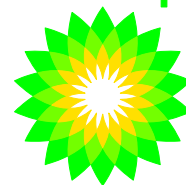


bp



Group Instruction for Supply

GIS 12-052

Power Transformers

REVISION FOR REVIEW



Table of Contents

	Page
Foreword	5
1. Scope	6
2. Normative references	6
3. Symbols and abbreviations	7
4. General	8
5. Proposal	8
5.1. Base and alternate quotations	8
5.2. Information to be supplied with quotations	9
5.3. Information to be submitted after receipt of order	9
6. Drawings and documentation	9
6.1. General	9
6.2. Installation, operating and maintenance instructions, and data requirements	10
6.3. Drawing requirements	10
7. Shipping	11
Annex A (Normative) Overhead transformers (500 kVA and smaller)	13
4. Ratings	13
4.2 Voltage ratings and tap ratings	13
7. Construction	13
7.1 Bushings and terminals	13
7.2 Accessory equipment	13
7.3 Polarity, terminal markings, and angular displacement	14
7.6 Windings	14
Annex B (Normative) Dry type transformers	15
4. Service conditions	15
4.2 Unusual service conditions	15
5. Rating data	15
5.4 Rated power	15
5.5 Voltage rating and taps	15
5.10 Insulation levels	16

Copyright © 2010 BP International Ltd. All rights reserved.
This document and any data or information generated from its use are classified, as a minimum, BP Internal. Distribution is intended for BP authorized recipients only. The information contained in this document is subject to the terms and conditions of the agreement or contract under which this document was supplied to the recipient's organization. None of the information contained in this document shall be disclosed outside the recipient's own organization, unless the terms of such agreement or contract expressly allow, or unless disclosure is required by law.

In the event of a conflict between this document and a relevant law or regulation, the relevant law or regulation shall be followed. If the document creates a higher obligation, it shall be followed as long as this also achieves full compliance with the law or regulation.



5.12	Nameplates.....	16
6	Construction.....	16
6.5	Terminals.....	16
6.6	Grounding.....	16
6.7	Shipping.....	16
6.8	Auxiliary cooling equipment	17
6.9	Accessory wiring	18
6.10	Windings.....	18
8	Testing and calculations.....	19
8.3	Routine, design, and other tests for transformers.....	19
	Annex C (Normative) Pad mounted transformers (2 500 kVA and smaller)	22
6	Tests.....	22
6.3	Power factor tests	22
7	Construction.....	22
7.1	General.....	22
7.2	Bushings and terminals.....	22
7.6	Tanks.....	22
9	Other requirements that may be specified for some applications	23
	Annex D (Normative) Liquid immersed transformers.....	24
4	Rating data	24
4.1	Service conditions.....	24
4.2	Kilovolt-ampere ratings	24
4.5	Taps.....	25
4.8	Routine tests.....	25
5	Construction.....	26
5.1	Accessories	26
5.2	Bushings.....	26
5.3	Lifting, moving, and jacking facilities	26
5.4	Nameplate	26
5.5	Ground pads.....	27
5.6	Polarity, angular displacement, and terminal markings	27
5.8	Tanks.....	27
5.9	Auxiliary cooling equipment	28
5.10	Power supply for transformer auxiliary equipment and controls.....	30
5.11	Radiators	30
5.12	Windings.....	30
5.13	Accessory wiring	30
5.14	Painting.....	32
5.15	Ground resistors	32
6	Basic construction features - load-tap-changing equipment	33
6.5	Control equipment and accessories	33
8	Other ratings.....	33
8.1	Other kilovolt-ampere ratings	33



9	Other construction features - general.....	34
9.4	Junction boxes.....	34
9.5	Disconnecting switches with interlocks and terminal chambers.....	34
9.12	Surge arresters.....	34
9.13	Other oil preservation system	34
9.14	Other insulating liquid	35
9.17	“Other” tests.....	36
	Annex E (Informative) The National Efficiency Standard (10 CFR 431).....	37
E.1.	General.....	37
E.2.	Product impact.....	37
E.3.	Liquid and dry transformers	37
E.3.1	General.....	37
E.3.2.	Oil filled.....	37
E.3.3.	Dry type	37
E.4.	Impact of A/B factors.....	37
E.5.	Design impact.....	38
E.6.	Exclusions.....	38
E.7.	Transformers losses	39
	Bibliography.....	40



Foreword

This is a revised issue of Engineering Technical Practice (ETP) GIS 12-052. This Group Instruction for Supply (GIS) reflects addition of dry type transformers requirements based on IEEE C57.12.01 and reflects experience gained in implementing outdoor liquid immersed power transformers since the publication of the first issue of this GIS in September 2003.

