

MINUTES OF THE MEETING WITH MANUFACTURERS OF TRANSFORMERS (ON BEHALF OF IEEMA) HELD IN CEA AT NEW DELHI ON 06/01/2016 TO DISCUSS ABOUT THE CAUSES OF HIGH RATE OF FAILURES OF 220 kV AND ABOVE VOLTAGE CLASS TRANSFORMERS

The list of participants is enclosed as Annexure-1.

- 1.0 Chief Engineer (PSE&TD), CEA, welcomed the participants and thanked the delegates from Transformer Manufacturing Industry for sparing their valuable time for the discussion on the causes of high rate of failure of power of transformers much before their useful life.
- 1.1 He informed that a Standing Committee, comprising experts in the field of design and operation of EHV Substations from CEA, various power utilities and research/academic institutes was constituted (in the year 2006) under Section 73, Clause(l) of the Electricity Act, 2003 to investigate the failure of 220 kV and above substation equipment and recommend measures to avert recurrence. As part of such activity, CEA has been receiving reports of failures of various substation equipments from various utilities.
- 1.2 The transformer, the costliest equipment in a switchyard/substation, is expected to serve the entire life of a substation which is considered to be 35 years as per CERC norm. It has become a matter of concern for utilities as many transformers are failing much before their useful life.
- 1.3 Chief Engineer (PSE&TD) further informed that 24 transformer failure cases have been reported to CEA during the period from October 2011 to August 2015 by 14 Utilities. He stated that number of transformer failure cases remains unreported as number of utilities including PGCIL, NTPC, NHPC and Private Utilities in the country do not report failures to CEA. Details of reported failures in terms of year of service are as below:

Years of Service	No. of Transformers failed
0-5 years	7 (29%)
6-10 years	5 (21%)
11-15 years	2 (8%)
16-20 years	4 (17%)
More than 20 years	6 (25%)
Total	24 Nos.

- 1.4 It is observed that many Transformers have failed within first few years of service which is a matter of concern as Transformers, in general, are meant to serve for 30-35 year. Out of these 24 transformers, 6 Number of failures are attributed to busing failure, 14 numbers are due to internal insulation failure, one failure on account of OLTC and rest 3 numbers of failures are due to other reasons. It is a matter of concern that 50% of transformer i.e. 12 Nos. of transformer has failed within 10 years of operation.
- 1.5 Chief Engineer (PSE&TD) stated that objective of this meeting was to discuss with transformer manufacturers about measures to be taken to improve service life of the transformers and minimize rate of failures. CEA requested manufacturers to come out

with the suggestions as to what action should be taken by manufacturers to improve performance of transformers and what action can be taken by utilities in respect of modification in specifications, testing, operation and maintenance of transformers etc.

2.0 Following points emerged after discussion:

1. CIGRE study shows that ageing of Transformers is not the main reason of failure. Bushing failure, insulation failure, OLTC failure etc are main contributor towards failure of transformers.
2. The postmortem of failed transformer needs to be done by utilities to come out real cause of failure without hiding the facts, be it manufacturing/design defects or system problem or operation & maintenance issue or negligence of utilities who is supposed to maintain the healthiness of transformer.
3. Increase in system fault and voltage stress due to transient over voltage generated by the system e.g. VFT generated by GIS installation are detrimental to the transformer health leading to increase in failure.
4. Availability of advanced computation tools have helped manufacturer to optimize the design and to reduce cost. Sometimes competition has compelled manufacturers to reduce cost by optimizing design at the cost of factor of safety and quality of material used in manufacturing process. The utilities should insist for Quality product rather than low cost product. The technical specification need to be framed accordingly.
5. The proper handling, loading, unloading, storage at site before assembling plays important role in satisfactory operation of transformer. Moreover, the erection of transformers should always be carried out by experienced technical team under the close supervision of manufacturer. Inordinate delay in commissioning of transformer after reaching at site should be avoided. When there is a wide gap between the year of manufacturing and year of commission of the transformers, proper care must be taken to ensure satisfactory operation of transformer:
 - a) Storage of transformer should be done as per manufacturer's recommendations.
 - b) Transformer should not be kept for more than three (3) months with inert gas (Nitrogen) filling and all throughout the period, required pressure needs to be maintained in order to avoid the exposure of active part to atmosphere.
 - c) After three (3) months, transformer should be filled with oil under vacuum and transformer should be provided with oil conservator including oil level indicator and breather. The oil parameters need to be monitored regularly.
6. Many utilities complain about the leakage of oil from transformer. The manufacturers need to ensure that high quality material is used for sealing system for oil and gas.
7. Whenever there is movement of transformer either from manufacturing works or from one station to other, SFRA should be carried out before movement and after shifting to new location. SFRA signature would provide valuable information about deformation in winding /core during transportation.
8. OLTC is one of the contributors to the failure of transformer. Possibility of eliminating OLTC from 400kV & 765kV class transformers should be

