CENTRAL NETWORKS

GRID TRANSFORMER SPECIFICATION

(Including 66/11.5/11.5kV three winding transformers.)

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REVISION LOG

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Notes:	Transformer impedance tolerance amended to +10/-5% in section 12. Transformer impedance values changed on type A & C in Appendix 1.				
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Notes:	Transformer impedance values changed on type A, E, F, H and I units. Reference to type G unit deleted.				
Version	1.1	Prepared by	Dave West	Date	October 2007
Notes:	Transformer impedance values changed in Appendix 1 on 132/11kV and 132/11/11kV units to reflect those in the CN Design Manual. Minor changes to contact details in Appendix 2. Appendix 1 & 2 Type G transformer removed from table.				
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SPECIFICATION FOR 132/66kV, 132/33kV, 132/11kV, 132/11/11kV and 66/11.5/11.5kV TRANSFORMERS

1. SCOPE

1.1. This Standard details the technical requirement for three phase oil immersed 132/66kV, 132/33kV, 132/11kV, 132/11/11kV and 66/11.5/11.5kV 50 Hz system rated transformers of 30, 45, 60 and 90MVA.

1.2. This Standard defines the Company requirements for Grid and 66kV three winding transformers and their associated auxiliary and earthing / auxiliary transformers. The equipment shall be designed to comply with the latest issues of the appropriate International Electrotechnical Commission Standards (IEC), British Standards (BS) and Electricity Networks Association Technical Specifications (ENA TS).

1.3. Neutral earthing resistors / reactors, automatic voltage control panels and associated protection panels are detailed in other specifications.

1.4. The scope includes:

- the tapchanger
- the marshalling kiosk
- the Primary phase CTs
- the Primary neutral CTs
- the Secondary neutral CTs
- all multicore / multipair cabling between those items
- all multicore / multipair cabling between other equipment such as WTI's, cooling pumps and fans.

1.5. On all transformers the scope will also include the provision of separate earthing connections to the main tank, each cooler bank, the Primary neutral earthing connection, co-ordinating rod earthing connections, the Secondary neutral earthing connection and the earthing / auxiliary transformer tank connections. This Standard takes precedence over those standards listed in Section 2 and any previous Company Standards. Other standards and specifications may be consulted if considered to be appropriate and / or complementary to those given in Section 2. When standards or specifications not listed in Section 2 are used they should be advised to the Company.

1.6. All materials and apparatus forming part of the complete unit shall comply with the appropriate standards and specifications current at the time of tendering unless otherwise agreed in writing by the Company. Any subsequent changes of material or material suppliers to those given in the Offer shall be subject to re-approval by the Company.

1.7. All documentation and communications shall be conducted in UK English.

1.8. The Tenderer shall state any non-compliance with the appropriate standards, specifications or this document. Any non-compliance shall be submitted with the Offer providing details of alternative proposals.

1.9. If provided, any proposed site layout is given for guidance purposes only.

1.10.A Project Specification (Appendix 2) will be issued for each project, which should be read in conjunction with this document.

2. REFERENCES

This Standard makes reference to the editions current at the time of tender of the following documents. When other references not listed in this section are used, the Tenderer should advise the Company.

2.1. British and International standards (including harmonised standards)

IEC 60076-1	Power transformers - General
IEC 60076-2	Power transformers - Temperature rise
IEC 60076-3	Power transformers - Insulation levels dielectric tests and external clearances in air.
IEC 60076-5	Power transformers - Ability to withstand short circuit.
IEC 60076-10	Power transformers - Determination of sound levels
IEC 60085	Thermal evaluation and classification of electrical insulation
IEC 60137	Insulated bushings for alternating voltages above 1000V
IEC 60214	On load tap changers
IEC 60269-1	Cartridge Fuses for Voltages up to 1000V a.c. and 1500V d.c.
IEC 60270	High Voltage Test Techniques - Partial Discharge Measurement
IEC 60354	Loading of oil-immersed power transformer
IEC 60529	Degrees of Protection Provided by Enclosures
IEC 60617	Drawing Symbols and Conventions
BS148	Specification for Unused and Reclaimed Insulating Oils for Transformers and Switchgear
BS381C	Specification for Colours for identification, Coding and Special Purposes
BS3692:2001	Specification for ISO metric precision hexagonal bolts, screws and nuts.
BS3939	Graphical symbols for electrical power, telecommunications and electronics drawings. General information, general index
BS 5493	Code of practice for protective coating of iron and steel structures against corrosion.

BS 7671	IEE Wiring Regulations
BS EN ISO 1461	Specification for hot dip galvanised coatings on iron and steel articles
BS EN ISO 1706	Aluminium and Aluminium Alloy – Castings – Chemical Composition and Mechanical Properties.
BS EN 60269-1	Cartridge Fuses for Voltages up to 1000V a.c. and 1500V d.c.
BS EN 60309-2	Plugs, Socket Outlets and Couplers for Industrial Purposes
BS EN 60898	Low Voltage Circuit Breakers for use in Household and Similar Installations
BS EN 60947-2	Low Voltage Circuit Breakers for use in Industrial and Similar Installations
BS EN 61010-031	Safety requirements for electrical equipment for measurement, control and laboratory use. Safety requirements for hand-held probe assemblies for electrical measurement and test

2.2. Electricity Networks association standards

ENA TS 09-6	Auxiliary, Multicore and Multipair Cables
ENA TS 41-11	Tubular aluminium busbars, connections and terminal fittings for 132kV outdoor substations
ENA TS 41-16	Apparatus Terminations, Conductor Sizes and Associated Fittings used in Outdoor and Indoor Substations.
ENA TS 41-24	Guidelines for Design of Main Earthing Systems in Substations
ENA TS 41-37	Switchgear for use on 66kV and 132kV distribution systems
ENA TS 50-18	Design and application of ancillary electrical equipment
ENA TS 50-19	Standard Numbering for Small Wiring (For switchgear and transformers together with their associated relay AVC panels)
ENA TS 98-1	Surface Preparation and Coating Systems for New Plant and Equipment.

2.3. Other Relevant Standards

Signs Regulations	Health & Safety (Signs and Signals) Regulations 1996.
RAL	A structured system of colour identification first introduced by RAL Deutsches Institut für Gütessicherung und Kennzeichnung in 1927. The 4-digit RAL colours fulfil the colour requirements of DIN regulations and are used as colour standards by industries worldwide.

3. DEFINITIONS

Where definitions are included in a standard or specification listed in Section 2, those definitions are to be used in preference to definitions given in other non-related publications.

The following definitions will apply at all times:

CMR	Continuous Maximum Rating – capable of delivering the maximum applied load constantly.
the Company:	the Company that is the owner of and responsible for the issue of this Standard.
Differ	with respect to locking, is a unique tumbler combination or pattern of characters, which distinguishes it from any other tumbler combination or pattern of characters.
Handover Certificate	a Certificate issued by the supplier / manufacturer to the Company which indicates that the supplier / manufacturer deems the equipment to be fit for service. It shall bear a unique reference number, be signed by a representative of the supplier / manufacturer and include the date of signing.
Offer	the technical and commercial details and terms and conditions under which the Tenderer is prepared to supply equipment and services to the Company for a specific project. The Offer shall be in accordance with this Standard and the accompanying Project Specification unless indicated otherwise by the Tenderer.
Padlockable	having the facility for applying a padlock to secure the equipment in the desired position. When in position the padlock must not interfere with the normal operation of any adjacent equipment or obscure labelling, indicators etc.
Project Specification	is a document specifying the Company requirements for the number, type, manufacturing requirements, specified works tests, delivery to site, off-loading and (if required) installation on bases prepared by others, multicore cabling, earthing, site testing and commissioning of equipment for a project. See appendix 2
Primary	the high voltage winding of the transformer and any components (e.g. CTs, Bushings) associated with it.
Principal Contractor	as defined in the Construction (Design and Management) Regulations.
Secondary	the low voltage winding of the transformer and any component (e.g. CTs, Bushings) associated with it.

