



BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

DOCUMENT No.	TB-391-316-020	Rev. No.	01	Prepared	Checked	Approved
TYPE OF DOC.	TECHNICAL SPECIFICATION		SIGN	sd	sd	sd
TITLE 2500kVA, 33/0.433 kV Station Transformer (Oil Filled)			NAME	TTR	SKS	AG
			DATE	28/12/16	28/12/16	28/12/16
			GROUP	TBEM	W.O. No	86006
Customer	Power grid Corporation Of India Ltd. (POWERGRID)					
PROJECT	±800kV, 6000MW HVDC Raigarh – Pugalur Terminals					
CA NO.	CC-CS/651-SR2/HVDC-3063/7/G10/CA-I/5817-5821 date: 2017-01-25					
Station	Raigarh & Pugalur					
01	10.02.17	TTR	SKS	AG	Revised as per ABB's comments	
Rev No.	Date	Altered	Checked	Approved	Revision Details	
Distribution				To	TBEM	
				Copies	1	

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1 Scope, Quantities and Specific Technical Requirements

1.1 Scope

This technical specification covers the requirements of design, engineering, manufacture, assembly, stage testing, inspection, testing before supply, packing, loading at works and transport to site of **Three Phase, 2500kVA 33/0.433 kV STATION TRANSFORMER (Oil Filled)** along with its accessories and auxiliary equipments / instruments etc. as mentioned in this section and in various other sections of this specification.

Supplier will provide supervision during installation and commissioning of these equipments.

The scope shall encompass and include all the activities listed above

The equipment is required for the following project:

Name of customer : Power Grid Corporation of India Ltd (POWERGRID)

Name of the project : ±800kV, 6000MW HVDC Raigarh – Pugalur Terminals

Site : Raigarh & Pugalur

Refer section-3 of this document for project details and general specification. In case of any conflict among the various sections of this specification, the order of precedence shall be section 1, section 2 & the section 3.

1.2 Quantities

1.2.1 Scope of supply

Item No	Description	Units	Raigarh		Pugalur	
			Quantity	Item designation	Quantity	Item designation
01	2500 KVA, 33 / 0.433 kV STATION TRANSFORMER with associated accessories (including auxiliary equipments/ fittings/instruments etc.)	Nos	08	S1.P(1,2,3,4). AL.T1 & S1.P(1,2,3,4). AL1.T2	08	S2.P(1,2,3,4). AL.T1 & S2.P(1,2,3,4). AL1.T2
02	Connectors on 33kV bushing to cable termination lug (including fixing hardware) for 8 nos of transformers	Lot	01	NA	01	NA
03	Supervision of Erection, Testing & Commissioning for each transformer	Nos	08	NA	08	NA
04	Type Test Charge for conducting type tests (except Dynamic Short Circuit Test) as per IS 2026 (for one transformer only)	Lot	01			

1.2.2 Mandatory Spares

Item No.	Description	Unit	TOTAL QTY OF SPARES
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			Raigarh S/s	Pugalur S/s
1	Bushing with metal parts (1 no. of each voltage rating)	Set	1	1
2	Oil temperature indicator	Set	1	1
3	Diaphragm for pressure relief vent	Set	1	1
4	Tap changer contacts	Set	1	1
5	Set of valves (one of each type)	Set	1	1
6	Buchholz relay	No	1	1
7	Silicagel container	No	1	1

1.2.3 Availability Spares

Item No.	Description	Unit	TOTAL QTY OF SPARES	
			Raigarh S/s	Pugalur S/s
1	Oil temperature indicator	Set	1	1
2	Diaphragm for pressure relief vent	Set	1	1
3	Set of valves (one of each type)	Set	1	1
4	Buchholz relay	No	1	1
5	Silicagel container	No	1	1

Note:- Total quantity may vary upto ±30% at contract stage. However, mandatory spares and availability spares quantity may vary upto ±100%.

