A2 - POWER TRANSFORMERS AND REACTORS

PS 3 BEST PRACTICES IN TRANSFORMERS AND REACTORS PROCUREMENT

Paper ID: 10438

PROCUREMENT OF TRANSFORMERS AND REACTORS - BEST PRACTICES ADOPTED TO ACHIEVE HIGHEST AVAILABILITY & RELIABILITY GOAL

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Introduction

Indian Electricity grid is one of the largest synchronised interconnected network in the world with 393 GW of installed power generation capacity as of 12 January 2022. POWERGRID, the largest Transmission utility in India, operates about 172,192 circuit kilometre Transmission Lines with 264 Sub-Stations and maintains more than 99.5 % Transmission system availability. The above network includes more than 3300 nos. of Transformers & of rating ranging from 66kV to 1200kV including Power Transformer, Shunt Reactor, Coupling Transformers for STATCOM/ SVC application, fault current limiting Series Reactors and HVDC Converter Transformers.

The Indian Transmission network is growing at exponential rate and there is an ambitious plan set by Government of India to achieve 500 GW of non-fossil power capacity by 2030 to utilize the huge potential of Green energy and as a part of mission to make fossil fuel consumption zero by 2070.

POWERGRID is maintaining system availability of more than 99.5%. The failure rate of Transformers & Reactors is well below the international failure rate. This is achieved due to reliable, trouble-free performance and minimal maintenance of Transformers and other associated equipment. In this paper, experience has been shared in various stages of Transformer procurement process followed by POWERGRID to achieve such milestones.

Method/Approach

- Tendering Process
- Technical Specification
- Standardization
- Quality control, Manufacturing check points
- Stringent Factory Acceptance Tests

Tendering Process

- Bidders/manufacturers qualification requirement
  - Capacity & Capability
  - Financial condition
  - Technical requirement
  - Past deliveries (timely or delay),
  - Past failures etc.
- Loss standardization
- Deviation to the technical specification and other commercial requirement evaluated thoroughly during the evaluation process

Technical specification

Key documents and play major role on reliability and availability of the Transformer. POWERGRID has revised their Technical specification time to time to align with the latest International standards and also adopted various best practices.

- Design Review
- Requirement of Dynamic Short Circuit Test
- Core & Winding
- Insulating Oil
- Bushings
- Gasket
- Particles in the oil
- Extended warrantee
- Empanelment of vendors
- Capacity & Capability
- Financial conditions
- Past deliveries (timely or delay),
- Past failures etc.
- Deviation to the technical specification and other commercial requirement evaluated thoroughly during the evaluation process

Standardization

POWERGRID has standardized various drawings, processes due to following advantages:

- The procurement process become simple and delivery time would be reduced resulting in early completion of project
- Due to standard design, frequent design reviews can be avoided
- Standard ratings and standard civil foundation block would facilitate interchangeability of different make of Transformer / reactor
- Standard fittings and accessories
- Lesser requirement of inventories

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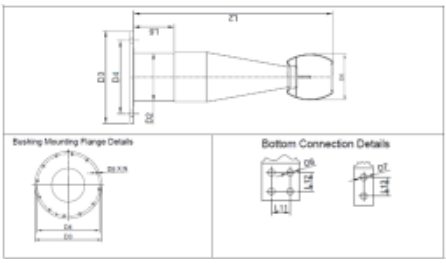
Standardization

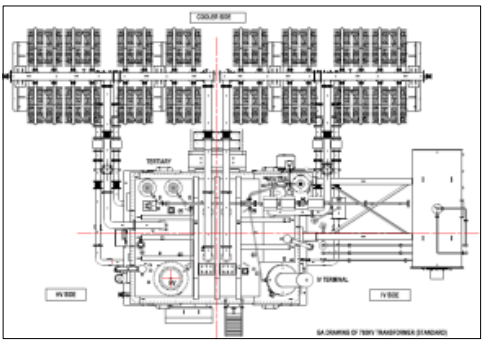
Due to massive expansion in Indian Grid in last few years and compressed timeline of the projects, there were frequent requirement of shifting of Transformers destined for a particular location to some other location to meet the commissioning targets. During initial stages, problems in mismatch of Bushing termination to connect with the HV/IV/ Tertiary/ Neutral according to the Substation layout, difference in foundations etc. were observed due to change of make of Transformers/ Reactors.

