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WORKSHOP &EXHIBITION

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SESSION: VI

MAINTENANCE

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SESSION: VI – MAINTENANCE

Maintenance

S. K. Negi
Gujarat Energy Transmission Corporation Ltd., Vadodara

CHAPTER – 1: STATE OF THE ART FOR MAINTENANCE OF TRANSFORMER

- PREAMBLE
- TERMINOLOGY
- MAINTENANCE PROCESS

1. *PLANNING*

Typical Maintenance Guideline Structure

Computer-Aided Maintenance Management Systems

i) Equipment Inventory
ii) Computerized Maintenance Guidelines
iii) Task Lists and Operations
iv) Maintenance Plan
v) Maintenance Schedules
vi) Work Orders
vii) Outage Planning

2. *ORGANISATION*
   a) Human Resources – Competencies
   b) Five levels of competency are defined
   c) Local Organization
3. *EXECUTION*
   a) Internal and External Resources
   b) Health and Safety : When Working on a Transformer
      i) Grounding
      ii) Working at Height

iii) Use of Voltage or Current Sources
iv) Pressure
v) Auxiliary Circuit
vi) Accumulated Mechanical Energy
vii) Closed Vessel
viii) Fire Extinguishing System
ix) Protection system
x) Electrical Hazards

4. *RECORDING (DATA MANAGEMENT)*
   - Preventive Maintenance Tracking
   - Corrective Maintenance Tracking
   - Recording the Results of Diagnostic Tests and Establishing Trends
5. *OPTIMISATION*

- *STANDARDS*
- *TRANSFORMER MAINTENANCE TECHNIQUE AND STRATAGY*
  i) Possible Impacts of on a Transformer by Lack of Maintenance
  ii) Condition Monitoring
  iii) Time Based Maintenance and Time based Condition Monitoring
     - Maintenance Frequency
  iv) Condition Based Maintenance
     - Oil tests reveal 'abnormal values
     - DGA reveals 'abnormal values
  v) Corrective Maintenance
  vi) Continuous On-Line Monitoring
  vii) Other On-Line Continuous Monitoring Technologies

CHAPTER – 2: BEST PRACTICES OF MAINTENANCE OF TRANSFORMER

- POWER TRANSFORMER CHECK POINTS
- OLTC CHECK POINTS
- PURPOSE OF TEST AND ACCEPTABLE VALUES
- MAINTENANCE SCHEDULE
- LIST OF TOOLS & PLANTS, CONSUMABLES & SPECIAL ITEMS
- ADOPTION OF NEW TECHNOLOGY

CHAPTER – 3: DO's AND DON'Ts FOR MAINTENANCE

CHAPTER – 4: OIL LEAKS CAUSE & PREVENTION

- Forms of Gasket

- O-Rings
- Gasket Installation
- Gasket Stocks
- Examples of Proper Gasket Mounting

CHAPTER – 5: DYRING OUT OF WET TRANSFORMER

- DIFFERENT DRYING TECHNIQUES

1. *Molecular Sieves*
2. *Hot Oil Circulation*
3. *Vacuum Drying Techniques*
4. *Low Frequency Heating / Low Frequency Heating plus Hot Oil Spray*

- Factors deciding drying out of Transformer (OFF line)
  - i) A typical Drying out Policy
  - ii) Drying out Procedure
  - iii) Dry Out Procedure By Vacuum Pulling, Nitrogen Filling & External Heating Method

  CASE STUDY (Off line) - (O/H report of 315MVA, 400/220/33KV)
- Factor deciding On line – on site transformer drying, de-sludging & oil refining / regeneration of transformer oil

  CASE STUDY (ON line) - (132KV Junagadh substation)

CHAPTER – 6: REPAIRING OF WET TRANSFORMER AT SITE

- CASE STUDY -1
- CASE STUDY -2
- CASE STUDY -3

CHAPTER – 7: SPARE TRANSFORMER INSTALLATION & MAINTENANCE PRACTICES

1. Installation
2. Sequence of operation
   - The sequence of operation adopted by GETCO for spare transformer
3. Arrangement/Installation of spare transformer
4. Maintenance of Spare Transformer

CASE STUDY – 1

Overhauling of 315MVA, 400/220/33KV, transformer:

Name of S/s: 400/220 kV Jetpur substation (GETCO)

Year of Manufacture: 1991

Scope of work: O/H of transformer with oil replacement

Reasons for carrying out O/H:

a) Sp. Resistance of oil was 0.13 x 1012 Ω.cm and Tan delta of oil was 0.2 as per ERDA result.

b) IR value trend was decreasing: HV to E: 250 MΩ, Tertiary to E: 240 MΩ, HV to Tertiary: 325 MΩ.

c) Tan delta trend was increasing i.e. more than 1.

d) TRF was running on fix tap. Spares were purchased from tap changer OEM (M/s. BHEL).

e) TRF has completed service life of more than 27 years. OEM (M/s. TELK) has also suggested for replacing the oil looking to oil parameters.