1.3 General Requirements

- 1) The station service transformer shall be of oil immersed type for outdoor installation. It shall comply with the requirements of IS-2026.
- 2) The station service transformers shall be designed and tested in accordance with relevant standards.
- 3) The transformer shall be designed for continuous duty with natural cooling.
- 4) The transformers shall have a nominal voltage rating of

Low voltage side	High voltage side
0.433 kV/√3	33 kV/√3
- 5) For the purpose of design of equipment / systems, an ambient temperature of 50 deg. C and humidity of 100% shall be considered. The

equipment shall operate in a highly polluted and highly corrosive environment.

- 6) All equipment shall be suitable for rated frequency of 50Hz with the variation of +3% to -5% and +/- 10% combined variation of voltage and frequency unless specifically brought out in specification
- 7) The creepage distance of the insulators shall be generally not less than 25mm/kV per unit of system phase to phase voltage.
- 8) The auxiliary transformer shall have a neutral bushing current transformer with two protection cores, details of which are mentioned below:

S. No.	CT Ratio	Characteristics / Burden	Class	Purpose
1	3200 /1 A	40Rct + 400 V, Im < 30 mA at Kpv /4	PS	REF Protection
2	3200 /1 A	40Rct + 400 V, Im < 30 mA at Kpv /4	PS	Spare

1.4 Interface requirements

Supplier shall provide potential free contacts on each transformer for communication to substation automation system for the following indications

- 1) Bunchholz Alarm & trip
- 2) WTI Alarm & trip
- 3) OTI Alarm & trip

1.5 Specific Technical Specification

Sl. No	Description	Parameters	
	STATION TRANSFORMER		
1	Type	Two winding	
2	Service	Outdoor	
3	Number of phases	Three	
4	Frequency	50 Hz	
5	Type of cooling	ONAN	
6	Rating	33/0.433kV, 2500kVA	
7	Impedance at 75°C with tolerance	0.0625pu (±10%)	
8	Duty	Continuous	
9	Overload	As per IS:6600	
10	Max. temp. rise over 50°C ambient		
i)	Oil (temp. rise measurement by thermometer)	50°C	
ii)	Winding (temp. rise measured by resistance method)	55°C	
11	Windings	Primary side	Secondary side
i)	System apparent short circuit level (kA)	As per IS:2026 (Part-I)	
ii)	Winding connection	Delta	Star

Sl. No	Description	Parameters	
iii)	Vector Group	Dyn 1	
iv)	Insulation	Uniform	
v)	Insulation level (kV)	52	0.433
a)	Power frequency test level (kVrms)	95	2
b)	Basic impulse level (kVp)	250	----
vi)	Method of earthing	Solidly earthed	
12	Tap changer		
i)	Tap range	tap range of +/-5% in steps of 2.5% on HV side	
ii)	Tap control	Off circuit tap change switch	
13	HV bushings	Primary side	
i)	Rated voltage, kV	52	
ii)	Rated current	100A	
iii)	Basic impulse level	250 kVp	
iv)	Wet and dry power frequency withstand voltage (kVrms)	95	
v)	Minimum total creepage distance (mm)	1300	
vi)	Mounting	Tank/ Transformer body	
14	Neutral bushing	Secondary side	
i)	Rated voltage (Volts)	1100	
ii)	Rated current (amps)	3000	
15	Terminal details		
i)	High voltage	Cable box suitable for 33kV cable and cable termination	
ii)	Low voltage phase and neutral	415V Bus Duct	
16	Minimum clearance in air	HV side	LV side
i)	Phase to phase	530 mm	25 mm
ii)	Phase to earth	480 mm	25 mm

The equipment must conform to the latest revision of all relevant standards.

1.6 Tests

1.6.1 Type Test

- 1) The bidder shall offer type tested (only for Dynamic Short Circuit Test) equipment for the project and the Employer shall accept the equipment type test reports under the following conditions:
 - (i) Type test in accordance with the IS: 2026
 - (ii) Type tests performed within ten (10) years from the date of 28th July 2015
 - (iii) The type tested equipment shall be of the same design, insulation class and rating as per the equipment offered under this contract. Technical justification will be submitted for differences between tested and offered equipments. Employer's interpretation for this

shall be final.

