFRA for Winding : LV

TEST OBJECT : 3P2WDualHV

VOLTAGE CLASS : -

W.O. No. : ET10335

SERIAL No. : ET10335/1A

CUSTOMER : ZETDC

TEST DATE : 26/06/2015

TIME OF TEST : Pre - Dispatch

TESTED AT : Transformer (T1) Division

Transformer Condition under Test

a) Transformer was fully filled with Oil

b) Transformer tap switch kept at Normal position.

c) Transformer fitted with bushings.

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Date : 26/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

SFRA MEASUREMENT

Test Connections

Trace No	Red Lead position	Black Lead Position	Other Terminal Condition
1	1U1	1N	OPEN
2	1V1	1N	OPEN
3	1W1	1N	OPEN
4	1U1	1N	LV SHORTED
5	1V1	1N	LV SHORTED
6	1W1	1N	LV SHORTED
7	2U1	2N	OPEN
8	2V1	2N	OPEN
9	2W1	2N	OPEN

Test Procedure for Winding : LV

1) The transformer tested was completely isolated from the power supply.

2) In order to maintain consistancy and repeatability of measurements, all terminals that are not under test were isolated and floating.

3) SFRA instrument was calibrated as per equipment operating manual.

4) Connections of the cables and Ground wire are followed as per the SFRA manual.

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Date : 27/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

TEMPERATURE RISE TEST

Measured no-load loss [kW] [Po]	:	**24.246**
Load loss [kW] [Pk] [at 75 ºC]	:	**143.850**
Total losses to be fed [kW] [Po + Pk]	:	**168.096**
Supply side : HV Short side : LV Tap position	:	**15**
Rated Current	:	**141.097 A**
Cooling	:	**ONAF [30 MVA]**
Yearly Average Ambient Temperature for Hot Spot calculation	:	**20 °C**

Measurements				TEMPERATURES [°C]										
Hour	**kW**	**kV**	**A**	**t1**	**t2**	**t3**	**t4**	**tAvg**	**I/L1**	**O/L1**	**I/L2**	**O/L2**	**ty**	**dty**
9:30	177.35	7.839	244.16	26.3	26.1	25.9	25.8	26.03	52.3	45.6	52.3	45.7	55.2	29.17
10:30	177.38	7.892	244.32	28.1	28.3	28.7	29.2	28.58	58.3	49.3	58.3	50.3	61.9	33.32
11:30	177.35	7.893	244.16	31.6	31.1	31.5	31.2	31.35	64.3	57.6	64.5	56.8	65.5	34.15
12:30	177.38	7.892	244.32	33.7	34.1	34.4	33.8	34.00	67.2	59.8	67.1	59.5	68.2	34.20
13:30	177.36	7.885	245.17	35.6	36.5	36.2	36.4	36.18	68.9	60.1	68.4	60.3	70.4	34.22
14:30	177.35	7.883	245.43	37.2	37.8	36.9	38.2	37.53	70.3	63.2	69.9	63.8	72.3	34.77
Current reduced to rated current 141.097														
15:30	177.38	7.882	245.22	37.9	38.2	37.1	38.5	37.93	69.8	61.2	69.7	61.5	71.2	33.27
HV(88)/LV Winding ShutDown Phase 1														

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Date : 27/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

TEMPERATURE RISE TEST

Hour	TEMPERATURES [°C]			
	OTI	WTI-HV	WTI-LV	WTI--
9:30	56	63	64	64
10:30	60	69	70	70
11:30	66	74	74	74
12:30	68	76	78	78
13:30	70	80	78	78
14:30	72	82	80	80
Current reduced to rated current 141.097				
15:30	69.8	61.2	69.7	61.5
HV(88)/LV Winding ShutDown Phase 1				

t1..... t3/t4 : Ambient Temperature	I/L1....I/L2 : Cooler Inlet Temp.	ty : Top Oil Temperature
tAvg : Avg. Ambient Temp.	O/L1..O/L2 : Cooler Outlet Temp.	dty : Top Oil Temp. Rise
FO : Fibre Optics	OTI : Oil Temp. Indicator	WTI :Winding Temp. Indicator
W/I1...W/I2 : Water Inlet Temp.	W/O1...W/O2 : Water Outlet Temp.	CB : Cable Box
MB : Marshalling Box		

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Date : 27/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

