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1. **NAME PLATE DETAILS:**

Si No. :

Make :

Power capacity : / / MVA

Voltage rating : / / V

Vector group :

% Impedance at nominal tap : %

Normal tap :

Frequency : HZ

No. Of winding :

Primary current :

Secondary current :

Type of cooling : / /

No. of H.V taps :

1. **MECHANICAL CHECK AND VISUAL INSPECTION:**

(As per TCS – P -105.Rev – 01, Item no 3.1.1)

|  |  |  |
| --- | --- | --- |
| Item | Description | Checked |
| 1 | Inspect for physical damage/defects |  |
| 2 | Check nameplates information as per contract specification |  |
| 3 | Check quality for paint work, condition of lifting lugs, quality of weld areas rust spots and wheel stoppers |  |
| 4 | Check tightness of all bolted connections |  |
| 5 | Check impact recorder for any abnormal impact during transportation  |  |
| 6 | Check integrity of diagram/airbag in the conservator |  |
| 7 | Check piping to buchholz relay has proper slope |  |
| 8 | Check that all grounding are securely connected |  |
| 9 | Check vertical/horizontal clearance of live parts to adjacent grounded point to conform standard |  |
| 10 | Check the valves between the tank and radiator  |  |
| 11 | Check the H.V – L.V and Tertiary bushing for any damage and completeness |  |
| 12 | Check phase marking in cable box and it should match with GIS and cables |  |
| 13 | Perform all the manufacturer specific checks |  |
| 14 | Check all pipes - hoses and fan protection(not rubber or plastic) |  |
| 15 | Check the color and quantity of silica gel in breather and oil pot level  |  |
| 16 | Check labeling of all auxiliary devices as per approved drawings |  |
| 17 | Check proper operation of all auxiliary devices  |  |
| 18 | Check oil leakage by applying 0.35 bar (35KPa) over pressure for 24 Hrs |  |
| 19 | Check the oil sampling devices are reachable from ground level |  |
| 20 | Check oil level in main tank, conservator, tap changer tank and bushing etc |  |
| 21 | Check all external wiring for correctness and tightness |  |
| 22 | Bleed trapped air at the bushing turrets and tank top |  |
| 23 | Check flow of oil in flow meter in correct direction and proper rate  |  |
| 24 | Check that the temperature sensor oil well is two third filled with oil |  |
| 25 | Check the each optical feed through unit is properly connected to the ports of Hot Spot Temp Measuring device |  |
| 26 | For new transformer, Internal inspection of the H.V. bushing before installation is required due to upper yoke any bents in the core and if any paint particles found |  |

1. **ELECTRICAL TEST:**

(As per TCS – P -105.Rev – 01, Item no 3.1.2,)

 Instrument : Megger 520

 Average oil temperature : °c

* 1. Core insulation Resistance Tested with 1000 VDC

|  |  |
| --- | --- |
| Insulation resistance between | Insulation resistance with 1000 V tester (G ohms) (1 mins) |
| Core to ground |  |
| Main core frame to earth |  |

* 1. Winding Insulation Resistance Test & Polarizing Index Tested with : 5000 VDC

|  |  |  |  |
| --- | --- | --- | --- |
| Insulation resistance between | 1 Mins ( GΩ ) | 10 Mins ( GΩ ) | Polarizing index |
| HV – ground |  |  |  |
| LV – ground |  |  |  |
| TW – ground |  |  |  |
| HV – LV |  |  |  |
| HV – TW |  |  |  |
| LV – TW |  |  |  |

 Criteria: Polarization Index (I.R at 10 min / I.R at 1 Min) Value > 1.3

1. **WINDING RESISTANCE (DC) TEST AT ALL TAPS**

 Instrument **:**

Oil temperature **:** ° C

Injecting Current **:**  A

* 1. HV Winding

Ambient Temperature:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Tap no. | Winding resistance (Ω) @ amb temp. | Avg Res /ph @ amb temp (Ω) | \* res /ph @ 75 ° c (Ω) | Factory Avg res @ 75˚c |
| R-N | Y-N | B-N |
|  |  |  |  |  |  |  |
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 (235 + 75)

\* Res / Ph @ 75 ° C. = Avg. Res / Ph @ Amb. Temp. X --------------------------

 (235 + Avg Oil Temp.)