Tenderer:	any Tenderer or manufacturer that submits a written Offer to the Company for the manufacture, test, supply, installation and commissioning such equipment. Tenderers will normally have been approved by the Company as registered suppliers and/or manufacturers.
The Company standard operational padlock:	The Company WEST standard padlock is made of brass and has a body which is 36mm long, 34 mm wide and 15mm deep, with a 5 mm diameter shackle having a clear inside width of 19 mm and an inside length of 28.5 mm (closed) and 40.5mm (open). The Company EAST padlock has a brass body, 6.4mm diameter shackle, clear inside width of 19 mm and an inside length of 28.5 mm (closed) and 20mm "U" bolt.
Thompson Strap	a device used to electrically connect together the “c” phases of the two delta secondary windings of a three winding transformer. It provides a path for zero phase sequence components of fault current and enables a single earthing transformer to be used to provide an earth connection for both windings.

4. THE COMPANY SYSTEM

Table 1

System Voltage	**11kV**	**33kV**	**66kV**	**132kV**
Rated voltage	12 kV	36 kV	72.5 kV	145 kV
Rated frequency	50 Hz	50Hz	50 Hz	50 Hz
Design Fault Levels 3ph	25 kA for 3 sec	25kA for 3 sec	31.5 kA for 3 sec	31.5kA for 3 sec
Design Fault Levels Ph-E	25kA for 3 sec	25kA for 3 sec	31.5 kA for 3 sec	40kA for 3 sec
Rated lightning impulse withstand voltage (peak value) to earth,	95kV	170kV	325 kV	550 kV
Minimum clearance values				
Basic electrical clearance (Phase-Earth)	0.16 m	0.5m	0.70 m	1.20 m
Phase to Phase clearance	0.25 m	0.6m	0.78 m	1.60 m
Insulation height (Pedestrian access)	2.44 m	2.44m	2.44 m	2.44 m
Safety working clearance (vertical & horizontal)	2.6 m	2.8m	3.10 m	3.50 m
Substation battery - Nominal supply voltage 110V with high impedance earthed centre point used for the detection of earth faults on either pole				

5. DESIGN

5.1. The transformers shall be suitable for installation outdoors and shall comply with IEC60076, except where modified by this Standard. Cooling shall be type ONAN/OFAF or ONAN/ONAF. The design of accessories shall be co-ordinated so that the thermal rating of the unit shall not be limited by these accessories.

5.2. The equipment shall be compliant with IEC 60076 Power Transformers where appropriate unless otherwise varied in this document. Any variations from this Standard shall be listed in the Offer. All equipment supplied in accordance with this Standard shall have been subject to approval by the Company prior to the Companies's placement of the order.

5.3. Standard Grid Transformers under this specification shall be 50Hz three phase units with electrically separate Primary and Secondary windings. They shall typically have a combination of natural and forced cooling. Non oil immersed units and those with alternative cooling methods may be considered if discussed prior to submitting any Offer.

5.4. The windings shall be able to withstand without damage the thermal and dynamic effects of external short circuit levels as stated in Appendix 1. The transformer shall be designed to ensure that leakage flux does not cause overheating in any part of the transformer. Avoidance of over-fluxing at the most onerous operating conditions, especially on cyclic overloading condition, is essential.

5.5. The transformer and all associated components shall be designed to be suitable for use at the defined cyclic rating, without exceeding any defined parameters, at an ambient temperature of 20 degrees C.

5.6. The transformer and all the ancillary equipment (e.g. CTs, instruments etc.) forming part of the transformer shall have been type tested by a recognised manufacturer or testing authority in accordance with the relevant BS and IEC standards before delivery. Where existing designs are proposed, copies of the relevant type test certificates shall be included with the Offer.

5.7. The transformer shall be supplied with suitable and sufficient anchorage points (painted yellow) for the attachment of work positioning and fall arrest lanyards for use when working at height. Provisions for removable edge protection shall be made when it is envisaged that prolonged working time is needed to be spent at height e.g tap change maintenance access. A slip resistant surface finish is to be provided on the transformer lid to reduce the risk of injury.

5.8. All labels shall be clearly visible from the normal operating position and shall indicate the function of the component, not merely a reference number.

5.9. All systems supplied by the substation 110V battery shall be required to operate throughout the voltage range defined in IEC 62271.

5.10. Manuals shall be provided which clearly indicate any special considerations and procedures for installation, commissioning, use, maintenance, and disposal in respect of

Health and Safety issues, environmental requirements and other Statutory obligations. The risk assessment process for possible hazards and particular areas of difficulty should examine the complete life cycle of the equipment from installation to removal and disposal, and should be highlighted in the installation and operation instruction manuals. The Company expects the unit to be in service for forty to fifty years under normal (cyclic) service conditions. The Tenderer shall provide details of the necessary maintenance and inspection requirements to achieve this performance.

5.11. The use of non uniform insulation systems at the neutral star point end of the HV winding on 132kv transformers is acceptable.

6. RATED POWER

6.1. The temperature rises associated with maximum power ratings and overloads for 132/66kV, 132/33kV, 132/11kV, 132/11/11kV and 66/11.5/11.5kV transformers are expected to be within the limits specified in IEC 60354. The designs submitted should comply with the temperature rise limits specified in IEC 60076, Part 2, Table IV when operating under ONAN and OFAF (or ONAF) conditions on any tapping position.

6.2. The transformer and all connections shall be capable of operating at any tapping position on a load cycle **preceded by 65%** of CMR for 24hours then **130% of CMR for 8 hours** followed by **16hours at 78%** of CMR with an ambient temperature of **20^0C** without exceeding a hot spot temperature of **140^0C**. It is recognised that under these operating conditions, loss of insulation life will occur.

6.3. The cyclic rating is to be included on the nameplate.

6.4. At 130% CMR operating at any tapping position with nominal secondary terminal voltage output, the winding hot spot temperatures should not exceed 140^0C with cooling air temperature of 20^0C. Temperature rise tests shall be carried out in accordance with Section 21.3.

7. TAPPINGS

7.1. The normal operating condition of transformers on the power system is to maintain the secondary voltage constant for either, variations in load on the secondary winding, or variations in voltage applied to the primary winding. (i.e. to boost the voltage by operating the tap changer)

7.2. Tapings shall be provided on the high voltage winding. The tapping range (expressed as a percentage of primary voltage with secondary voltage constant) shall be **minus 20% to plus 10%** unless stated otherwise in the Project Specification.

- Size of step = 1.67%
- Nominal position Tap = 7.
- Number of tapping positions = 19

- Tap changing shall be carried out by means of on-load tap changing equipment as specified in Section 13.

8. WINDING CONNECTIONS

8.1. For 132kV primary windings the connections shall be either:

i. The higher voltage winding connected in star with the higher voltage neutral brought out and the lower voltage winding connected in delta, the vector symbol being YNd1 or YNd11. Changing vector groups between YNd1 and YNd11 is to be by selectable links provided with easy access.

or

ii. The higher voltage winding connected in star with the higher voltage neutral brought out and the lower voltage winding connected in star with the lower voltage neutral brought out, the vector symbol being YNyn0. No stabilizing winding is required.

8.2. For three winding 66kV transformers the winding connections shall be:

The higher voltage winding connected in star and the lower voltage windings connected in star with the lower voltage neutrals brought out, the vector symbol being Yyn0yn0. No stabilizing winding is required.

9. LOSSES

9.1. Transformers are expected to have target losses indicated in the Transformer Specification Summary Appendix 1.

9.2. The guaranteed losses of each transformer shall be stated in the tender. These losses will be taken as the basis of evaluation of the tender, for acceptance or rejection of the completed transformer and for modification of the Contract Price, in the following manner:

9.3. Evaluation

9.3.1. During evaluation of Tenders, the total whole life cost of ownership, including cost of losses will be considered.