In the event that equipment furnished includes important modifications of, or significant departure from, the designs of equipment on which type test report has been furnished or if there is evidence that the equipment does not comply with the requirements of the Specifications, type test procedure was not properly followed as laid down in standards, the bidder shall conduct the type tests without any cost implication to the Purchaser.

- 2) All the type tests (Except Dynamic short circuit Test) in accordance with latest issue of IS: 2026 shall be conducted on one type of each transformer under this contract

- 3) Bushing

Offered equipments should have been type tested in accordance with the applicable IEC/IS and the detailed type test reports (on identical equipment) shall be submitted for approval. The type test reports submitted shall be of tests conducted within last 10 years prior to the date of 28.07.2015. The bidder should have conducted type test on identical or similar equipment/ components to those offered. In case type test reports are found to be technically unacceptable to BHEL/POWERGRID, the type test shall be conducted without cost and delivery implication to BHEL.

1.6.2 Routine tests

- 1) All standard routine tests in accordance with latest issue of IS: 2026 shall be carried out on each transformer.

1.7 Qualifying requirements

The manufacturer, whose transformers are offered should have designed, manufactured, type tested including short circuit test as per IEC/IS or equivalent standards and supplied transformers of at least 33 kV class of 800 kVA or higher. The transformer should have been in operation for at least 2 years as on date of 19th May 2015.

1.8 Manufacturing quality plan

Bidder to follow valid POWERGRID approved Quality Plan (QP) at contract stage.

1.9 Deviations

The bidder shall list all the deviation from the specification separately. Offers without specific deviation will be deemed to be totally in compliance with the specification and NO DEVIATION on any account will be entertained at a later date.

2 Equipment Specification

2.1 General

This section covers the general technical requirements of *Three Phase, 2500kVA, 33/0.433 kV STATION TRANSFORMER (Oil Filled)*. In case of any discrepancies between the requirements mentioned in this section and those specified in section-3 of this specification, this section shall prevail and shall be treated as binding requirement.

2.2 Standards

The Three Phase, 2500kVA, 33/0.433 kV STATION TRANSFORMER (Oil Filled) and accessories shall conform to the following standards.

IS 2026 (Part-I)	Specification for power transformer
IS 6600	Guide for loading of oil immersed transformers

2.3 Technical Requirements

2.3.1 General

- 1) The station service transformer shall be of oil immersed type for outdoor installation. It shall comply with the requirements of IS-2026.
- 2) The transformer shall be designed for overload condition as per international practices. The Bidder/Contractor shall furnish details of the overload capability of the transformer at the rated ambient and low ambient temperature conditions.

2.3.2 Requirements

- 1) Wherever cable connection is required suitable air insulated cable boxes shall be provided. It shall be of sufficient size to accommodate the cables and shall have removable side/top cover to facilitate cable termination and inspection. Removable drilled gland plates of non-magnetic material shall be provided in the cable box. Additional non magnetic support for cables should be provided.
- 2) Each transformer shall be provided on HV side with off circuit tap changing switch (tap range of +/-5% in steps of 2.5%) with indication and handle locking device. Dial type thermometer for indicating winding temperature at local marshalling box as well as at the remote operator work station/VPS in station control room shall be provided.
- 3) Potential free NO/NC contacts shall be provided for generating alarm for winding temperature rise at a remote place.
- 4) The station service transformers shall be designed and tested in accordance with relevant standards
- 5) The station service transformers shall be designed and tested in accordance with relevant standards.

2.4 Constructional requirements

2.4.1 Core

The core shall be constructed from high grade, non-aging, cold rolled grain oriented silicon steel laminations. The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that the flux density at any tap position with 10% voltage variation from the voltage corresponding to the tap shall not exceed 1.9 Wb/sq-m.