This revision also includes the National Efficiency Standard (10 CFR 431) that is applicable to both liquid immersed and dry type power transformers, effective on or after January 1, 2010. Refer to Annex E.

REVISION FOR REVIEW

1. Scope

- a. This GIS provides requirements for design, materials, fabrication, inspection, testing, documentation, and preparation for shipment of the following types of power transformers:
 1. Overhead (500 kVA and smaller).
 2. Dry type.
 3. Pad mounted (2 500 kVA and smaller).
 4. Liquid immersed.
- b. This GIS is organised as follows:
 1. Normative text (1 through 7) that includes requirements applicable to all of the transformers.
 2. Normative annexes (Annex A through Annex D) for the individual transformers. The annexes are organised in the exceptions specification style and are based on the applicable industry standard.
 3. Informative annex (Annex E) that discusses the National Efficiency Standard (10 CFR 431).

2. Normative references

The following referenced documents may, to the extent specified in subsequent clauses and normative annexes, be required for full compliance with this GP:

- For dated references, only the edition cited applies.
- For undated references, the latest edition (including any amendments) applies.

American National Standards Institute (ANSI)

ANSI C57.12.10	American National Std For Transformers- 230 kV and Below 833/958 - 8333/10 417 kVA, Single-Phase, and 750/862 - 60 000/80 000/100 000 kVA, Three-Phase w/o Load Tap Changing: and 3750/4687 - 60 000/80 000 kVA with Load Tap Changing-Safety Requirements.
ANSI C57.12.22	American National Std. for Transformers- Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2500 kVA & Smaller: High-Voltage, 34 500 GrdY/19 920 V & Below; Low Voltage, 480 V & Below - Req.
ANSI C57.12.90	INT Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.

American Society for Testing and Materials (ASTM)

ASTM D877	Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
ASTM D3487	Mineral Insulating Oil Used in Electrical Apparatus.
ASTM D4059	Standard Test Method for Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography.

Institute of Electrical and Electronic Engineers (IEEE)

IEEE C57.12.00	Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
----------------	---



IEEE C57.12.01	Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid-Cast and/or Resin-Encapsulated Windings.
IEEE C57.12.20	Standard for Overhead-Type Distribution Transformers, 500 kVA and Smaller: High Voltage, 34 500 V and Below; Low Voltage, 7970/13 800Y V and Below.
IEEE C57.91	IEEE Guide for Loading Mineral-Oil-Immersed Transformers.

National Fire Protection Association (NFPA)

NFPA 70	National Electrical Code (NEC).
---------	---------------------------------

Underwriters Laboratory (UL)

UL 1564	Safety Industrial Battery Chargers.
---------	-------------------------------------

3. Symbols and abbreviations

For the purpose of this GP, the following symbols and abbreviations apply:

AC	Alternating current.
AWG	American Wire Gage.
BIL	Basic insulation level.
CT	Current transformer.
DC	Direct current.
EMF	Electromagnetic field.
FAT	Factory acceptance test.
HTUA	High temperature underwriters approved.
HV	High voltage.
KNAF	Cooling class: insulating liquid, natural circulation, air cooled, forced circulation.
LED	Light emitting diode.
LV	Low voltage.
MSDS	Material safety data sheet.
NRTL	Nationally recognised testing laboratory.
ONAF	Cooling class: mineral oil, natural convection, air cooled, forced convection.
ONAN	Cooling class: mineral oil, natural convection, air cooled, natural convection.
PCB	Polychlorinated biphenyl.
PO	Purchase order.



RFQ Request for quotation.

4. General

- a. Transformer performance guarantees shall be provided for:
 1. No load losses.
 2. Full load losses.
 3. Percent impedance, both positive and zero sequence, between various windings.
 4. Percentage regulation at 100% and 80% power factor.
- b. PCB contamination of insulating liquid shall not exceed 1 ppm. PCB ppm shall be recorded on permanent nameplate.
- c. Transformer protection
 1. An overall system review of the transformer protection scheme, including secondary feeder breakers, shall be performed. Transformers that are fully loaded with induction motors shall be sized such that arc fault energy on the transformer load side breaker is limited to less than 40 cal/cm².
 2. Transformers with 480V secondary shall be size limited to a base rating of 1 500 KVA.
 3. Equipment to be provided by the transformer seller to meet the protection scheme requirements shall be specified on the applicable transformer data sheet.
- d. Unless specified otherwise on the applicable transformer data sheet, transformers shall be for a “step down” application.
- e. Special transformer applications, such as a “captive” transformer for large motor starting, shall be identified on the applicable transformer data sheet.
- f. The percent impedance shall be based on the self cooled rating of the transformer as specified on the applicable transformer data sheet.
- g. The tolerance shall comply with the applicable ANSI standard.
- h. Transformers intended for parallel operations shall be specified on the applicable transformer data sheet.