Date of commencement: 16.05.11

Date of completion: 02.07.11

Work done (Brief):

- All low voltage tests, IR value, Tan delta conducted before starting O/H work.
- Transformer oil completely drained out. Before draining, oil of main tank was heated up by a separate hot oil circulation @ 70° C.
- All oil sealing gaskets made from rubberized cork sheet got prepared and replaced.
- All fittings and accessories of the transformer such as HV & LV bushings, conservator, PRV, Buchholz relay, radiators, top plate, inspection covers, various valves etc, dismantled.
- Active part was completely washed by hot oil jet to remove sludge, carbon deposition and other foreign particles deposited. Hot oil removed.
- Tightening of core-bolts and checking its IR value
- Tightening of pressure screws for axial tightness of coil
- Paper covering to main leads
- Cleaning of transformer main tank from inside by hot oil jet.
- Flushing of radiators and servicing of radiator valves
- O/H of OLTC activity:
  - Un tanking diverter switch
  - Hot oil washing of diverter & selector chamber after un tanking diverter switch
  - Cleaning of fixed and moving contacts
  - Tightening of all clamping, connector & hardware
  - Replacement of all the oil seals and gaskets
  - Greasing of gears in driving mechanism
- Drying out of core-coil assembly by vacuum pulling, nitrogen filling and external heating method.
  - Final Dew point of nitrogen was -5° C at temperature of 70° C.
- New filter pads provided and filtered new oil stored in oil storage tanks.
- After confirming / ensuring oil BDV and ppm results, oil was filled in the main tank under vacuum and also in radiators, conservator, and diverter. Keeping radiators isolated, the main tank oil was filtered. Thereafter mixing of radiator bank oil with main tank oil done and again this mixed oil was filtered. Oil value obtained were BDV: 81 KV & water content: 9 ppm
- Degreasing and derusting of all external surfaces of tank and fittings was done and one coat of metal primer on rusted spots applied. Then transformer tank spray painted externally with two coats of specified shade oil paint.
- All the low voltage tests performed.
- Tan delta and SFRA test also carried out.

- All HV & LV jumpers provided.
- After successful completion of O/H work, transformer charged on 2.7.11 and load taken 5.7.11.

The test results before and after the overhauling were found as follow:

Tan delta results:

SN	Test Particular	16.5.11 (Before)		30.6.11 (After)	
		Corr. % PF	Cap (pF)	Corr. % PF	Cap (pF)
1	CH	1.00	7749.8	0.37	7612.6
2	CT	2.06	19261.5	0.80	18830.7
3	CHT (UST)	1.21	5840.5	0.27	5691.5

IR value results:

SN	Test Particular	16.5.11 (Before)			30.6.11 (After)		
		60 s	600 s	PI	60 s	600 s	PI
1	HV to Earth	173	215	1.28	981	1540	1.57
2	Tertiary to Earth	312	560	1.79	940	2060	2.19
3	HV to Tertiary	359	643	1.79	1221	2320	1.90

Conclusion:

There was remarkable improvement in tan delta and IR value of transformer after over hauling exercise.

Photographs:

Heating Arrangement for Drying out:

- Factor deciding ON LINE transformer drying, de-sludging & refining/ regeneration of transformer oil at site:

  Online process is feasible / advisable for Power transformers where,

- Oil parameters (like BDV, water ppm, Sp. Resistance, Tan delta, IFT) are found deteriorated and you may be compelled to replace oil
  - Tan delta shows increasing trend
  - IR/PI value shows decreasing trend
  - Gasket replacement is not required
  - Transformer outage is a major constraint.

CASE STUDY – 2

Name of S/s: 132KV Junagadh (GETCO)
Name of Agency: M/s. CEE DEE, Pune
Transformer details: 50MVA, 132/66 kV, Auto transformer
Make: GEC
Year of Manufacturing: 1992

Reason for O/H:

a) Oil fails in Sp. Resistance (0.08 x 1012 Ω.cm) and water content 50 ppm as per ERDA result.

b) IR value was low and shows decreasing trend: HV to E: 100 MΩ.

c) Tan-delta shows increasing trend i.e. >1.

Date of Commencement: 25.08.10

Date of Completion: 14.09.10

Comparison of results:

1. Routine oil test as per IS: 1866-2000.

S N	Test particulars	Acceptance criteria	(Before) 18-08-10	(After) 15-09-10	(After six months) 23.3.11
1	Electric strength (BDV) KV (rms)	More than 40	71	74	85
2	Water content, ppm	Max. 40	20	13	10
3	Neutralization value	Max. 0.3	0.13	0.003	0.002
4	Sediment & sludge, % by wt	Non detectable	Non detectable	Non detectable	Non detectable
5	Dielectric dissipation factor (Tan delta) at 90°C	Max. 1.0	0.24	0.004	0.004
6	Specific resistance (Resistivity) at 90°C, Ω.cm	Min 0.1 X 10^{12}	0.08 X 10^{12}	15 X 10^{12}	12 X 10^{12}
7	Interfacial tension, mN/m at 27°C	Min. 15	19	40	41
8	Flash point, °C	Min. 125	152	152	150

2. Insulation Resistance Measurement (in MΩ)

S N	Date of measurement	Phase to Earth			Amb Temp	PI Value
		10 sec	60 sec	300 sec		
1	(Before) 19.08.10	66	78.4	82.4	35	1.05
2	(After) 13.09.10	1980	2660	3360	30	1.26
3	(After six months) 21.04.11	980	1120	1376	38	1.23

S N	Particulars	(Before) 18.08.10		(After) 13.09.10		(After 6 months) 26.2.11	
		Corrected %DF	Capa. pF	Corrected %DF	Capa. pF	Corrected %DF	Capa. pF
1	Winding (Auto transformer)	1.58	8595.3	0.46	8529.9	0.40	9113.7

Conclusion:

The above On-line transformer oil processing technique gave us good results.

The results of oil parameters, Tan delta & PI values taken even after six months are almost identical to results taken after completion of on line process.

Back View for Plant:

Front View for Plant

Inlet to Plant View at Transformer Bottom Valve

Outlet from Plant View at Conservator Bottom Valve