* 1. LV Winding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Tap no. | Winding resistance (Ω) @ ambient temp. | Average Res /Ph @ Amb.Temp (Ω) | \* Res/ph @ 75 °C(Ω) | Factory resistance@ 75˚c |
| 1r-n | 1y-n | 1b-n |
| ----- |  |  |  |  |  |  |

(235 + 75)

\* Res / Ph @ 75 ° C. = Avg. Res / Ph @ Amb. Temp. X --------------------------

 (235 + Avg Oil Temp.)

* 1. TV winding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Tap no. | Winding resistance ( mΩ) @ ambient temp. | Average Res /ph @ amb. Temp (mΩ) | \* Res/ph @ 75 ° C(mΩ) | Factory resistance@ 75˚C |
| 2r-n | 2y-n | 2b-n |
| ----- |  |  |  |  |  |  |

 (235 + 75)

\* Res / Ph @ 75 ° C. = Avg. Res / Ph @ Amb. Temp. X --------------------------

 (235 + Avg Oil Temp.)

1. **MAGNETIZING CURRENT TEST (NO LOAD CURRENT TEST)**

Instrument:

 Condition:

 (1) Three phase voltage applied on HV side by keeping LV side open.

 (2) Current measurement carried at HV terminals.

|  |  |  |  |
| --- | --- | --- | --- |
| Tap No. | Measured voltage at HV side | Measured current at HV side (mA) | I0 % |
|  R-Y  | Y-B | B-R | Average volt | IR | IY | IB | AverageCurrent |
|  |  |  |  |  |  |  |  |  |  |
| N |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |

 Average current rated tap voltage

 I0 % = --------------------- × ----------------------- × 100

 Average voltage rated tap current

 I0 Criteria: < 0.5 %

1. **MAGNETIC BALANCE TEST**

Tap : ----L

|  |  |
| --- | --- |
| REF | Measured Voltage ( V ) |
| HV | LV |
| R – N | Y- N | B – N | 1r – n | 1y - n | 1b – n |
| R – N |  |  |  |  |  |  |
| Y – N |  |  |  |  |  |  |
| B – N |  |  |  |  |  |  |

 Tap : N

|  |  |
| --- | --- |
| REF | Measured Voltage ( V ) |
| HV | LV |
| R – N | Y- N | B – N | 1r – n | 1y - n | 1b – n |
| R – N |  |  |  |  |  |  |
| Y – N |  |  |  |  |  |  |
| B – N |  |  |  |  |  |  |

 Tap : ---- R

|  |  |
| --- | --- |
| REF | Measured Voltage ( V ) |
| HV | LV |
| R – N | Y- N | B – N | 1r – n | 1y - n | 1b – n |
| R – N |  |  |  |  |  |  |
| Y – N |  |  |  |  |  |  |
| B – N |  |  |  |  |  |  |

 Note:

 1. When applying voltage between R-N => Y-N + B-N

 2. When applying voltage between Y-N => R-N +B-N

 3. When applying voltage between B-N => R-N +Y-N

1. **VECTOR GROUP TEST**

 HV termination designation – R, Y, B, N

 LV termination designation – 1r, 1y, 1b, 1n

Condition:

* Three phase Voltage applied on HV side.
* Connect R and 1r.
* Tap changer kept at Tap position (Normal Tap)
* Voltage measurement