5. Proposal

5.1. Base and alternate quotations

- a. Base quotation shall comply strictly with this GIS and applicable data sheets.
- b. Alternate quotations may be submitted if deviations from this GIS or data sheets are clearly stated and a base quotation is offered.
- c. BP evaluation of quotations will take into account transformer efficiency that is based on no load loss, cooling losses, and load. (Loss = total loss minus no load loss.)
- d. Service proven designs
 1. Service proven designs shall be offered.
 2. If a design is offered that has not been proven in service for at least 2 yr, proposals shall indicate which parts of the transformer are affected and the extent of experience with these parts.
 3. Transformer designs scheduled to be superseded shall not be used.



5.2. Information to be supplied with quotations

The following information shall be provided with quotations:

- a. Exceptions.
- b. Equipment or features not specified.
- c. Detailed descriptions of proposed equipment, accessories, and features.
- d. Equipment layout and dimensions.
- e. Identification of equipment not UL listed.
- f. Identification of “third party” components, equipment, and systems.
- g. Price and availability of recommended spare parts.
- h. Itemised list of unassembled equipment, including shipping splits and ship loose items.
- i. Example of proposed wire marking identification system.
- j. Cost for witness testing.
- k. Installation, maintenance, and operating instructions.
- l. Type test certificates.

5.3. Information to be submitted after receipt of order

The following information shall be submitted after receipt of order:

- a. Size and location of conduit connections, cable entrances, and throats referred to transformer centrelines.
- b. Location of grounding pad(s) and size of holes.
- c. Size and location of anchor bolts.
- d. Horizontal and vertical clearances necessary for dismantling and removing core and cover.
- e. Weights of the core and tank without oil.
- f. Engineering data and drawings
 1. All engineering data and drawings provided for this equipment shall show equipment as specified and ordered.
 2. Engineering data and drawings, as listed, shall be supplied in the quantities shown in the RFQ and/or PO.
 3. Symbols used on drawings shall comply with applicable ANSI standards.

6. Drawings and documentation

6.1. General

- a. Drawings provided for equipment shall show the equipment as specified and ordered.
- b. Typical drawings shall not be acceptable.
- c. Design test documents shall need to be submitted only one time.
- d. Once design test data has been accepted by BP, additional copies shall not need to be submitted for each additional order.
- e. Approximate transformer overall dimensions, estimated weights, and average sound level data shall be provided with quotation.



- f. If specified, approximate ground resistor overall dimensions and estimated weights shall be provided with quotation.
- g. Guaranteed core loss values, winding loss values, and other required information shall be provided with the quotation.

6.2. Installation, operating and maintenance instructions, and data requirements

- a. Ratio correction factors and excitation curves for each size and type of current transformer shall be provided.
- b. Motor data sheets
 - 1. Vendor shall complete BP motor data sheets for cooling fan motors, oil pump motors, and all other auxiliary motors.
 - 2. Completed BP motor data sheets shall be subject to BP electrical TA or appointed representative approval.
- c. Installation, operating, and maintenance instructions
 - 1. Installation, operating, and maintenance instructions shall be provided for:
 - a) Power transformer.
 - b) All auxiliary devices, such as temperature, fluid level, sudden pressure and monitor, rapid relief, switches, and indicating devices.
 - c) Transformer assembly instructions and vacuum fluid filling.
 - d) Specifications and instruction manuals for resistor package.
 - e) Catalogue cutouts for each type of electrical device, such as relay, light, selector switches, pushbuttons, and monitors.
 - 2. Installation, operating, and maintenance instructions shall cover all the equipment provided.
 - 3. Copies of the installation, operating, and maintenance instruction books shall be provided in the quantities indicated in the RFQ and/or PO. One additional instruction book shall be shipped with the transformer and located in the control cabinet.
 - 4. Maintenance instructions shall include complete component information and catalogue data sheets to completely identify and describe all components, accessories, motors, ground resistors, etc., associated with the transformer.

