STATION SERVICE TRANSFORMER 33/0.415KV & 11/0.415KV

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Engineering Department

WEST BENGAL STATE ELECTRICITY TRANSMISSION COMPANY LIMITED

পশ্চিমবঙ্গ রাজ্য বিদ্যুৎ সংবহন কোম্পানি লিমিটেড
(পশ্চিমবঙ্গ সরকারের একটি উদ্যোগ)

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This version is 3.4

Note: Here, 11/0.415KV Transformer has been included with 33/0.415KV transformer.

1) **KVA rating of 1500KVA transformer has been changed to 1600KVA and the corresponding HV current in the Technical Specification is also changed accordingly.**
2) **All the valves provided in the transformer should be of Flange type wheel valve. T-type valve is not to be used.**
3) **A plain oil level gauge for conservator to be provided.**
4) **Regulation at 0.9 lagging p.f. to be added at clause**
5) **Energy Efficiency Level will be 2 instead of 1 below the chart at clause no.9**
6) **Load loss at both 50% and 100% included in Clause 8(v)**
7) **Table for Loss at 50% added.**
8) This point added in clause 6.9 – "For Remote indication & metering through SAS, please follow our technical specification for **Substation Automation System"**

TECHNICAL SPECIFICATION FOR
33/0.415KV & 11/0.415KV STATION SERVICE TRANSFORMER

1. SCOPE :

This specification covers design, manufacture, assembly, testing at manufacturer's works of 33/0.415KV **& 11/0.415KV** - 1500KVA,630KVA, 315KVA & 100KVA Auxiliary Power Transformer for efficient and trouble-free operation.

The transformer covered by this specification shall be complete in all respect. Any material or accessory which may not specifically mentioned here but which is usual and necessary for satisfactory and trouble-free operation and maintenance of the transformer, shall be supplied without any extra charge.

2. STANDARDS:

The transformer to be supplied shall comply with latest editions of the following standards:

IS: 1180	Specification of Outdoor type Oil-immersed Distribution Transformers up to and including 2500KVA, 33KV
IS: 2026	Specification for Power Transformers
IS: 335	Specification for insulating oil for Transformers
IS: 2099	Bushing for alternating voltage above 1000 V
IS: 6600	Guide for loading of oil immersed Transformers
IS:3637	Gas operated relay
IS:10028	Code of practice for selection, installation and maintenance of Transformer
IS:3639	Specification for fittings and accessories for Power Transformer
IEC:76	Power Transformer
IEC:354	Loading Guide of Oil Immersed Transformer
IEC:137	Bushing for AC Voltages above 1000 V

The use of any international standards which ensure better or similar performance are acceptable. In such case copy of the salient points of the standard adopted shall be clearly indicated and a copy of standard in English language shall be furnished.

3. I) DEVIATION:

Normally the offer should be as per Technical Specification without any deviation.

II) MODIFICATION:

If any modification felt necessary to improve performance, efficiency and utility of equipment, the same must be mentioned in the 'Modification schedule' with reasons duly supported by documentary evidences and advantages. Such modifications suggested may or may not be accepted, but the same must be submitted along with Pre-Bid Queries. The modifications not mentioned in Schedule will not be
considered.

4. GENERAL DESIGN:

i) In case of 400KV Sub Station, 33KV side fault level can be around 1000MVA.

ii) The transformer shall be suitable for outdoor installations in hot, humid & tropical climate.

iii) The transformer shall be capable of continuous operation at the rated output subjected to following variations:

a) Voltage variation +5 to - 10% (for 100KVA transformers, no tapping arrangement will be required) of rated voltage

b) Frequency variation +/- 3% of rated frequency i.e 50 Hz. iv) Vibration and noise levels of the transformer shall be minimum. The center of gravity of each transformer must be as low and as near the vertical centre line as practicable.

v) The transformer shall be designed to operate in overload conditions as per IEC-354 or IS:6600. It shall also be able to withstand without damage, the effects of external short circuit as per IS:2026.