Measured voltages following

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | R | Y | B | N | r | y | b |
| R | **×** | **×** | **×** | **×** | **×** | **×** | **×** |
| Y |  | **×** | **×** | **×** | **×** | **×** | **×** |
| B |  |  | **×** | **×** | **×** | **×** | **×** |
| N |  |  |  | **×** | **×** | **×** | **×** |
| r |  |  |  |  | **×** | **×** | **×** |
| y |  |  |  |  |  | **×**  | **×** |
| b |  |  |  |  |  |  | **×** |
| n |  |  |  |  |  |  |  |

Proof: Vector Group is

Result:

Equations to be satisfied for YNyn0 vector group as an example are

1. R-1b = Y-1y =>
2. Y-1b > B-1b =>

R,1r

1y

1b

1n

N

Y

B

1. B-1y = Y-1b =>
2. Y-1y > R-1y =>
3. Y-1b > Y-1y =>
4. R-1y = R-1b =>

1. **SINGLE PHASE IMPEDANCE MEASUREMENT**
	1. Condition:

 1. Apply voltage between R and Y.

 2. Short all low voltage side of transformer.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Tap | Measured voltage | Measured current | Factory resistance | Measured resistance | % Error |
|  |  |  |  |  |  |
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* 1. Condition:

 1. Apply voltage between Y and B.

 2. Short all phases of low voltage side of transformer.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Tap | Measured voltage | Measured current | Factory resistance | Measured resistance | % Error |
|  |  |  |  |  |  |
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* 1. Condition:

 1. Apply voltage between B and R.

 2. Short all phases of low voltage side of transformer.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TAP | Measured voltage | Measured current | Factory resistance | MeasuredResistance | % Error |
|  |  |  |  |  |  |
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1. **SHORT CIRCUIT TEST** (Percentage Impedance Measurement)

Ambient Temperature : °C

* 1. Tap ---- L
* Connect 3-phase supply to HV side and short LV side winding.

|  |  |  |  |
| --- | --- | --- | --- |
| Voltage (V) | R-Y | Y-B | B-R |
|  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Current (A) |   IR | IY | IB |
|  |  |  |

 \* Average voltage = volt

 \* Average current = Amp

 \* Rated current = Amp

 \* Frequency = 60 HZ

 \* Rated voltage = volts

% Impedance = (HV side Rated current / HV side Rated voltage) × (Average voltage / Average current) × 100 =

Note:

 Factory test = **%**

 Error = **%**

 Tolerance = +10 **%**

* 1. TapN
* Connect 3-phase supply to HV side and short LV side winding.

|  |  |  |  |
| --- | --- | --- | --- |
| Voltage (V) | R-Y | Y-B | B-R |
|  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Current (A) |   IR | IY | IB |
|  |  |  |

 \* Average voltage = Volt

 \* Average current = Amp

 \* Rated current = Amp

 \* Frequency = 60 HZ

 \* Rated voltage = Volts

% Impedance = (HV side Rated current / HV side Rated voltage) × (Average voltage / Average current) × 100 =

 Note:

 Factory test = **%**

 Error = **%**

 Tolerance = +10**%**

* 1. Tap --- R
* Connect 3-phase supply to HV side and short LV side winding.

|  |  |  |  |
| --- | --- | --- | --- |
| Voltage (V) | R-Y | Y-B | B-R |
|  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Current (A) |   IR | IY | IB |
|  |  |  |

 \* Average voltage = volt

 \* Average current = Amp

 \* Rated current = Amp

 \* Frequency = 60 HZ

 \* Rated voltage = volts

 % Impedance = (HV side Rated current / HV side Rated voltage) × (Average voltage / Average current) × 100 =

Note:

 Factory test =  **%**

 Error = **%**

 Tolerance = +10 **%**

1. **ZERO SEQUENCE IMPEDANCE MEASUREMENT**

* 1. Condition:1
* Shorted R , Y ,B On HV Side
* Single phase Voltage applied on HV side between shorted terminals R-Y-B and neutral N. Keep LV side open and TW side short.
* Measure the Voltage & Current on HV side