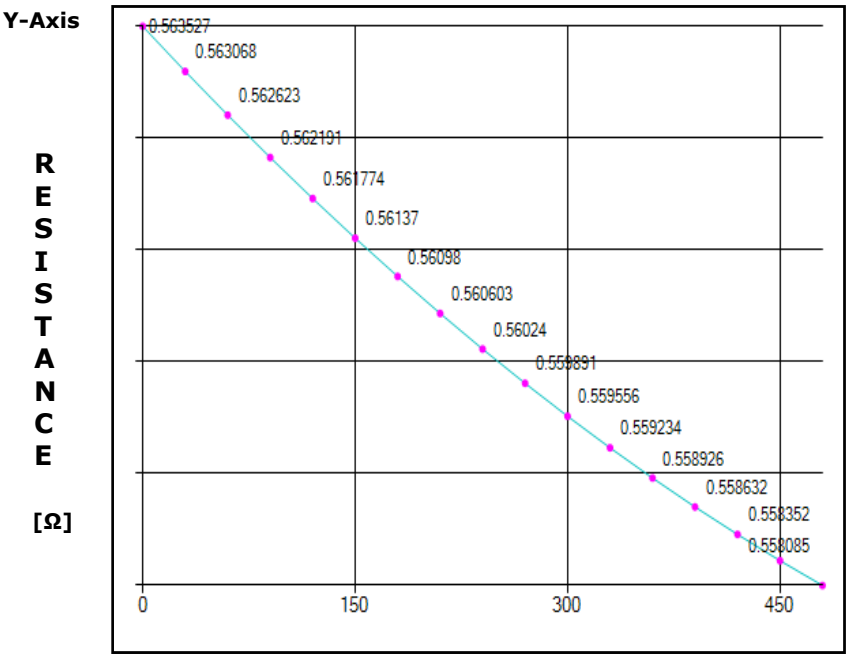
TEMPERATURE RISE TEST

RESISTANCE - TIME CURVE

Time [Sec]	HV(88) R[Ω]	Ext.Pol. R[Ω]
0		0.563527
30		0.563068
60		0.562623
90		0.562191
120		0.561774
150	0.5613639	0.561370
180	0.5609943	0.560980
210	0.5605963	0.560603
240	0.5602268	0.560240
270	0.5598856	0.559891
300	0.5595729	0.559556
330	0.5592886	0.559234
360	0.5588622	0.558926
390	0.5586348	0.558632
420	0.5583505	0.558352
450	0.5580947	0.558085
480	0.5578104	0.557832

COOLING TYPE : ONAF/30 MVA

WINDING -- HV(88) Phase 1



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Date : 27/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

