

Chapter - 7

Design Review

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CHAPTER - 7

DESIGN REVIEW

1. INTRODUCTION

A design review is a planned exercise to ensure that both parties understand the application and the requirements of the applicable standards and specification. It is the opportunity for both parties to scrutinize the proposed design to ensure that the requirements will be met not only technical requirements but also those relating to other aspects of the contract, like quality. The whole emphasis of a design review is directed at establishing what is being provided is fit for purpose in all respects for the intended performance in service and that the manufacturer uses proven materials, design tools, methodology and experience to assure the product will meet this requirement, also in all respects.

Design reviews implies also to strengthen the relationship between the purchaser and manufacturer and a good opportunity for the purchaser to better understand the technical capabilities of the manufacturer and for the manufacturer to understand the need of their customers for the sake to have products adapted to their needs. Hence the design review is a good opportunity to interchange experiences that can be used to propose enhancements or betterments. For these reasons it is strongly advisable for the purchaser to have expert transformer engineer(s) with them during the meeting.

A design review, initiated and chaired by the purchaser should be held for the purpose of conducting an in-depth review of the ordered Power Transformer and to allow the purchaser to have a clear understanding of the transformers design, manufacture and test including the likelihood of operating in service as intended.

The following are the pre-requisites for carrying out the design review:

1. It is desirable to have vendor assessment of the manufacturer before placement of order.
2. Design review should be part of the tender inquiry and it becomes obligatory on the part of the customer and manufacturer to ensure compliances with the contract specifications.
3. It is to be ensured that all stake holders are involved in the design review. The designer both mechanical and electrical, ultimate user, production head and if possible, sub vendor also could be invited for the design review. Agenda is to be prepared by customer and sent to manufacturer well in advance.
4. Review may include certain informations which are of proprietary nature. It is, therefore, desirable to have mutual agreement between the purchaser and the manufacturer for the confidentiality of information.
5. It is important for the success of design review that both the purchaser and manufacturer are clear on the requirements and well prepared to have open and frank sharing of information.

2. OBJECTIVES OF DESIGN REVIEW

Both the purchaser and manufacturer must understand that following objectives are met during the design review:

1. To ensure that there is a clear and mutual understanding of the transformer technical requirements according to purchaser specification and applicable industry standards.
2. To understand the application and verify the system and project requirements and to indicate areas where special attention may be required.

3. To verify that the design complies with the technical requirements.
4. To identify any prototype features and evaluate their reliability and risks.
5. To interchange experiences that can be used to identify eventual betterments in the design and / or improvements and changes in the specification.
6. To better understand the technical capabilities of the manufacturer.
7. To strengthen the technical relationship between purchaser and manufacturer and eventually to improve and go deep in the transformers design knowledge by some participant on the purchasers side.

3. ELEMENTS OF DESIGN REVIEW

Having understood the purpose of design review and objectives, it is important to know the various elements of design review which will clear all the doubts about the functionality (application), soundness of designs with margins, selection of material and components and also specific operating requirements for its designed life. They are broadly as follows:

S. No.	Elements
1.	System data
2.	Environmental data
3.	Transformer parameters
4.	Transformer design
5.	Transformer ancillaries and accessories.
6.	Transformer oil
7.	Fabrication
8.	Testing
9.	Name plate
10.	Transportation
11.	Site erection, testing & commissioning
12.	Health and safety equipments
13.	Contract documents and drawings
14.	Document submission time scale

Design review guidelines of Cigre WGA2.36 (Technical brochure 204) have elaborated above elements in detail as under:

Sr. No.	Elements of design review	Check Points
1.	System data	System Voltage Variations Tap changers System Frequency Variation System Short Circuit Capacity System Switching and Transformer Protection High Frequency Transients (HFT) Voltage Transients Current Harmonics Geomagnetic Induced Currents
2.	Environmental data	Ambient temperature range, rate of change of temperature and effect on the overload capability Lowest Cold Load Start-up (LCLS) Solar radiation Site altitude Humidity Pollution Seismic zone and response spectra Geomagnetic currents Ultraviolet (UV) radiation Isoceraunic level
3.	Transformer parameters	Alternating Current Terminal Voltages Insulation Levels – line to line and line to ground Winding Impedances Cooling Provisions Temperature Limits Short Circuit Withstand Capability Cable Connection Bushings and Isolated Phase Bus Bar Connections Sound Levels Losses – No load and load losses Excitation High Temperature Design
4.	Transformer design	Core Windings Thermal design The short circuit capability Core, Winding Assembly and Drying Leads and Cleats Insulation Design Leakage Flux Control Drying and Processing Sound Level Seismic
5.	Transformer ancillaries and accessories.	Bushings Bushing and Internal Current Transformers Tap Changers Internal Surge Arresters Control Cabinet and External Cabling Online Monitoring Equipment
6.	Transformer oil	Review as per exclusive Chapter 6 of this Manual.
7.	Fabrication	General Construction External Cooling Equipment Conservators/Preservation Systems Fabrication Drawings Gas Collection System Design Surface Preparation and Planning