9.4. Acceptance/Rejection

9.4.1. For the purpose of acceptance/rejection, the tolerance on losses shall be in accordance with IEC60076 current at the date on which the tenders must be lodged and shall apply individually to the tendered values of no-load loss and load loss at CMR, the latter being given at the reference temperature.

9.4.2. The Company shall have the right to reject a transformer which having tested losses, corrected to CMR and the reference temperature, exceeding either of the

guaranteed losses when adjusted by the appropriate tolerance. Cooler losses shall not be taken into account.

9.5. Performance

9.5.1. If the tested loss figures exceed the guaranteed figures then the following modifications to the Contract Price will apply:

i. For transformers where the total evaluated cost of losses is not greater than 105% of the total evaluated guaranteed losses, no variation to the Contract Price shall be made.

ii. For transformers where the total evaluated cost of losses exceed 105% of the total evaluated guaranteed losses, the Contract Price shall be reduced by the difference between the total evaluated cost of losses and 105% of the total evaluated guaranteed losses (capitalisation figures will be included in the Invitation to Tender letter)

10. NOISE

10.1. The Sound Pressure Level is not to exceed 65dB(A) when operating under any cooling regime (ONAN/ONAF or OFAF). This is applicable to all sizes/ratings.

10.2. Please specify the expected figures, as these will be taken into account in the evaluation of the Tender. Noise level measurements are required as a type test on the first of a new type only.

10.3. Transformers shall be designed to be as "quiet" as is reasonably practicable. Noise levels shall be designed and assessed in accordance with IEC 60076 –10. Noise tests shall be carried out at the Tenderer's works on fully assembled units (i.e. main tank connected to its coolers and with all fans/pumps in service).

10.4. The Company will give preference to units offered which have low noise emissions and will not accept noise levels above those given in Appendix 1. Designs incorporating tank mounted radiators shall achieve a maximum noise level of 60 dB(A) when operating OFAF. i.e. more stringent noise levels than those specified in Appendix 1.

11. FLUX DENSITY

11.1. For the purposes of determining the maximum flux density in the core and other magnetic components it may be assumed that the system highest voltage at 47 Hz represents the worst combination of voltage and frequency for continuous operation. Where a maximum peak flux density exceeding 1.9T will be induced in the core or any other magnetic component under the above condition at any tap position, then this shall be clearly stated in the tender and evidence provided to show that the transformer shall be capable of continuous service without damage under this condition.

11.2. Overfluxing: The maximum system voltage will not exceed +10% above nominalvoltage and the normal frequency 50Hz may vary between 47 and 51Hz.

12. IMPEDANCE

12.1. The Company's normal required impedances are summarised in Appendix 1 - Transformer Specification Summary. The tolerances for impedance are +10/-5%. Units having impedance outside of this tolerance will not be accepted by the company. Occasionally impedances other than those quoted in Appendix 1 are required on some projects but will be detailed in the Project Specification.

13. ON-LOAD TAP CHANGERS

13.1. On-load tapchangers shall be the high speed resistor type and shall comply with requirements of IEC 60214. They shall be designed for bi-directional power flow.

13.2. Provision shall be made to raise and lower the taps:

- Manually by detachable operating handle at the tapchange mechanism and
- By electrical push button control at the tapchange mechanism,
- Electrically from the remote AVC panel,
- And automatically by the Voltage Control and Monitoring Relay.

13.3. Where 'in-tank' tap changers are offered, all the necessary safety equipment fittings such as lifting device, safety harness anchor points, and circular type brackets for safety handrails rails used for maintenance and inspection activities, should also be included.

13.4. Both single compartment tank-mounted and in-tank types are acceptable and alternative designs will be considered. A tank-mounted type is preferred unless the in-tank type offers a significant increase in the maintenance interval and/or a significant benefit in lifetime maintenance costs. The Offer should state clearly the type of tapchanger proposed and the recommended maintenance requirements.

13.5. If a single compartment tapchanger is supplied, a "Rise in Pressure" sensing/protection device with two pairs of normally open volt free contacts shall be incorporated. Company approved types are given in the Approved Equipment list Appendix 3. Alternative types will only be accepted if prior approval in writing has been given by the Company.

13.6. The LV supply to the tapchanger will be isolatable and protected from within the Marshalling Kiosk, the isolatable device being capable of being locked off by a Company

standard lock. The isolating of the LV supply to the tapchanger shall not remove supply from the coolers, bund pump, kiosk heaters or any other accessories.

13.7. All wiring associated with the tapchange control system shall be kept electrically separate from other wiring to enable the Company to supply it from a discrete 'tapchange supply' switch-fuse on an 'essential services' 415V, 3 phase, 4 wire distribution board.

14. TAP CHANGER CONTROL

14.1. The control circuitry for all equipment supplied shall be fully compatible with the external circuitry detailed in the Project Specification drawings and Company Standards.

15. AUTOMATIC VOLTAGE CONTROL

15.1. Control of Tap Position shall be available;

- Mechanically at the tapchanger
- Electrically at the tapchanger
- Remotely from the Automatic Voltage Control (AVC) panel - located in the substation control / relay room. (Note:- all interfaces with telecontrol will be via the AVC panel)

15.2. Tapchangers shall provide facilities for remote tap position indication, tap change in progress indication and tapchange raise and lower complete indication.

15.3. Where the supply of AVC panels are included in the Offer this will be stated in the Project Specification. Details of this equipment will be provided separately in the separate Company AVC Standard.

15.4. Where a Tenderer is offering main transformer and associated AVC Panel, the Tenderer shall be responsible for commissioning both items working together in- situ, whether cabling between these items has been carried out by the Tenderer or by others. An overall schematic diagram giving the entire voltage control system (including drive motors, auxiliary and limit switches, voltage regulation relay, voltage reduction, manual and telecontrol functions) shall be provided by the Tenderer on a single drawing.

16. TERMINAL ARRANGEMENTS

16.1.Open Terminal Bushings

16.1.1. On 66kV and 132kV primary winding units, the HV terminations shall usually be outdoor bushings, with a smaller bushing insulator for the Primary neutral (where this is brought out).

16.1.2. On 66kV primary winding units the primary neutral is not bought out as its insulation level is uniform.

16.1.3. The Tenderer must specify the types of bushing to be used in the offered plant. Polymeric bushings are preferred but alternative bushing materials will be considered. Full technical particulars shall be provided with the Offer.

16.1.4. All bushings are to be rated for the full rating of the plant. i.e. CMR + 30%.

16.1.5. HV bushings to BS EN 60137 are acceptable provided that they comply with the requirements of the main transformer lightning impulse tests. The BIL required at the various voltage levels is given below in Table 2.0.

Table 2.0

Rated Voltage (kV)	Required BIL (kV) for bushings
145	650
72.5	325
36	170

16.1.6. Creepage distances shall be a minimum of 25mm per kV at the rated voltage.

16.1.7. If oil filled bushings are provided they shall have the following facilities:

- Oil level indication windows with the level readable from ground level.
- Sampling, draining and filling facilities.

16.1.8. Connecting stems are preferred. Full details of the proposed bushing connecting stems shall be supplied with the Offer. Any adaptor plates or palms will be provided by others.

16.2.Cable boxes

16.2.1. 11kV and 33kV windings shall normally be terminated using cable boxes.

16.2.2. All 11kV cable boxes shall be suitable for and supplied with stackable connectors to suit 630mm² XLPE single core 11kV cable. For 11kV the standard connector is - 600 series 1250A to ANSI/IEEE standard 386 - Table 2 Type D.