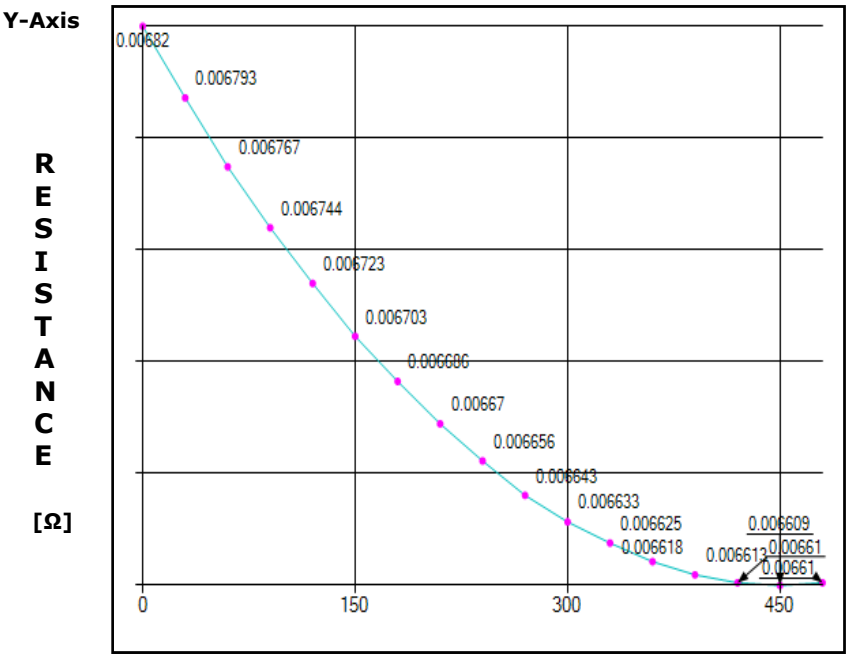
TEMPERATURE RISE TEST

RESISTANCE - TIME CURVE

Time [Sec]	LV R[Ω]	Ext.Pol. R[Ω]
0		0.006820
30		0.006793
60		0.006767
90		0.006744
120		0.006723
150	0.0067087	0.006703
180	0.0066844	0.006686
210	0.0066658	0.006670
240	0.0066509	0.006656
270	0.0066398	0.006643
300	0.0066353	0.006633
330	0.0066285	0.006625
360	0.0066212	0.006618
390	0.0066162	0.006613
420	0.0066104	0.006610
450	0.0066051	0.006609
480	0.0066016	0.006610

COOLING TYPE : ONAF/30 MVA

WINDING -- LV Phase 1



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Date : 27/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

TEMPERATURE RISE TEST

DETERMINATION OF TOP OIL TEMP. RISE		HV(88)	LV	
Reference Power	MVA	ONAF/30	ONAF/30	
Total Losses Supplied	kW	177.35	177.35	
Input Rated Losses to be fed	kW	168.096	168.096	
Top Oil Temp. Rise at Supplied Losses	ºC	34.77	34.77	
Corrected Top Oil Temp. Rise to the Input Rated Loss	ºC	34.77	34.77	
Cooler Inlet Temp. [1st group]	ºC	70.3	70.3	
Cooler Inlet Temp. [2nd group]	ºC	69.9	69.9	
Average [Cooler Inlet Temp.]	ºC	70.1	70.1	
Cooler Outlet Temp.[1st group]	ºC	63.2	63.2	
Cooler Outlet Temp.[2nd group]	ºC	63.8	63.8	
Average [Cooler Outlet Temp.]	ºC	63.5	63.5	
Average Oil Rise at Steady State	ºC	31.47	31.47	
DETERMINATION OF WINDING TEMP. RISE		HV(88)	LV	
Reference Power	MVA	ONAF/30	ONAF/30	
Top Oil Temp. Rise @ Rated Current	ºC	33.27	33.27	
Cooler Inlet Temp.[1nd group]	ºC	69.8	69.8	
Cooler Inlet Temp.[2nd group]	ºC	69.7	69.7	
Average [Cooler Inlet Temp.]	ºC	69.75	69.75	
Cooler Outlet Temp.[1st group]	ºC	61.2	61.2	
Cooler Outlet Temp.[2nd group]	ºC	61.5	61.5	
Average [Cooler Outlet Temp.]	ºC	61.35	61.35	
Avg. Oil Rise at Shutdown	ºC	29.07	29.07	
Reference Cold Resistance at :41.2ºC	Ohms	0.47756	0.00598	
Winding Resis. at Shutdown From (Cooling Curve)	Ohms	0.563527	0.00682	
Winding Temp. at Shutdown	ºC	90.92	80.00	
Average Ambient Temp. at Shutdown	ºC	37.93	37.93	
Gradiant	ºC	23.92	13.00	
Hot Spot Temp.	ºC	85.87	71.67	
RESULTS		HV(88)	LV	
Top Oil Temp. Rise	ºC	34.77	34.77	
Winding Temp. Rise	ºC	55.39	44.47	
Hot Spot Temp.Rise	ºC	65.866	51.67	

GUAR. VALUE	Top Oil Temperature Rise	°C	60
	Mean Winding Temp. Rise	°C	65
	Hot spot tempeature Rise	°C	20

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Date : 27/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

TEMPERATURE RISE TEST

Measured no-load loss [kW] [Po]	:	**24.246**
Load loss [kW] [Pk] [at 75 ºC]	:	**63.933**
Total losses to be fed [kW] [Po + Pk]	:	**88.179**
Supply side : HV Short side : LV Tap position	:	**15**
Rated Current	:	**94.064 A**
Cooling	:	**ONAN [20 MVA]**
Yearly Average Ambient Temperature for Hot Spot calculation	:	**20 °C**