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Tap | Rated voltage | RatedCurrent |  Measured |  Z0  | Calculated Z% | Factory Z% | % error |
|  V0  |  I0 |
| ---L |  |  |  |  |  |  |  |  |
| N |  |  |  |  |  |  |  |  |
| ---R |  |  |  |  |  |  |  |  |

* 1. Condition:2
* Shorted R , Y ,B On HV Side
* Single phase Voltage applied on HV side between shorted terminals R-Y-B and neutral N. Keep LV and TW side short.
* Measure the Voltage & Current on HV side

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Tap | Rated voltage | RatedCurrent |  Measured |  Z0  | Calculated Z% | Factory Z% | % error |
|  V0  |  I0 |
| ---L |  |  |  |  |  |  |  |  |
| N |  |  |  |  |  |  |  |  |
| ---R |  |  |  |  |  |  |  |  |

Calculation

 3 V0 / I**0**

 % Z = ---------------------------- × 100

 (VRATED / √3) /I **RATED**

1. **CAPACITANCE & TAN DELTA OF WINDING:**

 Oil temperature **:** ° c

 Correction factor **:**

(To convert % Dissipation Factor to 20 C°, Divide the measured % Dissipation Factor value with Correction Factor)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TestNo. | InsulationTested | TestMode | Test connection | TestKV | ma | Cap (ΡF) | P.F% | P.F %At 20 ̊ C | Watts |
| Eng | Gnd | Gar |
|  1  | CHG+CHL | GST | H | L | T | 10 |  |  |  |  |  |
| 2 | CHG | GST | H |  | L,T | 10 |  |  |  |  |  |
| 3 | CHL | UST | H |  |  | 10 |  |  |  |  |  |
| 4 | CLG+CLT | GST | L | T | H | 10 |  |  |  |  |  |
| 5 | CLG | GST | L |  | T,H | 10 |  |  |  |  |  |
| 6 | CLT | UST | L |  |  | 10 |  |  |  |  |  |
| 7 | CTG+CHT | GST | T | H | L | 5 |  |  |  |  |  |
| 8 | CTG | GST | T |  | H,L | 5 |  |  |  |  |  |
| 9 | CHT | UST | T |  |  | 5 |  |  |  |  |  |

 H = high voltage 110 kV winding G = body of Transformer grounded

 L = low voltage 15 kV winding T = 6.6KV tertiary winding

 Criteria: P.F% AT 20 ° C < 0.5

1. **TRANSFORMER TURNS RATIO (HV- LV)**

|  |  |  |  |
| --- | --- | --- | --- |
| Transformer name plate data | Measured ratioR-N/1r-n | Measured ratioY-N/1y-n | Measured ratioB-N/1b-n |
| Tap no. | HV | LV | Calc. Ratio | Ratio | Dev. (%) | I exc.(mA) | Ratio | Dev. (%) | I exc.(mA) | Ratio | Dev. (%) | I exc.(mA) |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
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Criteria Acceptable Tolerance for Ratio Deviation is + 0.5%

1. **CALIBRATION OF OIL AND WINDING TEMPERATURE SENSORS**

|  |  |  |  |
| --- | --- | --- | --- |
| Reference Temp. | Oil Temp Indicator | HV winding temp. indicator | LV winding temp. indicator |
| Starting Temp |  |  |  |
| 40 |  |  |  |
| 60 |  |  |  |
| 80 |  |  |  |
| 100 |  |  |  |
| 120 |  |  |  |
| 140 |  |  |  |

Criteria: ± 3

1. **WINDING TEMPERATURE CALIBRATION BY SECONDARY CURRENT INJECTION:**

 High voltage winding temperature indicator:

 Ct ratio :

 Full load current: A

 Current injection: A

|  |
| --- |
|  Reading |
| Time (min.) | Temp. Reading |
| 0 |  |
| 5 |  |
| 10 |  |
| 15 |  |
| 20 |  |
| 25 |  |
| 30 |  |
| 35 |  |
| 40 |  |

|  |  |
| --- | --- |
| Oil Temp. At start (A) |  ˚C |
| Oil Temp. At end (B) |  ˚C |
| Winding Temp. Before current injection (C) |  ˚C |
| Winding Temp. After 45 mins (D) |  ˚C |
| Simulated temp. Rise measured: [(D-C)-(B-A)] |  ˚C |