vi) The maximum flux density in any part of the core and yoke at rated voltage & frequency shall be such that the flux density with +12.5 percent combined voltage & frequency variation from rated voltage and frequency shall not exceed 1.9 Tesla.

vii) **Energy efficient transformers shall be offered in line with Indian Standard IS: 1180, part 1- latest amendment considering losses as per Energy level 2 or better.**

5. ACCESSORIES & FITTING :

The Transformer shall be complete with necessary fittings and accessories, such as:

i) Bushings.

ii)Conservator mounted on transformer tank with shut off valves between conservator and main tank.

iii) Oil level gauge with low-level alarm contacts.

iv) Dehydrating breather.

v)Externally mounted, 3 phase gang operated OFF load tap changing switch with tap marking (for transformers above 630KVA).

vi)Lifting eyes for top cover.

vii) Lifting eyes for core and winding.

viii) Lifting eyes for lifting complete transformer by crane and also by jacks.

ix) Inspection covers.

x) Oil sampling valves at top and at bottom.

xi) Filter inlet and outlet valves with nozzles at the bottom corner and at the diagonally opposite top of the tank corner.

xii)Mounting arrangement for transformers beyond 100KVA shall be suitable for mounting on rollers and that of 100KVA shall be with 2nos 75 X 40mm channels 460mm long as per latest edition of IS1180 (Part- 1).

xiii)Earthing terminals suitable to withstand maximum fault current

xiv) Dial type thermometer for oil temperature indication and winding temperature indication with maximum reading pointer and separate sets of contact for alarm and trip.

xiv) Pocket for inserting thermometer for oil temperature measurement.

xv) Rating plate and diagram plate.

xvi) Buchholz (gas) relay, double float type with one set of alarm and one set of trip contacts with testing petcocks.

xvii) Insulating oil required for first filling.

xviii) Pressure relief device.

xix) Oil drain valve at bottom.

xxi) All the valves provided in the transformer should be of Flange type wheel valve. T-type valve is not to be used. [R3.1]

Any other accessories other than those mentioned above if required for successful operation of transformer shall also be within the scope of supply.

6. CONSTRUCTIONAL FEATURES :

6.1 CORE :

It shall be made from high grade non-ageing, low Hysteresis loss and high permeability cold rolled grain oriented silicon steel laminations of M4 grade.

i) The whole core shall be electrically connected by copper strip of not less than 6.25 sqmm. cross section to the tank inside for being earthed to drain off any electrostatic potential that may build up.

ii) Each core bolt and part of the core clamping frame work shall be insulated from the core lamination. The core shall be tested to withstand a voltage of 2500 volts A.C. for a duration of one minute.

iii) The prime core materials are only to be used. Bidder's should furnish following document as applicable as a proof towards use of prime core material to be submitted after final approval of drawings and prior to starting manufacturing.

(a) Invoice of supplier.

(b) Mill's test certificate.

(c) Packing List.

(d) Bill of landing.

(e) Bill of entry certificating custom.

(f) Description of material, electrical analysis, physical inspection, certificate for surface defects, thickness and width of the materials.

iv) All transformers shall be subjected to routine test and no load and load loss measurement as per relevant IS as mentioned in the clause "TEST AT FACTORY AND TEST CERTIFICATES". Core materials should be directly procured from either the manufacturer or their accredited marketing organization of repute and not through any agent.

6.2 WINDING :

i) The winding shall be made of paper insulated continuous and smooth electrolytic copper conductor and shall be so designed that all the coil assemblies of identical voltage rating shall be interchangeable and field repairs to the winding can be made without special equipment. The insulation of the coils and assembly of windings shall be insoluble, noncatalytic, chemically inactive in the hot transformer oil. The insulation shall be of class "A" category.

ii) Liberal ducts shall be provided for oil circulation and prevention of any hot spot temperature in the winding that may affect the life of the transformers.

iii) Windings and leads shall be suitable to withstand short circuit stresses and other vibrations Guide tubes must be provided where possible.

iv) Joints must be welded or soldered with silver solder specially formulated for use on heavy copper connections. Bolt or clamp type connections must be used at the bushings, tap switch shall be provided with suitable locking devices to prevent loosening of connections.

v) Coil and core assemblies must be dried in full vacuum to ensure elimination of air and moisture within it.