Measurements				TEMPERATURES [°C]										
Hour	**kW**	**kV**	**A**	**t1**	**t2**	**t3**	**t4**	**tAvg**	**I/L1**	**O/L1**	**I/L2**	**O/L2**	**ty**	**dty**
1:00	94.53	5.760	178.84	25.8	26.2	26.3	26.2	26.13	41.0	28.3	41.1	28.9	41.3	15.17
2:00	94.52	5.772	178.86	24.7	24.7	24.5	24.3	24.55	49.5	35.3	49.8	35.7	50.2	25.65
3:00	94.53	5.759	178.88	24.5	24.3	24.2	24.1	24.28	51.3	39.5	51.2	39.1	52.5	28.22
4:00	94.55	5.762	178.85	23.8	24.2	23.7	24.1	23.95	52.2	41.2	52.5	41.4	53.1	29.15
5:00	94.52	5.761	178.89	23.5	23.9	23.5	24.0	23.73	52.6	43.5	52.9	43.7	53.5	29.77
6:00	94.56	5.762	178.91	23.1	23.5	23.2	23.7	23.38	52.9	44.2	53.5	44.3	53.8	30.42
7:00	94.53	5.763	178.88	22.8	23.1	22.9	23.3	23.03	53.2	45.0	53.8	45.1	54.2	31.17
Current reduced to rated current 94.064														
8:00	94.53	5.763	178.88	23.5	23.9	23.8	23.9	23.78	52.0	44.5	52.4	44.6	53.2	29.42
HV(88)/LV Winding ShutDown Phase 2														

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Date : 27/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

TEMPERATURE RISE TEST

Hour	TEMPERATURES [°C]			
	OTI	WTI-HV	WTI-LV	WTI--
1:00	39.00	48.00	48.00	50.00
2:00	48.00	56.00	56.00	56.00
3:00	50.00	60.00	60.00	58.00
4:00	52.00	60.00	60.00	60.00
5:00	52.00	60.00	60.00	60.00
6:00	52.00	62.00	62.00	62.00
7:00	54.00	62.00	62.00	62.00
Current reduced to rated current 94.064				
8:00	50.00	58.00	58.00	58.00
HV(88)/LV Winding ShutDown Phase 2				

t1..... t3/t4 : Ambient Temperature	I/L1....I/L2 : Cooler Inlet Temp.	ty : Top Oil Temperature
tAvg : Avg. Ambient Temp.	O/L1..O/L2 : Cooler Outlet Temp.	dty : Top Oil Temp. Rise
FO : Fibre Optics	OTI : Oil Temp. Indicator	WTI :Winding Temp. Indicator
W/I1...W/I2 : Water Inlet Temp.	W/O1...W/O2 : Water Outlet Temp.	CB : Cable Box
MB : Marshalling Box		

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Date : 27/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