16.2.3. The Secondary cable sockets may not share the current equally, dependent on the cable connections. For example a 30MVA 11kV incomer circuit will consist of three 630mm^2 cables per phase. Two cables of the same phase would be connected to same socket via stackable connectors. This double connection could occur in either cable box. Therefore each cable connection socket and its connections to the associated secondary winding shall be capable of continuously carrying at least 67% of the full cyclic rating of the winding. See Appendix 4 for details. Each component of the stackable cable connection assemblies shall be suitably rated to carry the full share of current presented to them at cyclic rating at 20°C ambient.

16.2.4. A typical arrangement for a delta secondary 11kV 30MVA winding would be to have six sockets (two per phase) in a cable box or boxes, to take a total of twelve cables. Each socket will carry a double stackable connector and therefore have two cables connected to it. Nine of these twelve cables (three per phase) will be connected to the incomer circuit breaker and the remaining three cables (one per phase) will be taken to the earthing transformer.

16.2.5. Company approved types of connector sockets and stackable connectors are given in the Approved Equipment list appendix 2. Alternative types will only be accepted if prior approval in writing has been given by the Company.

16.2.6. All 33kV cable boxes shall be suitable for and supplied with stackable connectors to suit up to 630mm² XLPE single core cable. For 33kV the standard connector is - 700 series 1250A to ANSI/IEEE standard 386 - Table 2 Type E.

16.2.7. For 33kV cable boxes associated with 90MVA units the requirement is for 3 single core 630mm² cables per phase plus 1single core 630^{2}mm cable per phase for the earthing/auxiliary transformer totalling four cables per phase.

16.2.8. It is unacceptable to have 4 x 33kV cables connected to one bushing so tenderers must consider limiting the connections to a maximum of two per bushing and supplying multiple cable boxes.

16.2.9. All 33kV terminations must be capable of accepting up to 3x630sqmm single core cables per phase for 90 MVA units and two 630mm² cables per phase for 60MVA units.

16.2.10. Other methods of connecting secondary cables will be considered if detailed in the Offer.

16.2.11. The cable box shall be designed to ensure that all cables can be disconnected by the removal of covers and without dismantling any other part of the cable box. Stuffing glands shall be provided by the Tenderer to fit over the cable sheath (nominally 52mm overall diameter for 11kV 630 mm^2 Cu XLPE cable). Split gland plates and removable box components shall be provided to enable the installation and removal of cables when terminated.

16.2.12. Adequate means shall be provided to support all cables underneath the cable boxes.

17. MARSHALLING KIOSK

17.1. The Marshalling Kiosk will provide the point at which all alarms, trips, controls, indications and CT outputs from the main transformer, the earthing or auxiliary transformer(s) and the bund pump are terminated and ferruled ready for connection with multicores to the relay panels.

17.2. A tank mounted or cooler support structure mounted weatherproof local marshalling kiosk is required on all transformers but some Project specifications may require a free standing unit. Paint finish to be the same as the main transformer.

17.3. Outdoor kiosks shall be manufactured to class IP54 of BS 60529 and shall be vented.

17.4. Fabrication of the control cabinet shall comply with the requirements of 'kiosks' within ENA TS 50.18 part 1.

17.5. The kiosk shall be constructed from a minimum of 3mm thick sheet steel and have stiffness such as to prevent mal-operation of relays and other apparatus by impact.

17.6. The kiosk shall have a roof design that sheds water and is able to withstand, without deformation, the weight of a person.

17.7. The kiosk shall have removable door(s) that can be fixed in the open position. Doors shall be weatherproofed by a suitable rain seal type arrangement. Door fastenings with integral handles shall be provided and shall include facilities for padlocking. Handles and padlocks shall be located not more than 1500mm above ground level. Where top hung doors are provided there shall be a minimum of 2000mm clearance from the bottom surface of any open door to ground level to permit personnel wearing safety helmets to stand upright.

17.8. Ventilation apertures shall be provided in positions that will ensure adequate through ventilation. Where the control cabinet is sub-divided then provision shall be made to ensure adequate through ventilation of all compartments.

17.9. Provision shall be made to limit the vibration generated by the power transformer to a level within the capability of any apparatus contained within the kiosk to withstand without incorrect operation.

17.10. Windows shall be provided for those compartments in which the winding temperature indicating instruments are located. The windows shall give unrestricted view of the instruments without opening the doors.

17.11. The base of the control cabinet shall be designed to act as the gland plate for cables and shall not be less than 450mm above ground level. There shall be sufficient space for at least 20% additional multicore / multipair cables (to be laid by others) in order to integrate the transformer installation into the remainder of the substation.

17.12. Kiosks shall have facilities for earthing in accordance with EATS 41-24.

17.13. The following shall be located within the tank mounted marshalling kiosk: -

- Winding temperature instruments.
- Cooler control equipment.
- One twin 13A 230Vac, single phase, double pole RCD protected socket outlet mounted on or within the tank mounted control cabinet. When externally mounted the socket shall be contained within a waterproof and dustproof housing. The socket outlet shall be supplied via an individual circuit breaker, which shall incorporate overload protection.
- One 110V AC 16A weatherproof socket, mounted on the outside of each kiosk.
- One 415Vac, 13Amp, three phase, 4 pole RCD protected socket outlet mounted on or within the tank mounted control cabinet. When externally mounted the socket shall be contained within a water and dust proof housing. The socket outlet shall be supplied via an individual circuit breaker, which shall incorporate overload protection.
- A suitable 110Vac, single phase, enclosed, low energy fluorescent lamp. The lighting shall be controlled by door operated switches. Adequate levels of illumination shall be attained in each compartment when the tank mounted control cabinet is subdivided. The lighting equipment shall be supplied via an individual circuit breaker, which shall incorporate overload protection.
- Suitable 110Vac, single phase, thermostatically controlled heaters to prevent condensation and to aid adequate ventilation. Adequate levels of heating shall be attained in each compartment when the tank mounted control cabinet is subdivided. The heating equipment shall be supplied via an individual circuit breaker, which shall incorporate overload protection and ‘supply on’ lamp indication. Heaters shall be adequately shrouded to prevent inadvertent contact with surfaces hot enough to cause burns.

17.14. All wiring associated with the sockets, lighting and heaters shall be kept electrically separate from all other wiring to enable the Company to supply them from a discrete ‘sockets, lighting and heater supply’ switch-fuse on the 110V house distribution board.

17.15. There shall be at least 20% spare terminal blocks in order to integrate the transformer installation into the remainder of the substation.

17.16. Apart from the tapchange mechanism box, 230V a.c. supplies shall not be present in any other compartment.

17.17. The tapchange motor may be supplied at 415/240V with all terminals suitably shrouded and the wiring segregated in accordance with EATS 50-18.

18. COOLING SYSTEM

18.1. The arrangement of cooling systems may be constrained by the Project Specification but normally either ONAN/OFAF or ONAN/ONAF types will be acceptable.

18.2. The Company has a preference for tank mounted cooling radiators provided that more stringent noise levels can be achieved. Noise level requirements are given in Section 10 and Appendix 1.

18.3. If the transformer (excluding coolers) cannot perform within a noise limit of 60dB(A), it may be necessary to consider the fitting of a noise housing to enclose the main tank. In this case, free standing coolers are likely to be required and the Tenderer shall discuss these options with the Company. Also, the Project Specification may detail site constraints which dictate the radiator arrangement. Where free standing coolers are required they shall be capable of connection to either end of the main tank.

18.4. For OFAF units, three stages of cooling are required, (ONAN, ONAF, and OFAF).

18.5. For ONAF units two stages (ONAN, ONAF) are required.

18.6. The radiators are to be galvanised and then painted to a finish defined in Section19.5.

18.7. Temperature settings shall normally be as shown below, but may be varied by the Project Specification or specific Tenderers recommendations. Settings should be suitable to allow CMR +30% to be delivered by the transformer without alarming. Where the Tenderer recommends settings different from those below, the settings shall be indicated in the Offer. Cooling systems will be controlled by the winding temperature instruments mounted in the marshalling kiosk.