6.3 TANK:

The tank and cover of the transformer must be of good commercial grade low carbon steel of adequate thickness. The thickness of top, bottom and side plates shall be stated in the tender. Joint of tank and cover shall be tightened by bolts.

i) The tank shall be so shaped as to reduce welding to a minimum. All seams shall be double welded where practicable. The completely assembled transformer must be designed to withstand, without permanent deformation, a pressure of 25% greater than the maximum operating pressures resulting from the system of oil preservation used. The tank must be designed for filling with oil under full vacuum.

ii) Bushing turret covers, access holes cover, pockets of thermometers shall be so designed to prevent any ingress or collection of water.

iii) Any compressible gasket which can be damaged by over compression must have metallic stops to prevent over compression. Guides within the tank or other satisfactory means must be provided for locating the core and coils when they are lowered into or removed from tank. Ample space must be there below core and coil for sediment to collect.

iv) Design shall be such that Tank Cover can be lifted independently without lifting active part of core, winding etc.

6.4 COOLING:

i) Transformer shall be suitable for 100% continuous maximum current rating with ONAN Cooling within the specified maximum temperature rise of 40^{o}C for oil & 45^{o}C rise for winding.

ii) Radiators are to be used for cooling. They must withstand the vacuum pressure conditions specified for the tank and shall be accessible for cleaning and painting. Radiators may be removable and connected to the tank by machined flanges radiator tubes or are fixed to the tank by welding.

6.5 BUSHINGS :

All bushings shall confirm to the requirements of latest revision of IS:3347. Bushings must be well processed, homogenous and free from cavities or other flaws. Glazing must be uniform in colour and free from blisters, burns and other defects. **36 KV** bushings shall have creepage distance of minimum 900 mm. **11 KV bushings shall have creepage distance of minimum 300 mm**

6.6 TAP CHANGER/TAPPINGS :
(applicable for transformers of capacity more than 630KVA)

i) The Off-load tap changing shall be affected by an external 3 phase gang operated tap changing switch. The operation shaft shall be brought out of the tank and provided with hand wheel so that it can be operated at standing height from G.L. and be easily accessible.

ii) A visual tap position indicator shall be provided near the operating handle and provision shall be made to pad lock the handle in each tap position. The locking arrangement shall be such that pad lock cannot be inserted unless required contacts corresponding to the tap position are correctly connected with full contact pressure.

All contacts of the tapping shall be silver plated and held in position under strong contact pressure.

iv) Taps shall be provided on high voltage windings.

v) Any improved design may be offered with complete literature.

6.7 Conservator:

Oil preservation shall be made by means of conservator tank. It shall be suitably mounted on a transformer tank. The conservator shall be connected with main tank by the pipe through Buchholz Relay with necessary stop valves at both ends of Buchholz relay.

i) Conservator tank shall be provided with dial type oil level indicator, visible from the G.L. and fitted with low oil level alarm contact. A plain oil level gauge for conservator to be provided.[R3.1]

ii) Conservator tank shall be provided with dehydrating breathers.

iii) The Buchholz relay shall have two contacts one for alarm and the other for tripping. The relay shall also comprise of a drain cock, air vent, and facility of testing with air injection / mechanical testing facility.