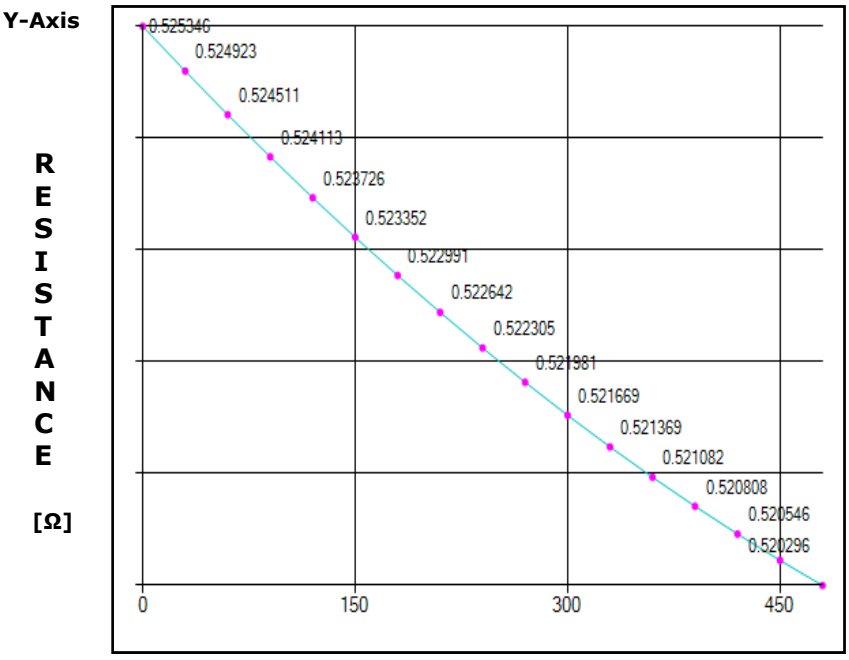
TEMPERATURE RISE TEST

RESISTANCE - TIME CURVE

Time [Sec]	HV(88) R[Ω]	Ext.Pol. R[Ω]
0		0.525346
30		0.524923
60		0.524511
90		0.524113
120		0.523726
150	0.523343	0.523352
180	0.523012	0.522991
210	0.522625	0.522642
240	0.522293	0.522305
270	0.521989	0.521981
300	0.521686	0.521669
330	0.521409	0.521369
360	0.521023	0.521082
390	0.520802	0.520808
420	0.520553	0.520546
450	0.520304	0.520296
480	0.520028	0.520059

COOLING TYPE : ONAN/20 MVA

WINDING -- HV(88) Phase 2



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Date : 27/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

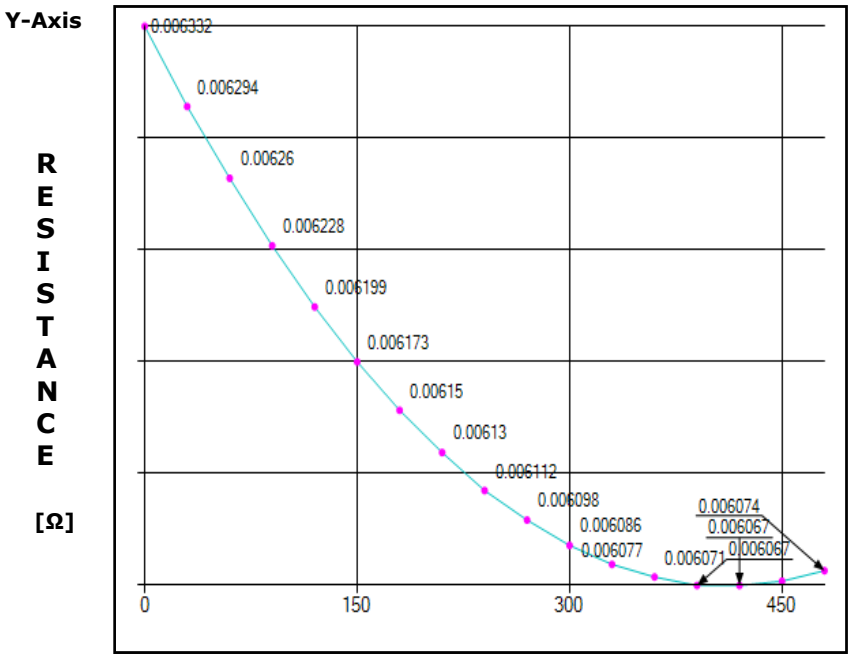
TEMPERATURE RISE TEST

RESISTANCE - TIME CURVE

Time [Sec]	LV R[Ω]	Ext.Pol. R[Ω]
0		0.006332
30		0.006294
60		0.006260
90		0.006228
120		0.006199
150	0.006178	0.006173
180	0.006161	0.006150
210	0.006115	0.006130
240	0.006102	0.006112
270	0.006094	0.006098
300	0.006090	0.006086
330	0.006083	0.006077
360	0.006077	0.006071
390	0.006072	0.006067
420	0.006067	0.006067
450	0.006062	0.006069
480	0.006057	0.006074

COOLING TYPE : ONAN/20 MVA

WINDING -- LV Phase 2



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Date : 27/06/2015 **W.O.No :** ET10335 **Serial No :** ET10335/1A