Coolers start at	75 degC
Coolers stop at	55 degC
Alarm	115 degC
Trip	130 degC

18.8. Isolating the LV supply to the coolers shall not remove supply from the tapchanger, bund pump, kiosk heaters or other ancillary apparatus.

18.9. Coolers are required with detachable radiators, valves for oil filtering, motors, fans, pumps and related control gear associated with a forced cooling system.

18.10. The cooling fans shall be shrouded and provided with guards to prevent fouling or injury.

18.11. The cooler control equipment shall be mounted within the tank mounted marshalling kiosk.

18.12. All wiring associated with the forced cooling system shall be kept electrically separate from all other wiring to enable the Company to supply the forced cooling system from a discrete 'cooler supply' switch-fuse on the LTAC board.

18.13. The forced cooling system shall include a 'cooler supply' switch-disconnector mounted within the tank mounted control cabinet in order to provide local disconnection of the incoming supply. The isolatable device shall capable of being locked off by a Company standard lock.

18.14. The cooler supply shall be monitored and a cooler fail time delay (alarm) relay shall be primed in the event of loss of any or all three phases.

18.15. Starting of all fan and pump motors shall be via grouped timed sequence to prevent oil surges in the transformer and overload of the cooler supply. The supply to each group shall be monitored and a cooler fail time delay relay shall be primed in the event of loss of any or all three phases. In order to prevent nuisance alarms the cooler fail time delay relay shall only be primed if forced cooling is initiated. Furthermore the cooler fail time delay relay shall have a setting such that an alarm is not generated until any timed sequence starting of the fan and pump motors has been completed.

18.16. Each fan and pump motor shall be supplied via an individual circuit breaker, which shall incorporate thermal overload and single phasing protection. Auxiliary contacts shall be provided on the circuit breaker to prime a cooler fail time delay relay in the event of the circuit breaker opening.

18.17. The cooler control circuit shall be supplied via an individual circuit breaker, which shall incorporate thermal overload protection. Auxiliary contacts shall be provided on the circuit breaker to prime a cooler fail time delay relay in the event of the circuit breaker opening.

18.18. Provision shall be made for initiating the forced cooling system manually at the tank mounted control cabinet, remotely via the Company's Telecontrol system, or automatically by the HV and LV Winding Temperature Instruments. When initiation is remotely via the Telecontrol system, indications shall be provided to confirm the status of the forced cooling system.

18.19. Telecontrol interposing control relays are to be supplied and installed (in the transformer protection panel) by others. These relays will have normally open output contacts that close for a 2 seconds pulse on initiation.

19. CURRENT TRANSFORMERS

19.1. Current Transformers General

19.1.1. Current Transformers (CTs) are required in accordance with Appendix 1 of this Standard unless stated otherwise in the Project Specification.

19.1.2. All Protection CTs shall be manufactured to IEC 60044-1.

19.1.3. Test windings are **not** required.

19.1.4. Transformer primary and secondary ratings and current transformer ratios shall be agreed with the Company prior to manufacture. The Company will not accept any consequential delays or additional costs for changes if such details have not been agreed in writing with the Company prior to manufacture.

19.1.5. The low temperature class shall be -25ºC for indoor and outdoor equipment.

19.1.6. Current transformers and their ancillary equipment shall have a design life of no less than 40 years.

19.2. Current Ratings

19.2.1. The rated continuous primary current of the current transformer shall be designed to match the maximum continuous rating of its associated circuit (CMR +30%). Current transformers used in power transformers shall have continuous ratings that match the cyclic rating of the transformer.

19.2.2. Current transformers shall have thermal ratings adequately matched to the rated primary continuous current.

19.2.3. The rated dynamic current shall be 2.5 times the rated short time thermal rated current of the current transformer.

19.2.4. Short time and peak withstand ratings of current transformers shall match the primary equipment short time ratings. The duration of the short time rating is typically 3 seconds.

19.3. Insulation and voltage withstand rating

19.3.1. Current transformer primary windings shall have rated withstand voltages identical to that of their associated plant or equipment.

19.3.2. The rated power frequency withstand voltage for secondary windings shall be 3 kV (r.m.s.). The rated withstand voltage for inter-turn insulation shall be 4.5 kV (peak).

19.4.Ratios

19.4.1. Current transformer ratios are stated in Appendix 1 or if different, in the Project specification

19.5.Class and design parameters – Class Px - Protection

19.5.1. Within BS EN 60044-1 it is stated that additional requirements maybe cited for particular protective systems. These additional requirements were covered within the specifications BS 3938 and EATS 35-17. BS 3938 was withdrawn in 1998; however, the clauses therein are still pertinent to Class Px current transformers intended for use on the Central Networks system. Therefore, the withdrawn specification is still referred to in this text.

19.5.2. Magnetisation curves shall be submitted for each Class Px type current transformer at least 1 month before delivery. The curve shall be drawn on suitable graph paper with the voltage and current axis shown, and must include the following information;

- Substation name
- Circuit name
- Location of current transformer
- Ratio
- Rated continuous primary current
- Rated output
- Accuracy class
- Accuracy limit factor
- Knee point voltage (at maximum secondary turns)
- Exciting current (at 50% of knee point voltage)
- Resistance of winding
- Temperature and weather conditions during test
- Date
- Dimension diagram

19.5.3. For tapped current transformers the knee point, excitation current and secondary resistance shall be specified for the full winding.

19.5.4. Type A or Type B Class Px CT variants will be stated by the Company on a contract by contract basis.

19.5.5. Type ‘A’ current transformers shall generally be used on feeder protection schemes, such as distance, unit etc. The high knee-point is required to ensure minimal saturation under maximum fault conditions with high X/R ratios.

19.5.6. Type ‘B’ current transformers shall normally be used on schemes that can tolerate a larger degree of saturation, such as high impedance differential protection, mesh corner protection, restricted and balanced earth fault protection etc.

19.5.7. In the following tables:

- Vk, the knee point voltage corresponds to the point on the magnetisation curve where a 10% increase in voltage results in a 50% increase in current.
- Ie, the maximum excitation current (at a given voltage), corresponds to the current output of when a voltage is applied to the secondary terminals of the current transformer with the primary connections open-circuit.
- Rct corresponds to the maximum current transformer secondary resistance corrected for a temperature of 75°C.

19.5.8. 132kV current transformers

Type	V_k	I_e	R_{ct} (Ohm)
A	60(R_{ct} + 12)	60mA @ 50% Vk	2.4
B	95(R_{ct} + 2.5)	60mA @ 50% Vk	2.4

19.5.9. 66kv current transformers

Type	V_k	I_e	R_{ct} (Ohm)
A	60(R_{ct} + 10)	30mA @ 50% Vk	2.4
B	85(R_{ct} + 2.5)	30mA @ 50% Vk	2.4

19.5.10. 33/11kv current transformers

Type	V_k	I_e	R_{ct} (Ohm)
B	85(R_{ct} + 2.5)	30mA @ 50% Vk	5

19.6.Class and design parameters – Class 5P – Protection and Instrumentation

19.6.1. 132kV Current Transformers

At 132kV class 5P current transformers shall be used as backup protection. The following shall apply: -

Accuracy Class	5P
Rated Secondary Output	15VA
Rated Secondary Current	1A
Accuracy Limit Factor	20
Rated Continuous Secondary Current	1.5x
STR	3 Secs

19.6.2. 66/33/11kV Current Transformers

At voltages of 66kV and below current transformers can be used either as backup protection or main protection. The following shall apply: -

Accuracy Class	5P
Rated Secondary Output	15VA
Rated Secondary Current	1A or 5A*
Accuracy Limit Factor	10
Rated Continuous Secondary Current	1.5x
STR	3 Secs

* 1 amp secondaries are preferred, however at 11kV and below 5 amp secondaries maybe required in some instances. This shall be advised by the Company.