6.8 TERMINAL ARRANGEMENT As PER WBSETCL Maker's LIST (if mentioned in BOQ)

i) 33 KV SIDE :

The terminals shall be through outdoor type **36KV** bushings conforming to IS:2099 (latest edition) and provided with Bi-metallic terminal connectors (rigid type) suitable for ACSR conductor / Al. tube as per approved drawing.

ii) 11 KV SIDE :

The terminals shall be through outdoor type **12KV** bushings conforming to IS:2099 (latest edition) and provided with terminal connectors (rigid type) suitable for cable connection.

iii) L.V. SIDE & Neutral side:

For Transformers upto 630KVA capacity –

Connection from transformer LV terminal to the respective 400V switchgears shall be made through three phase 4 core PVC Aluminium Cable. LT terminals of transformers shall be brought out through LV Bushing on top cover mounted or side wall mounted bushing enclosed by a termination box with cover. The neutral terminal shall be brought out along with the LV terminals through a separate bushing for connection to the respective switchgear neutral bus.

For Transformers beyond 630KVA capacity -

Connection from transformer LV terminal to the respective 400V switchgears shall be made through nonsegregated phase TPN bus duct. LT terminals of transformers shall be brought out through LV bushing on top cover or side wall mounted bushing enclosed by a terminal box with flange/cover suitable for connection of LT bus duct. The neutral terminal shall be brought out alongwith LV terminals through a separate bushing for connection to the switchgear neutral bus. Arrangement for one bushing NCT shall be required for REF protection purpose. Terminals of this CT shall be terminated to transformer marshalling box.

6.9 MARSHALLING BOX :

Sheet steel enclosed marshalling box (cold rolled thick sheet steel of thickness minimum 2 mm with powder coated paint or 3.0 mm (min) thick hot rolled with or without power coating paint) having degree of protection IP 55 as per IS : 13947 should be supplied with the transformer. Local cabling from field instruments like Buchholz relay, WTI CT, MOG etc. shall be within the scope of supply. WTI, OTI etc. should be mounted inside the marshalling box.

For Remote indication & metering through SAS, please follow our technical specification for **Substation Automation System" R[3.4]**

6.10 INSULATING OIL :

The oil shall conform to IS: 335-1983.

6.11 PAINTING :

i) All steel surfaces shall be cleaned by sand blasting or chemical process as required to produce a smooth surface, free of scale, grease and dirt. Steel surface in contact with insulating oil shall be painted with heat resistant oil insoluble insulating varnish.

ii) External surfaces shall be given a coat of high quality red or yellow chromate primer and finished with two coats of synthetic enamel paint shade 631 as per ISS. iii) Paints shall be carefully selected to withstand tropical heat, rain etc. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

6.12 MOUNTING ARRANGEMENT:

Mounting arrangement of the transformers shall be such that the bottom of the tank is at a sufficient height above foundation for cleaning purpose. Transformers beyond 100KVA shall be mounted on rollers and that of 100KVA shall be with 2nos 75 X 40mm channels 460mm long as per latest edition of IS-1180 (Part-1).

6.13 FOUNDATION AND STEEL STRUCTURE:

The transformers shall be furnished complete with base frame, anchor/foundation bolts and hardwires.

7. CONTRACT DRAWINGS AND MANUALS:

In the event of placement of Letter of Award, the following drawings & G.T.P are to be submitted in six (6) copies for approval:

i) Typical general arrangement drawing showing constructional features of the transformers giving tentative dimensions, weights and clearances.

ii) Sectional view showing disposition of various fittings and accessories

iii) Bushing's drawings, GA, sectional drawing with technical parameters

iv) Dimension of the largest package to be shipped and the mode of transportation.

v) Wheel base details.

vi) Type test certificates of similar transformers previously manufactured.

vii) Leaflets on: Buchholz Relay, Temperature indicator, Tap changer, H.V. & L.V. bushings, Oil level gauge, Off load tap changer etc.

viii) Drawings of plan and elevations in details showing wheel loading, centre of gravity etc.

ix) Foundation drawing.

x) Name plate, Rating plate Drawings.

xi) Control schematic and wiring diagram.

xii) Transport and shipping package details.