MVA : 30 **Customer :** ZETDC

TEMPERATURE RISE TEST

DETERMINATION OF TOP OIL TEMP. RISE		HV(88)	LV	
Reference Power	MVA	ONAN/20	ONAN/20	
Total Losses Supplied	kW	94.53	94.53	
Input Rated Losses to be fed	kW	88.179	88.179	
Top Oil Temp. Rise at Supplied Losses	ºC	31.17	31.17	
Corrected Top Oil Temp. Rise to the Input Rated Loss	ºC	31.17	31.17	
Cooler Inlet Temp. [1st group]	ºC	53.2	53.2	
Cooler Inlet Temp. [2nd group]	ºC	53.8	53.8	
Average [Cooler Inlet Temp.]	ºC	53.5	53.5	
Cooler Outlet Temp.[1st group]	ºC	45.0	45.0	
Cooler Outlet Temp.[2nd group]	ºC	45.1	45.1	
Average [Cooler Outlet Temp.]	ºC	45.05	45.05	
Average Oil Rise at Steady State	ºC	26.95	26.95	
DETERMINATION OF WINDING TEMP. RISE		HV(88)	LV	
Reference Power	MVA	ONAN/20	ONAN/20	
Top Oil Temp. Rise @ Rated Current	ºC	29.42	29.42	
Cooler Inlet Temp.[1nd group]	ºC	52.0	52.0	
Cooler Inlet Temp.[2nd group]	ºC	52.4	52.4	
Average [Cooler Inlet Temp.]	ºC	52.2	52.2	
Cooler Outlet Temp.[1st group]	ºC	44.5	44.5	
Cooler Outlet Temp.[2nd group]	ºC	44.6	44.6	
Average [Cooler Outlet Temp.]	ºC	44.55	44.55	
Avg. Oil Rise at Shutdown	ºC	25.60	25.60	
Reference Cold Resistance at :41.2ºC	Ohms	0.47838	0.00598	
Winding Resis. at Shutdown From (Cooling Curve)	Ohms	0.525346	0.006332	
Winding Temp. at Shutdown	ºC	68.32	57.46	
Average Ambient Temp. at Shutdown	ºC	23.78	23.78	
Gradiant	ºC	18.94	8.08	
Hot Spot Temp.	ºC	75.79	61.67	
RESULTS		HV(88)	LV	
Top Oil Temp. Rise	ºC	31.17	31.17	
Winding Temp. Rise	ºC	45.89	35.03	
Hot Spot Temp.Rise	ºC	55.792	41.674	

GUAR. VALUE	Top Oil Temperature Rise	°C	60
	Mean Winding Temp. Rise	°C	65
	Hot spot tempeature Rise	°C	20

WITNESSED BY	**TESTED BY**	**APPROVED BY**

Transformer Test Pro (TTP) Software for Transformer Testing

A Graphical User Interface, Data Acquisition (DAQ) & Report Generation Software, to increase the Productivity, Consistency, Reliability of Testing of Transformers of all ratings up to 900 MVA

Features of TTP Software

- Inbuilt drivers for automatic measurements acquisition from any type of communicable Test Instrument. Allows editing & entering measurements manually
- Gives alarms for invalid or incorrect measurements
- Easy storage & retrieval of all the test reports
- Prints Test Report complying with IS, IEC, ANSI & SABS
- Auto indexing & page numbering of test reports as selected test sequence
- Analysis Report facility
- Prints detailed test report, short test report & extra short report with single page.
- Facility of printing formulae sheet when required
- Suggests Capacitor Bank Connection
- Instant data back-up facility
- ERP Integration
- Remote On-line test witness

Benefits of TTP Software

- Reduction in testing process time
- Instant error-free calculations, report generation & printing
- Increases the testing productivity

TTP Software suitable for testing of

Generator Transformer	Power Transformer	Furnace Transformer	Distribution Transformer
Station Transformer	Auto Transformer	Rectifier Transformer	Locomotive Transformer
Dry Type Transformer	Neutral Ground Transformer	Unit Auxiliary Transformers	

TTP software suitable for testing of Transformers with

Parameters	TTP suitability for
Conductor	Aluminum / Copper
Phases	1 /3
Windings	2 / 3 / 4 / Auto / Unloaded Tertiary
	Single / Dual / Split / Zigzag / Fork connection Auto Transformer
Vector Group	All, Single / Dual
Cooling	ONAN / ODAF / ODWF / OFAF / ONAF / ANAF / ANAN / AN
Testing Options	Final / Internal / Stage / After short circuit / Before short circuit / Customer witness inspection