Sr. No.	Elements of design review	Check Points
8.	Testing	As per Annexure - 7.1
9.	Rating Plate	As per figure 7.1
10.	Transportation	Transportation Plan and Handling Design for Transport Transportation Shipping Profile Transportation Routing Transportation Shipping Impact Withstand Fixtures on Transformer Marking of Center of Gravity Ship and Barge Issues Rail Car Issues Road Transport Issues Transportation monitoring management of transformer Transportation of transformer accessories, components removed from the transformer Acceptance criteria for receiving transformer Transformer Unloading to Foundation
11.	Site erection, testing & commissioning	As per the exclusive Chapter 5 of this Manual.
12.	Health and safety	As per guideline and policy of customer. Also refer Chapter - 5 on Erection, Testing and commissioning of this Manual.
13.	Contract documents and drawings	As per Annexure - 7.2.
14.	Document submission time scale	As agreed between purchaser and manufacturer.

Design review does not absolve or substitute manufacturer's ultimate responsibility for the adequacy of transformer design and construction, including design limits and margins, quality, performance on test and in service.

REFERENCES

The following list may be referred, but this is not a limitation on referring to other standards and codes as long as it serves the purpose for effective design review.

IEC 60044: Current Transformers.

IEC 60050: International Electrotechnical Vocabulary – Chapter 421: Power Transformers and Reactors.

IEC 60060-1: General Definitions and Test Requirements.

IEC 60071-1: Insulation Coordination - Part 1: Definitions, Principles and Rules.

IEC 60071-2: Insulation Coordination - Part 2: Application Guide

IEC 60076-1: Power Transformers - Part 1: General.

IEC 60076-2: Power Transformers - Part 2: Temperature Rise.

IEC 60076-3: Power Transformers - Part 3: Insulation Levels and Dielectric Tests.

IEC 60076-5: Power Transformers - Part 5: Ability to withstand Short-Circuit.

IEC 60076-6: Power Transformers - Part 6: Reactors

IEC 60076-7: Power Transformers - Part 7: Loading guide for oil- immersed Power Transformers.

IEC 60076-8: Power Transformers - Part 8: Application Guide for Power Transformers.

IEC 60076-10: Power Transformers - Part 10: Determination of Transformer and Reactor Sound Levels.

IEC 60076-11: Power transformers - Part 11: Dry-type transformers

IEC 60076-18: Power transformers - Part 18: Measurement of frequency response

IEC 60076-16: Power transformers - Part 16: Transformers for wind turbine applications

IEC 60137: Bushings for Alternating Voltage Above 1000 V.

IEC 60214-1: Tap-Changers - Part 1: Performance requirements and Test Methods.

IEC 60214-2: Tap-Changers - Part 2: Application guide.

IEC 60270: High-voltage test techniques - Partial discharge measurements

IEC 60296: Fluids for Electro-technical applications - Unused mineral insulating oils for transformers and switchgear

IEC 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles

IEC 60815-2: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 2: Ceramic and glass insulators for a.c. systems

IEC 62032: Guide for the Application, Specification and Testing of Phase-Shifting Transformers

Other documents of relevance are:

ISO 9001: Quality System – Model for Quality Assurance in Design/Development.

CIGRÉ TB 209: Short Circuit Performance of Power Transformers

CIGRÉ TB 528: Guide for Preparation of Specifications for Power Transformers

CIGRÉ TB 530: Guide for Conducting Factory Capability Assessment for Power Transformers.