Four (4) copies of operation, maintenance & erection manuals and all drawings both in hard and soft shall be supplied. The manuals shall be bound or hard paperback volumes and shall contain all the drawings and information required for erection, operation and maintenance of the transformer. The manuals shall particularly contain marked erection prints identifying the component parts of the transformer, with assembly drawings.

8. TESTS AT MANUFACTURER'S WORKS AND TEST CERTIFICATES:

All routine tests as per stipulation of relevant Indian Standard at manufacturer's works shall be carried out in presence of the representative of WBSETCL. The contractor shall give at least 15 (fifteen) days advance notice of the date when the tests will be carried out. The entire cost of acceptance and routine test that are to be carried out as per relevant IS shall be treated as included in quoted price of Station Service Transformer. Routine test results of each transformer along with acceptance test results shall be submitted in three (3) copies for approval:

The following tests shall be carried out on all transformers as a part of routine test as per IS2026 and as per our standard requirement.

i)Resistance of each winding at all taps (wherever applicable).

ii)Ratio Test for all taps.

iii) Polarity, phase vector relationship and terminal markings.

iv) Measurement of No-Load Loss and No-Load Current at 90, 100 and 110 percent rated voltage.

v) Measurement of load losses. (Both 50% and 100%) [R3.3]

vi) Impedance voltage at normal, maximum and minimum tap for each pair of winding.

vii)Regulation at rated load and at unity, 0.8 lagging p.f , 0.9 lagging p.f.[R3.1]

viii) Efficiencies at u.p.f. 0.8 p.f. at 50%, 75% and 100% loading.

ix) Separate source voltage withstand test.

x) Induced over-voltage withstand test.

xi) Magnetic Balance test.

xii) Physical verification and dimension checking.

xiii) Oil leakage test on transformer as per CBIP for 12 hours (min.)

xiv) Measurement of Tan Delta and Capacitance of windings and bushing.

xv) Zero sequence impedance measurement.

xvi) Insulation resistance between windings and windings to earth.

Following tests shall be performed on one finished & empty tank in presence of technical personnel of Client / manufacturer of transformer at free of cost and three copies of test results are to be submitted to the Chief Engineer, Engg. Deptt. for approval. Manufacturing may be taken up only after obtaining manufacturing clearance.

i) Vacuum withstand strength of tank shall be tested at a maximum internal pressure of 3.33 KN/m2 for one hour. The permanent deflection shall not exceed the value specified in CBIP manual.

ii) Pressure Test: Pressure test shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35KN/m² whichever is lower measured at the base of the tank and will be maintained for one hour. The permanent deflection of flat plates after the excess pressure released shall not exceed the value specified in CBIP manual.

9. **Maximum Loss of Station Service Transformer (33 KV/0.415 KV)**

RATING	Loss At 100% Load (In W)				
	Energy Efficiency Level 1	Energy Efficiency Level 2	Energy Efficiency Level 3	Energy Efficiency Level 4	Energy Efficiency Level 5
100 KVA	1774	1612	1467	1335	1215
315 KVA	3332	2956	2623	2326	2064
630 KVA	5697	5214	4771	4365	3996
1600 KVA	12685	12147	11632	11140	10668

RATING	Loss At 50% Load (In W) [R3.3]				
	Energy Efficiency Level 1	Energy Efficiency Level 2	Energy Efficiency Level 3	Energy Efficiency Level 4	Energy Efficiency Level 5
100 KVA	510	467	421	378	340
315 KVA	1101	1026	956	891	830
630 KVA	2000	1875	1760	1651	1549
1600 KVA	4515	4267	4034	3813	3604

If not specifically mentioned at BOQ then Energy Efficiency Level-2[R3.1] to be considered

Maximum Loss of Station Service Transformer (11 KV/0.415 KV)

