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20 **Remote Transformer monitoring cum Tap changer control system (TCS)**

Microprocessor based technology with built in self supervising capability has been envisaged for the control of forced cooling equipment, condition monitoring and OLTC control of transformers.

The TCS should provide facilities such as SCADA links, transformer cooler control and data logging, control of the OLTC, remote OLTC tap position indication in digital form at local and the remote temperature indications for windings and top oil, temperature alarms and trip, marshalling of other control and alarm functions and recording of accumulated "use of life" local display of status of control and alarm functions and selection of local and remote control etc.

Following will be functions of TCS:

i) Monitoring:

The TCS will be capable of monitoring the analog data and status signals of the following:

Transformer LV load, voltage, tap changer status including tap position, tap changing in progress, status of control switches, , OLTC motor trip, temperature difference between OLTC compartment and main tank. Temperature and condition of the transformer cooler status including top oil temperature, , winding hot spot temperature, run status of cooler fans and / or pumps, fan or pump trip, Interface.

This data will be available for display, data logging and remote communication. For each analog value the TCS will display the present and minimum and maximum value reached since the last time that the minima and maxima where reset to the current values.

The TCS will have integrated feature to accept three wire resistor input to display tap position and PT-100 input to display top of oil temperature

ii) Cooling Control:

The TCS will be capable of controlling all cooling systems of the transformer including pumps, fans. The control function will operate in such a way as to keep the transformer temperature within the limit set by the Purchaser.

The TCS will be capable of Predictive mode to turn on the cooling system based on predicted top oil and winding hot spot temperatures in addition to normal control based on actual temperatures. This should work in the event of a sudden sustained increase in load current, before the temperatures had risen to normal control settings, so as to keep the transformer cooler longer. Predicted

temperature will be based on a thermal model of each specific transformer (based on actual heat run tests), ambient temperature and load.

Periodic automatic testing:

It will be possible to automatically exercise testing of the cooler system at preset intervals to ensure that they are still functional, with an alarm if the test fails.

iii) OLTC Control:

The control will include selection of the following operating modes and features as applicable, by push buttons or keys at the controller or from SCADA.

- Manual OLTC control by push buttons or keys at the controller or from SCADA.
- AVR (automatic voltage regulation).
- Independent mode Master or follower parallel mode.
- Circulating current parallel mode.
- Circulating current based on MVA rating of transformer
- AVR time delay will be settable with definite time, fast – tap – down and inverse-time modes.
- AVR will have be provided with Line Drop Compensation ("LDC").
- AVR will be blocked, if the voltage drops below the under voltage set points, to prevent false operation in the event of supply line faults.
- VT fuses failure etc.
- OLTC operations will be blocked if the current though the OLTC exceeds a preset value.

iv) Performance calculations and Predictions

The TCS will be capable of calculating –

- Watts and VARs
- Accumulated number of tap changers from each tap position (discrete counter for each position) and total number of tap changers
- Winding hot spot temperatures for each winding and maximum achieved.
- Accumulated insulation ageing (use of life) based on the winding hot spot (years) as per the loading guide for oil immersed power transformer.
- The use of life calculations will also convey to the operator the amount of overload available for two hours duration from the time in question
- Accumulated operating hours for each fan and pump group.

v) Alarms:

Alarms will be extended to the SCADA system for:

- Voltage out of range for too long (AVR mode only).
- Voltage exceeds over-voltage alarm setting or is less than under-voltage alarm setting.
- OLTC auxiliary power failure OLTC fail (tap changed in progress too long or OLTC motor trip).
- Temperature abnormalities such as high oil temperature and high winding temperature.
- Top oil or winding hot spot temperature exceeds alarm settings.
- Top oil or winding hot spot temperature exceeds trip or stage to alarm settings.
- Cooler auxiliary power failures Cooler fail (contactor failed to close when switched on, or motor trip, or oil flow failed)
- All OLTC and temperature trip signals will be provided by means of voltage free contacts where the contacts have a rating of not less than 0.4A at 125 VDC resistive.
- All other trip signals such as Buchholz, pressure relief and OLTC surge will be provided directly from the voltage free contacts of the respective device, not via the TCS. The alarms can however be wired via the TCS.

  All transformer fault alarm & trip signals (Bucholz, WTI, OTI, PRD, OSR, MOG) will be wired from transformer Marshalling box to HT panel control & relay panel and subsequently these signals (through auxiliary contact) will be wired to TCS unit. All wiring as required for above functions of TCS will be provided by contractor.

Automatic voltage regulator with voltage transformer will be provided for automatic control of OLTC. The regulator will have a delay between the sensing of change of voltage and the change of tap. The delay will be inversely proportional to the degree of voltage variation. The voltage setting will be continuously adjustable from 90% to 100% of rated voltage. The dead band will be continuously adjustable from 0.5% to 4% of rated voltage. The operation of OLTC will be blocked if the voltage drops to less than 80% of rated voltage. A hand reset operation indicator and self reset alarm contact will be provided which operates:

- Instantaneously if auxiliary supply fails.
- With a delay of 3 seconds if regulated supply fails or drops below 80% of setting
- If regulated voltage remains +3% outside the set dead band for more than 15 minutes.

Line drop compensation will be provided with resistive and reactive drops upto 20% of rated voltage in steps of 1%. Resistance and reactance settings will be independently adjustable.

CTs required for current reference will form part of transformer, mounted on bushings. The secondary terminals of the CTs will be wired to outdoor type terminal block provided with shorting links.

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