 Low voltage winding temperature indicator:

 Ct ratio :

 Full load current : A

 Current injection : A

|  |
| --- |
| Reading |
| Time (min.) | Temp. Reading(˚c ) |
| 0 |  |
| 5 |  |
| 10 |  |
| 15 |  |
| 20 |  |
| 25 |  |
| 30 |  |
| 35 |  |
| 40 |  |
| 45 |  |

|  |  |
| --- | --- |
| Oil Temp. at start (A) |  ˚C |
| Oil Temp. at end (B) |  ˚C |
| Winding Temp. Before current injection (C) |  ˚C |
| Winding Temp. After 45 mins (D) |  ˚C |
| Simulated Temp. Rise Measured: [(D-C)-(B-A)] |  ˚C |

1. **OIL DIELECTRIC STRENGTH:**

 Electrode form : IEC 156 1995

 Distance : 2.5 mm

 Minimum strength : 50 KV

|  |  |  |  |
| --- | --- | --- | --- |
| Sample location | Test # | Break down voltage (KV) | Average Break down Voltage (KV) |
| Main tank Top |  |  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
| Main tankBottom |  |  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
| OLTC |  |  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
| Conservator |  |  |  |
|  |  |
|  |  |
|  |  |
|  |  |

1. **TESTING OF FANS:**

Group # 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Fan no. | IR with 1000 V ( GΩ ) | starting current (A) | running current (A) | Direction |
| IR | IY | IB | IR | IY | IB |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
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Total current consumption by group # 1 cooling fans

|  |  |  |
| --- | --- | --- |
|  | STARTING | RUNNING |
| IR | IY | IB | IR | IY | IB |
| Group # 1 |  |  |  |  |  |  |

As per approved drawing

1. Verified group # 1 starts at ° c

 2. Verified group # 1 stops at ° c

Group # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Fan no. | Ir with 1000 V( GΩ ) | Starting current(A) | Running current (A) | Direction |
| IR | IY | IB | IR | IY | IB |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
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Total current consumption by group # 2 cooling fans

|  |  |  |
| --- | --- | --- |
|  | Starting current (A) | Running current (A) |
| IR | IY | IB | IR | IY | IB |
| Group # 2 |  |  |  |  |  |  |

1. Verified group # 2 starts at ° C

2. Verified group # 2 stops at ° C

1. **ON LOAD TAP CHANGER:**

|  |  |  |
| --- | --- | --- |
| No | Explanation of event | Results |
| 1 | MCB of tap changer motor(Q1) |  |
| 2 | AC socket(X19) & mcb(F25) |  |
| 3 | Heater & thermostat & mcb(F16) |  |
| 4 | Lighting(E1) & door switch(S10) |  |
| 5 | Mechanical operation check |  |
| 6 | Mechanical upper limit lock |  |
| 7 | Mechanical lower limit lock |  |
| 8 | Electrical opertion |  |
| 9 | Electrical limit lock | Upper |  |
| Lower |  |
| 10 | Counter operation check |  |
| 11 | Local operation check |  |
| 12 | Stop and rotation pointer |  |
| 13 | Motor starting / running current |  |
| 14 | Motor handle interlock |  |
| 15 | Local / remote check(local operation switching) |  |
| 16 | Motor drive & OLTC tap # comparison  |  |
| 17 | Sound during operation |  |
| 18 | Alarm signals for control room |  |
| 19 | Emergency stop switch |  |
| 20 | Tap position indicator |  |
| 21 | Tap changer in progress |  |
| 22 | Tap changer faulty |  |
| 23 | Tap changer from remote | Raise |  |
| Lower |  |
| 24 | OLTC local |  |
| 25 | OLTC remote |  |
| 26 | Tap position | Raise |  |
| Lower |  |
| 27 | Tap changer incomplete |  |