Tests Covered By TTP Software

SR. NO.	TESTS
1	Measurement Of Voltage Ratio And Check Of Phase Displacement
2	Measurement Of Winding Resistance
3	Measurement Of Insulation Resistance
4	Measurement Of No Load Loss And No Load Current
5	Test To Prove Over fluxing Capability / Oil Soaking Test
6	Measurement Of Load Loss And Impedance Voltage
7	Three Winding Losses Of Three Phase Transformer
8	Measurement Of Impedance Voltage
9	Measurement Of Single Phase Impedance
10	Calculation Of Efficiency And Regulation
11	Separate Source Voltage Withstand Test
12	Induced Over Voltage Withstand Test (Uniform / Non Uniform Insulaion Method)
13	Induced Over Voltage Withstand Test With Partial Discharge
14	Magnetic Balance And Magnetizing Current Test
15	MEASUREMENT OF NO LOAD LOSS & NO LOAD CURRENT AT LOW VOLTAGE
16	Measurement Of Load Loss And Imped. Voltage With Spill Current
17	Measurement Of Load Loss And Impedance Voltage At Low Voltage
18	Measurement Of Single Phase / Three Phase Short Circuit Impedance
19	Magnetic Circuit Test
20	Check Of CT Ratio And Polarity
21	Excitation Current Measurement
22	OLTC Motor Current Measurement
23	Check Of CT Knee Point Voltage
24	Check Of CT DC Resistance
25	Tests On On – Load Tap Changer (OLTC)

SR. NO.	TESTS
27	Measurement Of Capacitance And Dissipation Factor
28	Measurement Of Harmonics
29	Measurement Of Acoustic Noise Level
30	Measurement Of Power Taken By Cooler Circuit
31	Measurement Of Zero Phase Sequence Impedance
32	RSO Test
33	Lightening Impulse Voltage Withstand Test
34	Lightening Impulse Voltage Withstand Test For Neutral Winding
35	Measurement Of Transferred Surge Voltage
36	Temperature Rise Test For Overloading Cycle
37	DGA Test On Oil Before And After Temperature Rise Test
38	Oil BDV Test
39	Water Content Test
40	Measurement Of Vibration Of Transformer At Rated Excitation
41	Functional Checks Of Control Panels
42	Switching Impulse Voltage Withstand Test
43	Oil Leakage Test
44	Pressure Deflection Test
45	Vacuum Deflection Test
46	Test On Pressure Relief Device
47	Jacking Test
48	Measurement Of Oil Quantity For First Oil Filling
49	Visual Inspection And Dimensional Test On Assembled Transformer
50	Calibration Of WTI & OTI
51	Frequency Response Analyser
52	Thermal Imaging
53	Dew Point Measurement

Order Code:

TTP-R – Transformer Test Pro Software for Routine Tests.
TTP-RH – Transformer Test Pro Software for Routine & Heat Run Tests
TTP-F – Transformer Test Pro Software for Routine, Type and Special Tests

Suffix:

-E- Transformer Test Pro Software with ERP integration
-W- Transformer Test Pro Software with Website integration

The Automation People
PROLIFIC
ISO 9001 : 2008 & ISO 14001 : 2004

List of Test Instruments supported by TTP Software for Automatic Data Acquisition

Insulation Tester	
SN	**Manufacturer**
1	AVO
2	MEGGER-MIT1020
3	MEGABRAS-MD5060e
4	MOTWANE 5KPIV4
5	MEGGER-MIT525
6	SIVANDA IR5K4
7	MEGABRAS-MD5060e
8	GW-INSTEK

Resistance Meter	
SN	**Manufacturer**
1	RAYTECH WR-50
2	TINSLEY 5896C
3	MOTWANE XWRM-10
4	PRESTIGE
5	RAYTECH WR-14
6	RTF
7	TWRM-10A
8	TRM25
9	TWRM-10A
10	GW-INSTEK

Power Analyser	
SN	**Manufacturer**
1	LMS
2	YOKOGAWA - WT3000
3	YOKOGAWA - WT230
4	YOKOGAWA - WT330
5	YOKOGAWA - WT333
6	Veer
7	YOKOGAWA - WT500
8	HIOKI- 3337

Ratio Meter	
SN	**Manufacturer**
1	SIVANANDA ATRM-1(UP)
2	RRAYTECH TR-MARK IIIR
3	UDEY RATIO METER
4	Tinsley 4167F
5	SIVANANDA
6	TINSLEY 4167D
7	RAYTECH-TR SPY

Oil BDV Tester	
SN	**Manufacturer**
1	SIVANANDA-OIL/BDV
2	MEGGER-OTS100AF/2
3	SIVANANDA-OIL/BDV
4	MEGGER-OTS100AF/2

Temperature Scanner	
SN	**Manufacturer**
1	NIPPON
2	RADIX
3	YOKOGAWA
4	SCHNEIDER