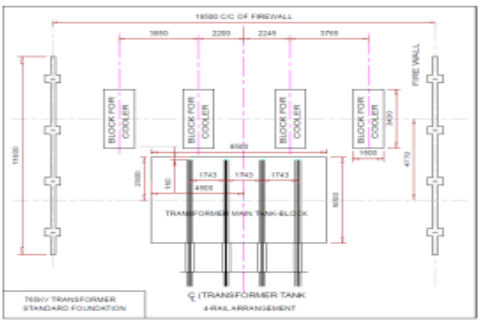
Bushing Oil end dimensions and connection

Standardized Bushing oil end dimensions, flange, connection type etc.
Interchangeability
Reduce the spare bushing inventory
Reduce restoration time (bushing replacement)



General arrangement and foundation drawing – 500MVA, 765kV Transformer





Quality control, Manufacturing check points

Approval of MQP & COV:

To comply the requirement of technical specification Approved Manufacturing Quality Plan is followed to comply the technical specification (as applicable).

Periodical process audit of every manufacturer (basically who are supplying raw material and bought out items to Transformer manufacturers). Based on successful compliance in line with technical specification manufacturers are approved for supply of raw material and bought out items. Accordingly, Compendium of Vendor (COV) has been prepared. Transformer/Reactor manufacturers have to procure above items from POWERGRID approved vendors listed in COV.

Approval of Raw material & Tank fabrication

Quality team approves the procurement of CRGO, Copper, Insulation items, Insulating Oil, Fabrication of Tank based on approved design document and technical specification and MQP.

Stage inspections

Further, Customer hold point (CHP) /Inspection clearance report is used at various stages of process like-Core Building, Core-Coil Assembly, Vapour Phase Drying, Tanking, Oil filing and Testing after successful compliance in line with approved MQP and technical specification. After clearance of current process, manufacturers are allowed to proceed for next stage of manufacturing.

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Stringent Factory Acceptance Tests

Testing is one of the ways to validate the design, manufacturing, material selection and requirement of technical specification. POWERGRID has specified Routine & Type tests in line with IEC 60076 and some special tests (as routine or type) based on experience to ensure quality product and suitable for long run operation.

Following tests (in addition to IEC requirement) are specified in technical specification of Transformer & Reactor

Special test for Transformer

- **Overload testing in short-circuit method,**
- **Over-excitation test, (for 765kV Transformer),**
- **Measurement of transferred surge on Tertiary,**
- **Short duration heat run test (for routine tested units)**

Special test for Reactors

- **2-Hour excitation test except type tested unit,**
- **Vibration & stress measurement at Um/√3 level and 1.05Um/√3 level and**
- **Short time over voltage Test (765kV Reactor)**

Standard Test procedure

There are certain areas in IEC 60076 where certain agreement is required between manufacturer and purchaser.

Further, there are some tests, where ambiguity is there regarding test procedure/ acceptance of test results.

To have more clarity and uniformity in the testing, POWERGRID prepared exhaustive Standard test procedure after detailed deliberations with all manufactures.

It helps to shorten the total testing time and become a good reference document for test inspector assigned for witnessing testing.

Conclusion

- Earlier, there were failures of Transformers & Reactors in POWERGRID mainly due to Short circuit fault in underlying system, Dielectric failures, Bushing failures, Core earthing related issues, moisture related issues.

- POWERGRID adopted various improvement measures as highlighted in the paper from time to time to improve the performance of Transformer & Reactor to achieve highest Availability & Reliability goal. With this, the failures of Transformers & Reactors have reduced significantly and failure rate has come down below International failure rate. The Transmission Network availability is achieved more than 99.5% due to better performance of Transformer & Reactor connected in the Grid.