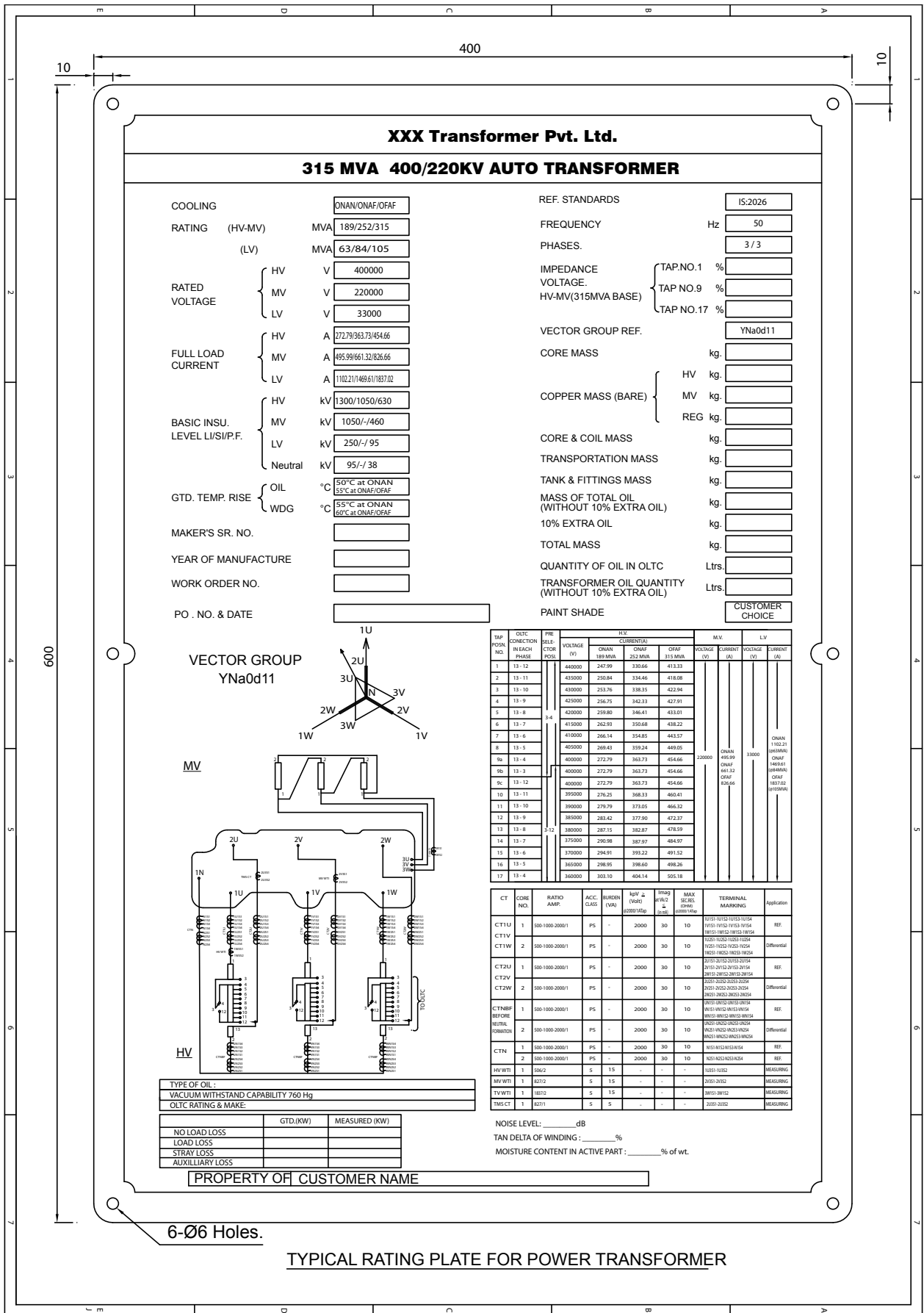


Fig. 7.1: Typical Rating Plate

ANNEXURE 7.1

TESTING

Sr. no.	Tests, measurements & checks
1	Dimensions, fittings and equipment
2	Turns ratio
3	Polarity & phase relationship
4	Insulation resistances
5	Winding resistances
6	Insulation power factor
7	Capacitances
8	Load loss & impedance voltage
9	Impedance characteristic across tap range
10	Zero-phase-sequence impedance
11	No-load loss & magnetizing current
12	Audible sound
13	Temperature rise
14	Gas in oil analyses
15	Lightning impulse voltage tests
16	Switching impulse voltage tests
17	Applied voltage tests
18	Induced voltage test & partial discharge
19	Single-phase magnetizing current test
20	Oil pressure
21	Control system, components, instruments
22	Ancillary equipment power losses
23	CT checks
24	RSO
25	Frequency Response Analysis (FRA)
26	Tap changer
27	Secondary wiring insulation resistances
28	Oil samples
29	Inventory
30	Contract documents
31	QA records

ANNEXURE 7.2

Contract Documents and Drawings for approval

Sr. No.	Documents
1	Contract drawings Certificates a. ISO Quality Assurance b. ISO Environmental c. OHSAS
2	Product Source Schedule
3	Production Plan & Reporting Programme
4	Design Review Minutes
5	Quality System
6	Quality Plan
7	Test Plan
8	Factory Acceptance Test (FAT) Reports
9	Transport Plan
10	Transformer Site Commissioning Plan
11	Method Statements
12	Risk Assessments
13	Training
14	Site Works
15	Site Contractor(s) & Supervision.
16	Site Tests
17	Operation & Maintenance Manuals