1. **MCB TEST AT MARSHALLING KIOSK:**
	1. Mechanical Checks & Physical Inspection:

|  |  |  |
| --- | --- | --- |
| Item | Description | Checked |
| 1 | Inspect for physical damage / defects |  |
| 2 | Verify connection as per approved drawings |  |
| 3 | Verify tightness of all connections |  |
| 4 | Check ferrules |  |
| 5 | Check apparatus list |  |

* 1. Electrical Tests:

 Thermal over Load Test:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| MCB No. | Make | Type | Setting(A.) | InjectedCurrent (A.) | Measured tripping time (s) | criteria(sec.) |
|  |  |  |  |  |  |  |
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1. **FUNCTION CHECK OF FAN PANEL ACCESSORIES:**

|  |  |  |
| --- | --- | --- |
| Item | Functions | Terminals |
| 1 | Main power supply 3ph AC 380/220V,60hz |  |
| 2 | Backup power supply 3 ph AC 380/220V,60hz |  |
| 3 | Voltage monitors(under voltage relays)27-1,27-2,check 27X1, 27X2 operating with <V |  |
| 4 | Main power supply 3ph AC 380/220V 60hz to motor drive unit for OLTC |  |
| 5 | 220V AC socket & MCB #52C-1(RT1, RT2) |  |
| 6  | Lighting and door switches? |  |
| 7 | Heaters, MCB 52C-3 and Manual, off, auto switch  |  |
| 8 | Thermostat  |  |
| 9 | Fan group 1 man/auto switch  |  |
| 10 | Fan group 2 man/auto switch  |  |
| 11 | Fan(g1 & g2) local/remote switch |  |
| 12 | Fan g1 on/off manual  |  |
| 13 | Fan g2 on/off manual |  |
| 14 | Fan g1 on/off auto  |  |
| 15 | Fan g2 on/off auto |  |
| 16 | Man/auto interlock check |  |
| 17 | In auto position (group 1 fans- -starts at HV/LV winding temp reaches 70˚C -stops at HV/LV winding temp reaches 60˚C -stops at oil temp reaches 60˚C |  |
| 18 | In auto position -group 2 fans* Starts at HV/LV winding reaches 80˚C
* Stops at winding temp reaches 70˚C
* Stops at oil temp reaches 70˚C
 |  |
| 19 | Fan G -1 MCB trip signal for all G-1 MCB  |  |
| 20 | Fan G-2 MCB trip signal for all G-2 MCB  |  |
| 21 | Fan G-1 & G-2 signal  | Auto |  |
| Manual |  |
| 22 | Fan signal from | Local |  |
| Remote |  |
| 23 | Fan group-1 | On |  |
| Off |  |
| 24 | Fan group-2 | On |  |
| Off |  |
| 25 | Fan faulty signal Jumpers  | Group-1 |  |
| Group-2 |  |

1. **SUPERVISION EQUIPMENT FUNCTIONAL CHECKS:**

|  |  |  |  |
| --- | --- | --- | --- |
| Item | Equipment |  | Terminal at Marshalling Kiosk |
| 1 | Main tank buchholz relay | Alarm |  |
| Trip |  |
| 2 | Cable champers buchholz relay | Alarm |  |
| Trip |  |
| 3 | OLTC Protective (oil surge) Relay | Trip |  |
| 4 | Main tank over pressure relief device | Trip |  |
| 5 | OLTC over pressure relief device | Trip |  |
| 6 | Main tank oil level indicator (alarm only) | Min |  |
| Max |  |
| 7 | OLTC oil level indicator | Min |  |
| Max |  |
| 8 | Oil Temperature Indicator | Alarm |  |
| Trip |  |
| 9 | Winding temperature Indicator (high) | Alarm |  |
| Trip |  |
| 10 | Winding temperature indicator (low) | Alarm |  |
| Trip |  |