RATING	Loss At 100% Load (In W)				
	Energy Efficiency Level 1	Energy Efficiency Level 2	Energy Efficiency Level 3	Energy Efficiency Level 4	Energy Efficiency Level 5
100 KVA	1650	1500	1365	1242	1130
315 KVA	3100	2750	2440	2164	1920
630 KVA	5300	4850	4438	4068	3717
1600 KVA	11800	11300	10821	10363	9924

RATING	Loss At 50% Load (In W) [R3.3]				
	Energy Efficiency Level 1	Energy Efficiency Level 2	Energy Efficiency Level 3	Energy Efficiency Level 4	Energy Efficiency Level 5
100 KVA	475	435	392	352	317
315 KVA	1025	955	890	829	772
630 KVA	1860	1745	1637	1536	1441
1600 KVA	4200	3970	3753	3547	3353

If not specifically mentioned at BOQ then Energy Efficiency Level-2[R3.1] to be considered

- Loss capitalisation will not be done.
- The losses shall be firm and no positive tolerance should be allowed.
- No weightage shall be given for supply of transformer with losses less than the specified value.
- Bidder must specify the offered losses as “FIRM”.
- **REJECTION:** WBSETCL may reject any transformer during tests or in service if any of the individual loss exceeds the permissible maximum value specified in the table.

10 TEST REPORTS AND TYPE TESTS:

Only type tested Station Service Transformer are to be offered conforming to our technical specification and relevant IS and IEC Station Service Transformer offered should be similar with ones on which type testing has been carried out as per relevant IS & IEC. Three sets of complete type test reports carried out in Govt. recognized Test House or Laboratory/NABL accredited laboratory shall have to be submitted by successful bidder positively along with submission of drawings during detailed engineering. Successful bidder may require to produce original copies of type test reports at the time of detail Engineering if asked by WBSETCL.

i) Complete identification, date and serial no.

ii) Method of application where applied duration and interpretation of each test.

iii) Relevant drawings as documented with test report.

11 GURANTEE:

Electrical characteristics shall be guaranteed by the bidder. In case of failure of materials to meet the guarantee, WBSETCL shall have right to reject the material. Guaranteed Technical Particulars are to be submitted by successful bidder during detailed engineering along with submitted drawings/documents.

However, format for submission of G.T.P. shall be handed over to intending bidders at the time of sale of tender documents.

SPECIFIC TECHNICAL PARAMETERS

		33/0.415KV SST	11/0.415KV SST
01	RATING	1600 KVA/ 630 KVA/ 315 KVA / 100 KVA	
02	NO LOAD VOLTAGE RATIO	33 KV/ 0.415 KV	11 KV/ 0.415 KV
03	PF WITHSTAND VOLT	70KV (rms)	28KV (rms)
04	LIGTHNING IMPULSE VOLTAGE	170KV (p)	75KV (p)
05	RATED HV CURRENT	28A/11A/5.5A/1.75A	84A/33A/16.5A/5.25A

06	RATED LV CURRENT	2087 A/ 877 A / 438 A / 139 A

07	PHASE	3
08	FREQUENCY	50Hz
09	VECTOR	Dyn11
10	IMPEDANCE VOLT	4.5% (Transformers up to 630KVA), 5% (beyond 630KVA & up to 1250KVA), & 6.25% (for 1600KVA and above)
11	TAP	OFF LOAD TAP CHANGER: +5% to -10% in steps of 2.5% on H.V. side (transformers beyond 630KVA)
12	INSULATION	OIL IMMERSED
13	COOLING	ONAN
14	TEMP RISE OVER AMBIENT - OIL	40°C
15	TEMP RISE OVER AMBIENT - WINDING	45°C

GUARANTEED TECHNICAL PARTICULARS FOR
33/0.415KV or 11/0.415KV STATION SERVICE TRANSFORMERS

(To be filled in and signed by the Bidder)

SL	**DESCRIPTION**	
1	**GENERAL**	
1.01	Name of Manufacturer	
1.02	Manufacturer's Type	
1.03	Conforming Standard	
1.04	Date of Last Type Test	
1.05	Dimension of the Main Tank (L x B x H)	
1.06	Weight of the Transformer with oil	