19.7.Class and design parameters – Class 3 – Instrument CT's

19.7.1. Instrument Current Transformers are used for two main applications within Central Networks, automatic voltage control and winding temperature. The following shall apply: -

Accuracy Class	3
Rated Secondary Output	15VA
Rated Secondary Current	1A

19.8.Current Transformer Accommodation

19.8.1. The position of each CT with respect to its P1 and P2 terminals shall be permanently marked, either in the chambers or on labels permanently fixed to the chamber covers. Current transformers shall be installed according to the following with respect to terminal markings;

- In transformers, the P1 markings shall be electrically nearer to the windings than the corresponding P2 markings.
- In transformer neutral connections the P1 markings shall be electrically nearer the winding than the corresponding P2 markings.

19.8.2. An earthed metal screen shall fully and effectively shroud current transformers and their associated secondary wiring if inserted within a cable box. Care shall be taken with the design to ensure that the sheath of the cable does not short out the current transformer.

19.8.3. In the case of current transformers housed within inaccessible locations manufacturers shall endeavour to provide a means of primary injection through current transformers without requiring access to the primary conductor or CT. Test facilities shall not affect normal operation of the transformer or CT's and should be designed to be inherently safe.

NOTE: Inaccessible locations are defined as those that would require significant fitting work and/or the disturbance of primary insulating medium to access. Examples include: transformer turret CT's and switchgear compartment CT's.

19.8.4. Bushing type CT's shall be supplied with an integral primary conductor. The nature of the connection to the primary network shall be such that it provides good contact, is mechanically sound under all conceivable operating conditions, does not promote corrosion and does not restrict the electrical rating of the primary circuit. The type of connection shall be advised by the Company.

19.8.5. Outdoor CT's shall be enclosed in a single outdoor weatherproof housing with a degree of protection of IP55 in accordance with BS EN 60529. The housing shall also incorporate at least four fixing points suitable for mounting onto a permanent structure. The internal diameter through the housing shall be advised by the Company, but in any event be no less than 60mm.

19.8.6. Secondary terminals/connections etc. shall be rated for their intended duties. Terminal posts shall be of the stud and screw type in accordance with ENA TS 50-18 part 2, suitable for a cable of 2.5mm^2. The screw and stud terminal shall be capable of accepting up to two ring type terminations.

19.9.Small Wiring & Terminations

19.9.1. CT small wiring shall generally meet requirements of ENA TS 50-18 part 2 in addition to the following clauses.

19.9.2. CT secondary wiring shall be no less than 2.5mm^2 diameter, copper stranded conductor (7/0.67), black PVC sheathed cable in accordance with BS 6231. Cables for use in plant or kiosks situated outdoors shall use type CR cable; all other cable shall be type BR.

19.9.3. Current transformer secondary wires shall be brought out to an accessible location, preferably such that personnel can access from ground level (this clause does not apply to outdoor weatherproof CT's).

19.9.4. CT small wiring shall be terminated onto screw and stud terminals or insertion, spring captive type terminal blocks (Type B to ENA TS 50-18 part 2), dependant on the application. Cable terminations shall be either ring type crimped (compression) or flat blade type crimped (compression) again, dependant on the application. Bare wire terminations are not acceptable.

19.9.5. CT wiring shall be supported where necessary and run in straight routes as far is as reasonably practicable to avoid excessive loops or sharp bends.

19.9.6. All wires shall have an indelible marking at each end, numbered in accordance with Central Networks requirements.

19.9.7. Cables shall be suitably glanded in accordance with ENA TS 50-18 part 2.

19.9.8. Current transformers that are designed to summate across items of plant or equipment (such as mesh corners) shall be provided with test blocks with facilities for disconnection and shorting by the selection of appropriate links. Test blocks shall be located as near as practicable to the CT location. It is not acceptable to site the test blocks on the indoor protection relay cubicle. Test block types shall be agreed with the Company in writing prior to order.

19.10. Rating Plates and Labelling

Terminal markings, rating plates etc shall be designed in accordance with specification BS EN 60044-1.

19.11. Testing

Testing shall be carried out in accordance with BS EN 60044-1 and BS EN 185, including, as applicable, the additional tests required for Class Px type current transformers.

19.12. HV Neutral CT

The transformer neutral connection shall be brought out through the tank lid, connected to the HV neutral current transformer and then supported on insulators to ground level and connected to the substation earthing system.

19.13. LV CT's

19.13.1. Phase CT's will supplied by others and mounted in the secondary switchgear.

19.13.2. Secondary Neutral CTs are included in the Offer and shall be of outdoor specification to IP67 and housed within a suitable protective and weatherproof enclosure. On star/star units they will be mounted on the main transformer tank. On star / delta units they will be mounted in the earthing / auxiliary transformer neutral cable box.

19.13.3. A CT (if required) is to be supplied mounted in the LV terminations of the main transformer, yellow phase only, for Line Drop Compensation purposes. The technical specification for the CT will be shown in the Project Specification. The CT P1 markings shall be electrically nearer to the windings than the corresponding P2 markings. Connections from both ends of each CT secondary winding shall be brought out to terminal blocks in a dry terminal chamber. External cables shall connect these terminals to the marshalling kiosk.

19.13.4. CT wiring to the marshalling kiosk shall be ferruled as the CT terminal markings indicated in the example given in table 3 below - and not as EATS50-19 C10, C30, C50 etc.

Table 3

(The letter “S” in the sequence denotes secondary winding.)

Primary terminal P1 and corresponding secondary terminal S1 are nearest the transformer winding in each case.

For illustration purposes only.

CT Stacking (No 1 nearest Tx winding)	Phase A Ferruling	Phase B Ferruling	Phase C Ferruling	HV Neutral Ferruling
1	1S1A - 1S2A	1S1B - 1S2B	1S1C-1S2C	1S1N-1S2N
2	2S1A – 2S2A	2S1B – 2S2B	2S1C-2S2C	2S1N-2S2N
3	3S1A – 3S2A	3S1B – 3S2B	3S1C-3S2C	
4	4S1A – 4S2A	4S1B – 4S2B	4S1C-4S2C	

20. FITTINGS

All transformers shall be supplied complete with the following fittings:

20.1. Winding Temperature Instruments

20.1.1. The purpose of the Winding Temperature Instrument is to simulate the hot spot temperature a transformer winding. In order to do this a Winding Temperature current transformer (WTCT) shall be employed. The WTCT shall be connected into the B (b) phase of the respective HV and LV windings.

20.1.2. Winding Temperature Indicators for both HV and LV windings will be mounted within the tank mounted marshalling kiosk. One WTI is required for each winding. The units are to be mounted at a height where they can be read by a person standing at ground level and shall be capable of being read whilst protected from the weather.

20.1.3. Indication of the winding temperature shall be based upon the reference condition of rated power of the associated winding. As this is an empirical measurement the WTI shall be calibrated in accordance with the following formula. The data shall be based upon results obtained during the temperature rise test. The device tolerance shall be +/-3 degrees under rated power.

$$\theta_c = \theta_a + \Delta\theta_{br} + 1.1\Delta\theta_{wor}$$

Where;
θ_c = winding hot spot temperature
θ_a = ambient temperature
$\Delta\theta_{br}$ = top oil temperature rise at rated power
$\Delta\theta_{wor}$ = winding temperature differential at rated power (i.e. the amount by which the average temperature rise of the winding exceeds the average temperature rise of the oil)

$$\Delta\theta_{wor} = \theta_{wr} - \theta_{or}$$

Where;
θ_{wr} = temperature rise of winding as measured by resistance (corrected to rated power)

θ_{or} = average oil temperature rise (corrected to rated power)

20.1.4. . Where Winding Temperature Instruments use computer software for configuring parameters, modifying parameters, or for extracting event records, copies of the operating software shall also be supplied. Any software supplied shall be licensed to the Company. Ports shall be provided on the front of the device to enable connection of a laptop computer. The port should permit serial data transfer, preferably via a 9 pin serial type connector. Ports shall be positioned such that access is unimpeded and clear of any live equipment

20.1.5. Winding Temperature Instruments, capillaries and mountings shall be designed such that they will not sustain damage or mal-operate under normal or abnormal (short circuit fault) conditions. Test results that demonstrate compliance to BS EN 60255-0-21 shall be provided to the Company on request. Anti-vibration mountings shall be provided if the equipment cannot demonstrate compliance with BS EN 60255-21.