2.4.2 Windings

The conductor shall be of electrolytic copper, free from scales and burrs.

2.4.3 Insulating oils

The oil supplied with transformer shall be unused and have the parameters for unused new oil conforming to IS: 335 while tested at oil Contractor's premises, No inhibitors shall be used in oil. 10% extra oil shall be supplied for topping up after commissioning in nonreturnable containers suitable for outdoor storage.

2.4.4 Terminal arrangement

- 1) Bushing terminals shall be provided with suitable terminal connectors of approved type and size for cable termination on HV side and bus duct termination on LV side.
- 2) The neutral terminals of 433V winding shall be brought out on a bushing along with the 433 volt phase terminals to form a 4 wire system for the 415 volt. Additional neutral bushing shall also be provided for earthing.

2.4.5 Off circuit tap changing equipment

The tap change switch shall be three phase, hand operated for simultaneous switching of similar taps on the three phases by operating an external hand wheel.

2.4.6 Marshalling Box

A metal enclosed, weather, vermin & dust proof marshalling box shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have a degree of protection of IP 55 as per IS: 13947Part-1.

2.4.7 Cable boxes

Whenever cable connections are required, suitable cable boxes shall be provided and be air insulated. They shall be of sufficient size to accommodate purchaser's cables and shall have suitable removable side/top cover to facilitate cable termination and inspection. Cable boxes shall be dust and vermin proof. Necessary electrical clearances to be maintained inside the cable box to accommodate 33 kV cables.

2.5 Inspection and testing

Bidder to follow POWERGRID approved quality plan at contract stage.

- 1) The bidder shall draw up and carry out a comprehensive inspection and testing program during manufacture and commissioning of the transformer. The Inspection and Test plan shall be duly approved by Powergrid
- 2) The bidder shall carry out all routine tests on the transformers as per relevant standards. Routine tests shall be carried out on all the transformers

2.5.1 Inspection

2.5.1.1 Tank and accessories

- 1) Physical and dimensional check of transformer tank and accessories.
- 2) Crack detection of major strength weld seams by dye penetration test.

2.5.1.2 Core

- 1) Physical inspection and check of quality of varnish, if used.
- 2) Sample testing of core material for checking specific loss, bend properties, magnetisation, characteristics and thickness.
- 3) Check on completed core for measurement of iron loss and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core.
- 4) HV test

2.5.1.3 Insulating material

- 1) Sample checks for physical properties of the material.
- 2) Check for dielectric strength
- 3) Check for the reaction of hot oil on insulating material

2.5.1.4 Winding

- 1) Sample check on winding conductor for mechanical properties and electrical conductivity and on installation covering.
- 2) Sample check on insulation paper for pH value, Bursting strength, Electric strength.

2.5.1.5 Assembled Transformer

- 1) Check complete transformer against approved outline drawing provision for all fittings, finish etc.
- 2) Jacking test on all the assembled transformers.

2.5.1.6 Oil

All standard tests in accordance with relevant Standards shall be carried out on oil samples taken from the transformer before and after testing of the transformer.

The contractor shall also prepare a comprehensive inspection and testing programme for all bought out sub-contracted items and shall submit the same to the Purchaser for approval. Such programme shall include the following components:

- a) Buchholz Relay
- b) Winding temperature Indicator
- c) Bushings
- d) Marshaling Box
- e) Tap changer switch
- f) Oil temperature indicator