considered (based on system studies) in consultation with POSOCO/RLDC and CEA. Utilities like NHPC & NTPC have taken proactive step by eliminating tap changer from Generator Transformers. The reduction in number of steps can also be considered in case of OLTC of 220kV and below voltage class transformers.

9. Devices sensitive to the rate of rise of pressure inside the transformer tank may be considered in place of PRD which operates only above a set pressure.
10. It is being observed that technical specification of transformer is not uniform across the utilities. There is wide variation in technical requirement. Standardization of specification including Quality Assurance Plan (QAP) is the need of hour. The utilities may also consider following additional measures to improve performance of transformer.
 - a) The maximum temperature rise of oil and winding may be reduced by 5°C.
 - b) Maximum value of $\tan\delta$ for winding and bushing in particular may be limited to 0.5.
 - c) The adequate insulation should be provided between core and ground and insulation resistance between core and ground should be about 1 M Ω .
 - d) Switching impulse withstand voltage test may be specified for transformers of 220 kV class.
 - e) Better quality of cellulose paper insulation should be used, thermally upgraded paper can also be considered for all rating of power transformer. But all manufacturers were not in favour of use of thermally upgraded paper for all ratings of power transformer.
 - f) Use of Fiber Optic Sensors for hot spot monitoring of winding can be considered for all transformers of 100 MVA and above rating.
 - g) Three phase partial discharge measurement may be resorted to.
11. There was divergent view regarding stage inspection of transformer at manufacturer works. Some of the manufacturers were of view that stage inspection is not required. However, all were in favour of factory inspection and stringent tests. The online facility is being developed by some of the manufacturers to facilitate utilities to monitor various stages of manufacturing process of their transformer without visiting the manufacturer's works and in the process stage inspection at manufacturer's works can be avoided by utilities, if they desire.
12. The history of transformer, records of all test results including tests carried out before & after failure incidences (factory tests, pre-commissioning tests, tests during O&M etc.) should be properly maintained and should be available at the substation for the benefit of O&M staffs.
13. Time based maintenance is not sufficient to monitor the health of equipment. Condition Based Maintenance practice should be followed. More focus should be on the trend of test results rather than absolute values.
14. On-line Condition monitoring is the trend of future. Composite health monitoring devices (with intelligent IEDs) which can monitor a number of parameters like $\tan\delta$, capacitance of winding and bushing, gas formation, moisture content etc are available and such diagnostic tools should be used. To start with critical transformers may be focused because of high cost of online condition monitoring devices.

15. Lot of valuable time is lost in transportation from the failure site to manufacturer's works & back to site and for replacement of failed transformers, if spare transformer is not available. The manufacturers should take initiative to promote and carry out on-site repair of transformers, which would save lot of valuable time and money.
16. IEEMA requested CEA to include representation from manufacturers in the Standing Committee.

The meeting ended with vote of thanks to the Chair.

LIST OF PARTICIPANTS

Central Electricity Authority, New Delhi

1. Shri S.K.Ray Mohapatra, Chief Engineer, PSETDin the Chair
2. Shri Y.K.Swarnkar, Director, PSETD
3. Ms. Bhaavya Pandey, Assistant Director, PSETD
4. Ms. Noopur Chaudhary, Assistant Director, PSETD
5. Mr. Mohit Mudgal, Assistant Director, PSETD

IEEMA

1. Mr. J. Pandey, Sr. Director
2. Mr. Uttam Kumar, Executive officer

Bharat Heavy Electricals Limited

1. Mr. V.K. Bassi, AGM
2. Mr. A. Kulshreshtha, AGM
3. Mr. J.S. Kuntia, AGM

Crompton Greaves Ltd.

1. Mr. Abhay Dukle, AGM (Design)

Alstom

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1. Mr. Vijay S Kumaran

Bharat Bijlee Ltd.

1. Mr. M P Singh, GM
2. Mr. D.R. Torvi, GM Electrical

EMCO

1. Ms. Anagha Dixit, GM Engineering

Transformer & Rectifiers

1. Mr. Jitendra Mamtora, Chairman