20.1.6. The forced cooling on/off shall operate on a hysteresis characteristic. All alarm and trip contacts shall operate over a calibrated temperature range of 25Deg C to 150 DegC

20.1.7. Each Winding Temperature Indicator shall: -

i. be microprocessor based.
ii. have power supply unit suitable for 125Vdc nominal voltage but able to withstand at least 150Vdc to allow for battery boost conditions.
iii. include a winding temperature current transformer input.
iv. have four sets of volt free contacts for initiation of forced cooling (one pair of contacts), winding temperature alarm (one pair of contacts) and winding temperature trip (two pairs of contacts). Each contact shall be able to be set to operate at discrete user definable temperatures.
v. have tripping contacts designed to meet the requirements of BS EN 60255-23 CA3. Alarm contacts shall be designed to meet the requirements of BS EN 60255-23 CA2, under nominal voltages of 110V dc or 230V ac.
vi. incorporate a watchdog that detects thermocouple or associated wiring faults, power supply failure and internal component failure. Upon detection of a fault the forced cooling shall be automatically switched on and the winding temperature alarm and winding temperature trip contacts shall be inhibited from operation. A contact shall be provided for the initiation of an alarm to the Companies's Telecontrol system.
vii. continually display the 'hot spot' corrected temperature and display the maximum temperature since the last reset on request (which shall be a hand-resetting device).
viii. include event recording which time and date stamps the maximum temperature since last reset.
ix. Incorporate a transducer with a 0-10mA output to give remote indication of the 'hot spot' corrected temperature via the Companies's Telecontrol system.

Company approved types are given in the Approved Equipment list Appendix 3. Alternative types will only be accepted if prior approval in writing has been given by the Company.

20.2.Equipment Finishes

20.2.1. Materials employed in surface preparation and treatment shall be suitable to provide a minimum life to first maintenance paint of 15 years in a polluted environment.

20.2.2. Exterior finish should comply with 'C4' in IEC 12944 (polluted and minor salt erosion with 15 years to first paint.

20.2.3. All fixings for outdoor use shall be stainless steel or galvanised to BS EN ISO 1461 and where appropriate shall be of high tensile steel (grade 8.8) in accordance with BS 3692:2001.

20.2.4. When a painted surface finish is used, the Companies standard colours are:-

- For outdoor equipment -Dark Admiralty Grey 632 from BS 381C (Gloss) or RAL 7032 Pebble Grey.
- For indoor equipment - Light Admiralty Grey 697 from BS 381C (Semi-gloss) or RAL 7032 Pebble Grey.

20.2.5. Any variation from the standard colour and texture will be specified in the Project Specification.

20.2.6. Alternative finishes, particularly the Tenderer's standard finish, will be considered by the Company. Variations from the above standard finishes shall be clearly identified in the Offer. Use of alternative finished shall be subject to prior written agreement with the Company.

20.2.7. Slip resistant surfaces are to be provided on the transformer lid.

20.2.8. Coolers shall be galvanised prior to surface finishing.

20.2.9. A spare quantity of paint shall be left on site by the Tenderer for patch painting/touching up small areas of damage caused by the Company.

20.3.Interlocking

Interlocking shall conform to the Company Interlocking Standard. Any specific requirements will be given in the Project Specification. Where interlocks are provided they shall not be fitted to any parts that can be removed without the use of tools.

20.4.Designations and Labelling

20.4.1. All transformers shall be provided with nameplate labels; engraved metal - brass, stainless steel or aluminium. Labels and fastening shall be to the satisfaction of the Company.

20.4.2. All transformers shall have designation labels fitted before it arrives on site. The designation label details reqiuired for each project will be defined in the Project Specification. A labelling schedule shall be provided with the General Arrangement drawings for approval by the Company.

20.4.3. All switches and fuses shall have engraved labels indicating their function (not merely a reference number).

20.4.4. For cubicles and kiosks, designation labels are to be provided on the inside and outside of all doors. The labels shall be engraved, black lettering on white background. Positions of any other labels shall be agreed by the Company at the time of Order.

20.4.5. Labels for Mandatory, Prohibitory, Warning or Information purposes shall comply with the Health and Safety (Signs and Signals) Regulations 1996.

20.4.6. HV Phase identifying discs are required and these shall be mounted on the turrets as close as possible to the bases of bushings. The discs shall be of Perspex or similar durable plastic material. They shall be 75mm diameter and fixed such that they are readily interchangeable.

20.4.7. Phase identification discs shall be supplied in the following colours:

RED	BS381C 537 Signal red
YELLOW	BS381C 355 Lemon Yellow
BLUE	BS381C 166 French Blue

20.4.8. For the purposes of phase identification, the required phase sequence will be "A" phase – RED, "B" phase YELLOW and "C" phase BLUE unless specified differently in the Project Specification.

20.4.9. No LV phase identification colours are required at the LV terminations.

20.5.Special Tools and Spares

20.5.1. Any special tools required for maintenance shall be provided as part of the Offer. All tool kits shall be supplied in wall mountable tool boxes.

20.5.2. The Tenderer shall indicate in the Offer, recommendations for spares and whether these have been included in the Offer.

20.6.Co-ordinating Rods

20.6.1. Co-ordinating rods shall be provided on the Primary side bushings only. The transformer shall be designed with fixing points such that the rods can be fitted either inboard or outboard without fabrication work. The Project Specification shall define whether the transformer shall be supplied initially with inboard or outboard mounted rods.

20.6.2. The co-ordinating gap which will be adjustable between 660mm and 712mm shall be initially set to 660mm for 132kV. A similar adjustment for 66kV is required and will be set initially to 530mm unless otherwise stated in the Project Specification.

20.6.3. Arcing horns shall be provided on outdoor secondary bushings. The gap shall be 510mm for 66kV and 315mm for 33kV.

20.6.4. Co-ordinating rods and earthing electrodes shall be positioned so as to minimise damage to the transformer or other fittings in the event of an arcing fault.

20.7.Main Electrical Connections

20.7.1. Main electrical connections shall be provided in the form of a standard palm connector complying with EATS 41-11 or EATS 41-16. Fixings shall take into account any bi-metallic requirements.

20.7.2. High voltage connections shall be of tinned copper or aluminium alloy LM6-M or LM8-M to BS EN 1706. Unless otherwise indicated in the Project Specification, they shall be arranged so that the terminal palm is horizontal.

20.7.3. If aluminium alloy terminal palms are used, provision shall be made, including in respect of safety clearance, for the connection of busbars containing copper to be connected to the underside of the terminal palm.

20.7.4. Unless otherwise detailed in the Project Specification, the terminal palms shall comply with Figure A1 of EATS 41-11.

20.8.Earthing

20.8.1. Provision for earthing the main tank shall be provided at all corners of the transformer and bonded together using 40 x 4mm copper earth tape to provide multiple earth continuity. Co-ordinating rods and ancillary earths for the tap changer, marshalling kiosk and cable boxes shall be connected to this bonding using 25 x 3mm copper tape.

20.8.2. Earthing connections shall not be in electrical contact with the main tank or other steelwork except at the designated point of connection. This shall be achieved by the use of saddles made of plastic or other suitable insulating material.