2.6 Factory Test

- 1) All standard routine tests in accordance with latest issue of IS : 2026 shall be carried out on each transformer.
- 2) The transformer shall conform to all the type tests in accordance with latest issues of IS : 2026. The manufacturer shall submit type tests & additional test reports as listed above as already carried out on transformers of identical design for POWERGRID/BHEL aproval. In such a case validity of type test reports shall be in line with clause 1.6.1 of technical specifications. Following parameters in general shall be ensured for establishment of identical design as per IEC 60076, Part-V.
 - a) Same Voltage ratio, KVA rating, vector group & impedance.
 - b) Same conceptual design of core and winding.
 - c) Same arrangement and geometrical sequence of the main windings.
 - d) Same type of winding conductors.
 - e) Same type of main windings.
 - f) Absorbed power at short circuit (ie rated power/per unit short circuit impedance) between 30% and 130% of that relating to the reference transformer.
 - g) Axial forces and winding stresses occurring at short circuit not exceeding 120% of those relating to the reference transformer.
 - h) Same manufacturing process.
 - i) Same Clamping and winding support arrangement.
- 3) In addition to all type and routine tests, transformer shall also conform to following additional type tests as per IS : 2026.
 - a) Measurement of zero sequence impedance
 - c) Measurement of acoustic noise level. This shall conform to NEMA standard publication TR-1.
 - d) Measurement of capacitance and tan delta of transformer winding.
 - e) Test on oil samples as per IS 335-1993

- 4) All auxiliary equipment shall be tested as per the relevant IS Test Certificates shall be submitted for bought out items.
- 5) High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.
- 6) Tank Tests:
 - a) Routine Tests: As per CBIP Manual on Transformers including
 - i. Vacuum Tests: As per CBIP Manual on Transformers
 - ii. Pressure Test: As per CBIP Manual on Transformers
- 7) In addition to the above, the following checks should be carried out at manufacturer's works before despatch for all transformers:
 - a) Check for interchangeability of components of similar transformers and for mounting dimensions.
 - b) Check for proper packing and preservation of accessories like radiators, bushings explosion vent, dehydrating breather, Buchholz relay, conservator etc.
 - c) Check for proper provision of bracings to arrest the movements of core and winding assembly inside the tank.
 - d) Test for gas tightness and derivation of leakage rate. To ensure adequate reserve gas capacity during transit and storage.
- 8) The Contractor shall submit a detailed inspection and testing programme for field activities, covering areas right from the receipt of material stage upto commissioning stage as per IS : 1886 - Code of practice for installation and maintenance of transformers. The indicative checks and tests are given below.
 - a) Physical checks on each transformer on receipt at site for any damage or short supply.
 - b) Tests on oil samples
 - c) Oil leakage test
 - d) Physical checks for colour of silica in breather
 - e) Check for oil level in breather housing, conservator tank, etc.
 - f) Check for correct operation of all protections and alarms.
 - g) Insulation Resistance Measurement for Main Winding, control wiring etc.
 - h) Continuously observe the transformer operation at no load for 24 hours.
- 9) Fittings

The following fittings shall be provided with each transformer covered under this specification.

 - a. Conservator with drain plug and oil filling hole with blanking plate
 - b. Plain oil Gauge

- c. Silica gel Breather
- d. Pressure Relief vent
- e. Pocket on tank cover for Thermometer
- f. Valves
- g. Earthing Terminals
- h. Rating & Terminal Marking Plates
- i. Lifting Lugs
- j. Rollers
- k. Air Release Plug

The fittings listed above are only indicative and any other fittings which generally are required for satisfactory operation of transformer are deemed to be included.

2.7 Spare parts

- 1) The list of spares for outdoor type transformers covered under section 1.2.2 & 1.2.3

2.8 Bushings, Hollow Column Insulators, Support Insulators

- 1) Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC-60137 while hollow column insulators shall be manufactured and tested in accordance with IEC-62155/IS: 5621. The support insulators shall be manufactured and tested as per IS: 2544/IEC-60168 and IEC-60273. The insulators shall also conform to IEC-60815 as applicable.
- 2) Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.
- 3) Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.
- 4) Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.
- 5) When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.
- 6) Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may

in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

- 7) All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

2.8.1 Tests

In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS: 2099 & IS: 2544 & IS : 5621.



3 General Technical Requirements

Please refer TB-391-316-000 : 'General Technical Requirements- Section 3'