1.07	Volume of the Oil (KL)	
1.08	Continuous maximum KVA Rating	

1.09	Primary Voltage (Volt)	
1.10	Secondary Voltage (Volt)	

1.11	No load voltage ratio	
1.12	Primary Current (Amp)	
1.13	Secondary Current (Amp)	
1.14	Vector Group	
2	Insulation Level	

2.01	Power frequency withstand voltage (KVrms)	
2.01.1	On H.V. side	
2.01.2	On L.V. side	
2.02	Full wave Lightning Impulse withstand voltage	
2.02.1	HV Winding (KVp)	
2.02.2	LV Winding (KVp)	
2.03	Induced over voltage (KVrms)	
2.03.1	HV Winding	
2.03.2	iLV Winding)	

3	Rated temperature rise over maximum ambient temperature (50°C) at rated output (°C)	
3.01	oil	
3.02	winding	
3.03	Hot spot temperature	
4	Exciting current referred to H.V. & 50 c/s at (Amp.)	
4.01	90% rated voltage	
4.02	100% rated voltage	
4.03	110% rated voltage	
4.04	Power factor of excitation current at 100% rated voltage and 50 c/s	

5	No load loss (Core loss) (KW) at 50 c/s and at	
5.01	90% rated voltage	
5.02	100% rated voltage	
5.03	110% rated voltage	

5.04	Copper (load) loss at 75°C (KW) (excluding aux. Loss)	
5.05	Aux. Loss	
5.06	Total loss at normal tap and at rated frequency and at 75°C (KW) winding temperature including aux. loss. (for both for 50% and 100% load)[R3.3]	
6	Percentage Impedance at rated current and voltage (%)	
6.01	At normal tap	

6.02	At highest tap	
6.03	At lowest tap	
7	Resistance per phase at 75°C (Ohm)	
7.01	H.V.	
7.02	L.V.	
8	Regulation at full load (75°C) and following p.f.	
8.01	unity p.f.	
8.02	0.90 lagging	
8.03	0.80 lagging	

9	Efficiency at unity &0.8 p.f. (lag) at various loads (Unity p.f./ 0.8 p.f.)	
9.01	100% load	
9.02	75% load	
9.03	0% load	
9.04	25% load	
9.05	Zero sequence impedance (75°C) at normal tap & maximum/minimum tap positions (Ohm)	
10	Core particulars	
10.01	Materials & grade	
10.02	Thickness of stamping (mm)	

10.03	Flux density in the core at rated voltage and 50 c/s (Tesla)	
10.04	Flux density at 110% rated voltage and 50 c/s (Tesla)	

11	Windings :	

11.01	Current density in H.V. winding (Amp./Sq.cm.)	
11.02	Current density in low voltage winding (Amp./Sq.cm.)	
11.03	Phase to phase clearance of HV Bushing In Air	
11.04	Phase to phase clearance of LV Bushing In Air	
11.05	Phase to phase (L.V.)	

11.06	Clearance of HV Bushing terminal to ground	
12	Tap changer	
12.01	Type of tap changer	
12.02	Taps provided at Winding (Like HV or LV)	
12.03	Position of tap (Like on the neutral end or in the middle of the winding)	
12.04	No. of taps provided on the winding and % variation of each tap	
12.05	Permissible over loads, % of full load	
12.06	Core type or shell type	

13	HV Bushing	
13.01	Name of manufacturer	
13.02	Impulse withstand voltage on H.V. winding (KVp)	
13.03	1-min. P.F dry withstand voltage on H.V.Bushing (KVrms)	
13.04	1-min. P.F. wet withstand voltage on H.V.Bushing (KVrms)	
13.05	Details of L.T. Bushings and switch fuse assembly with regard to "Manufacturer", capacity & relevant technical particulars	