6.3. Drawing requirements

- a. The location of the transformer(s) (i.e., substation number and unit) shall be identified on the drawing title blocks.
- b. Transformer locations shall be identified on the data sheets.
- c. Typical drawings shall not be acceptable, unless they are revised to show only the equipment being provided.
- d. Reproducible drawings for approval shall be provided as follows:
 - 1. Outline drawings - completely dimensioned, in U.S. units, showing:
 - a) Plan and all elevations, including clearance for bushing and core and coil removal.
 - b) High voltage termination details.
 - c) Low voltage termination details.
 - d) Location of all manholes and handholes.



- e) Location of all accessories.
 - f) Ground resistor details, including dimensions, weights, and mounting requirements.
 - g) Size and location of all conduit entrances for BP connections.
 - h) Anchoring details for attaching the transformer to the foundation.
 - i) Ground pad locations.
 - j) Weight of transformer and centre of gravities, with and without oil, and shipping weights.
 - k) Quantity of insulating fluid (total and per compartment or tank).
 - l) Control cabinet details.
 - m) Conduit layout drawings.
2. Elementary (schematic) wiring diagrams - An elementary (schematic) wiring diagram shall be provided for:
- a) Forced cooling equipment (if applicable) control scheme.
 - b) Transformer protection control schemes, including current transformers.
3. Detailed connection (wiring) diagrams - showing:
- a) Interconnecting wiring of all components of the forced cooling equipment (if applicable).
 - b) Wiring of all devices with switches and relays, or electrical connections, including current transformers.
 - c) Identification of all terminal blocks and connections to be made by BP.
 - d) Drawing of diagrammatic nameplate with all nameplate data provided.
 - e) Ground resistor.

7. Shipping

- a. Vendor shall be responsible for adequacy of preparation for shipment. Vendor shall identify the packing methods used to ensure proper transport without damage.
- b. Transformers shall be shipped completely assembled. No components shall be shipped separately without the written permission of BP. Components shipped separately shall be properly tagged to identify final installation location.
- c. Entire transformer shall be shrinkwrapped with protective covering.
- d. Radiators shall be protected with non-hygroscopic padding material.
- e. Components with moving parts that might be damaged in shipment shall be securely blocked and braced to prevent damage.
- f. Shipping blocks, binding, etc., shall be clearly marked such that their removal is ensured. Special precautions that need to be observed in removal of shipping restraints shall be clearly marked on shipping container or crate.
- g. Complete installation instructions for parts shipped separately from tank and core assembly shall accompany transformer shipment.
- h. Transformer shall be shipped filled with oil for normal 25°C (77°F) levels, unless specified otherwise on the electrical data sheets.



- i. Shipments shall be identified with BP requisition and appropriation numbers and transformer tag number.
- j. MSDSs
 1. MSDSs for equipment shall be provided to shipper at time of shipping.
 2. MSDSs shall comply with relevant regulations that apply to equipment locations.
 3. If any shipped chemical is exempt from the laws in 2., a statement to that effect shall be included on the MSDS.
 4. MSDSs shall be required for all chemicals received at BP facilities.
 5. Equipment or materials containing or coated with insulating oils, corrosion inhibitors, antifreeze solutions, desiccants, or other chemical or hydrocarbon substances shall be prominently tagged at openings to indicate the nature of the contents and precautions for shipping, storage, and handling.
 6. A current MSDS for each substance shipped in or with the equipment that may be regulated by the federal Occupational Safety and Health Administration Hazards Communication Rule (OSHA HCR) requirements shall be forwarded to the facility prior to shipment.
 7. Copies of the MSDS shall be affixed in a protective envelope to the outside of the shipment.
 8. MSDS shall fully comply with federal/state OSHA HCR for MSDS preparation, including a statement that the substance is considered hazardous under HCR. If any products are exempt from HCR, a statement to that effect shall be included.
- k. Transformers larger than 10 000 kVA shall be shipped with shock meters inside the transformer and on the truck/railcar bed.
- l. Transformers shall be suitably protected for handling during shipment.
- m. Transformers larger than 750 kVA and transformers shipped by rail shall have impact recorders.
- n. If specified, each resistor assembly, including current transformer, shall be fully factory assembled for shipment and ready for connection to transformer neutral and system ground network.
- o. Preparation for shipment
 1. Preparation for shipment shall comply with vendor standards, unless noted otherwise on the RFQ and/or PO.
 2. Vendor shall be solely responsible for the adequacy of the preparation for shipment provisions employed in respect of materials and application, to provide materials to their destination in ex-works condition if handled by commercial carrier systems.
 3. BP shall reserve the right to inspect and approve the equipment packaging before shipment.