20.8.3. The HV neutral earth connection, using 50 x 6 mm copper strip, shall be supported on insulators and taken directly to ground level. This copper strip shall be cladded to prevent theft. The 50x6mm copper tape shall be bonded to a suitable point on the 40x4mm perimeter tape which shall also be cladded to prevent theft.

20.8.4. All tape to tape joints shall be brazed connections and all tape to plant connections must be double bolted. All copper tape shall be secured effectively to prevent theft and painted the same colour as the transformer.

20.9.Conservator

20.9.1. The main tank oil conservator shall have two oil level dial gauges - one at each end with a double element relay for detecting conservator high and low oil levels. Each element shall include auxiliary contacts that shall be used for oil level high and oil level low alarm purposes. Connections from both sides of each auxiliary contact shall be brought out to terminal blocks in a dry terminal chamber. External cables shall connect these terminals to the tank mounted control cabinet.

20.10. Breathers

20.10.1. The main transformer and tap changer require separate conservators with associated breathers.

20.10.2. Dessicant type breathers are acceptable for tapchangers only. A diaphragm type oil preservation system is required for the main unit where an expansion volume of air at atmospheric pressure is provided above the oil but prevented from direct contact with the oil by a flexible diaphragm or bladder. Other suitable alternatives will be considered for the main tank

conservator. A desiccant (silica-gel) breather shall be provided for the air space. Where sealed systems are supplied with uninhibited oil, consideration shall be given to the need to use a passivator in the oil.

20.10.3. Dessicant breathers shall not contain Cobalt Chloride.

20.10.4. Company approved types of dessicant are given in the Approved Equipment list Appendix 3. Alternative types will only be accepted if prior approval in writing has been given by the Company.

20.11. Anti Vibration Pads

Anti-vibration mountings are required for the main transformer and earthing transformers and shall be provided and placed in position by the supplier at the time of transformer installation. Company approved types are given in the Approved Equipment list Appendix 3. Alternative types will only be accepted if prior approval in writing has been given by the Company.

20.12. Thompson Strap

Transformers with double delta 11kV secondary windings shall be fitted with a Thompson Strap connection used to link the "c" phase windings. The strap shall be accessible by the removal of a suitably labelled bolted cover in the lid of the transformer and storage facilities for the strap when not in use shall be provided in the same compartment. The transformer nameplate should indicate if the strap is connected or not connected at time of despatch.

20.13. Provision for Noise Enclosures

Where noise enclosures are to be provided, a separate radiator bank design will be necessary. The transformer main tank bushings will require extension turrets and modification of all other associated items to make the unit suitable for the fitting of the enclosure. The Project Specification will indicate whether a noise enclosure is required.

20.14. Buchholz Relays

20.14.1. The relay shall be mounted in the connection pipe-work between the transformer and conservator tank. The pipe-work shall be as long and straight as possible at a defined gradient, sloping upwards.

20.14.2. Buchholz relays shall be double element type and of a type approved by the Company. Company approved types are given in the Approved Equipment list Appendix 3. Alternative types will only be accepted if prior approval in writing has been given by the Company. The gas float alarm shall have one pair of volt free contacts for an alarm and the gas/oil surge device shall have one pair of volt free contacts for the trip. Contacts to conform to BS EN 60255-23 CA2 and CA3 respectively.

20.14.3. Magnetic operating switches are preferred instead of mercury switches.

20.14.4. Connections from both sides of each auxiliary contact shall be brought out to terminal blocks in a dry terminal chamber. External cables shall connect these terminals to the tank mounted marshalling kiosk.

20.14.5. Facilities shall be provided for collecting gas samples and bleeding the relay from ground level. It shall also be possible to inject air into the relay to confirm operation of the surge detection element. (Testing by mechanical operation of the surge detection element will not be accepted).

20.14.6. Separate Buchholz relays shall be provided for the main tank and tapchanger.

20.14.7. A single element oil actuated relay shall be fitted to the tapchanger selector compartment. The relay shall include two pairs of volt free contacts for protection trip purposes. Connections from both sides of the auxiliary contact shall be brought out to terminal blocks in a dry terminal chamber. External cables shall connect these terminals to the tank mounted marshalling kiosk.

20.14.8. Testing: the relay shall be individually tested at the factory and on site and results recorded.

- Routine Tests shall include: The complete assembly shall be pressure tested at 1.4 bar for 6 hours.
- Type Tests shall include: Mechanical vibration tests (3,000 hours at an amplitude of 0.25mm peak to peak at 100Hz frequency) – in this time no mal-operations should occur.

20.15. Pressure Relief Devices

20.15.1. A pressure relief, spring operated, self-sealing device complete with ducting to direct oil down to 1000mm above ground level on operation shall be fitted to the transformer main tank. The device shall include two pairs of volt free contacts for protection trip purposes. Connections from both sides of the auxiliary contact shall be brought out to terminal blocks in a dry terminal chamber. External cables shall connect these terminals to the tank mounted control cabinet.

20.15.2. The PRD outlet ducting is to be made vermin proof.

20.15.3. Ducting is to have a removable securable/lockable access cover to enable testing and resetting of the Pressure Relief Device (PRD) and the cover is to be clearly labelled "PRD Test Access".

20.15.4. Company approved types are given in the Approved Equipment list Appendix 3. Alternative types will only be accepted if prior approval in writing has been given by the Company.

20.16. Small wiring

20.16.1. Small wiring shall comply with the Company's Design Specification DS 19-04.

20.16.2. Terminations shall comply with the Companies's Design Specification DS 19-05. Terminal blocks for protection CT that summate shall have facilities for disconnection and shorting by the selection of appropriate test links.

20.16.3. Terminal blocks shall comply with the Companies's Design Specification DS 19-09.

20.16.4. Manufacturers / suppliers shall include a total of 20% spare terminal blocks to facilitate future modifications

20.16.5. SCADA wiring within the marshalling kiosk shall be terminated onto type 'C' terminal blocks, as defined in DS 19-09. Type 'C' termination blocks incorporate a hinged disconnecting link.

20.16.6. SCADA terminal blocks shall cater for multipair type cable termination. The Company utilises multipair cables constructed in accordance with ENA TS 09-6, clause 4 (PVC insulated multipair light current control cables) with armour and a collective screen. Multipair cable armour shall be earthed at the kiosk end using a suitable gland.

20.16.7. Terminal blocks shall be in a readily accessible position in the kiosk to permit ease of termination of multicore and multipair cables. The Company requires that all multicore and multipair cables are suitable glanded. Gland plates for multicore and multipair cables shall preferably be bottom entry and suitable for the fitting of compression type glands accepting PVC/SWA/PVC cables to ENA TS 09-6 clause 2 and clause 4.

20.16.8. A suitably rated earthing point/rail shall be mounted near to the terminal blocks / cable glands to permit earthing if non-ferrous gland plates are utilised. The earthing point / rail shall be directly connected to the kiosk common earth bar.

20.16.9. Small wiring shall be identified using the Companies Design Specification DS 19-13; with the exception that SCADA wiring shall be identified in accordance with the project specific requirements. The supplier shall confirm with the Company their specific requirements before proceeding with the design.

20.16.10. The Company will not accept any consequential delays or additional costs for changes if the ferruling system has not been agreed in writing with the Company prior to manufacture.

20.16.11. The supplier shall only use alternative wiring identification where identification is not clear, and only with prior written agreement of the Company.

20.16.12. Terminal blocks for protection CT wiring shall have facilities for disconnection and shorting by the selection of appropriate links. Any test blocks shall be from the Company Approved List. Alternative types may be acceptable if prior written agreement is obtained from the Company.

20.16.13. All cables shall be adequately supported. Where cable trays are provided they shall be GRP, Stainless Steel, or PVC. Trays of galvanised mild steel are not acceptable.

20.16.14. Gland plates for multicore and multipair cables shall be bottom entry, fully drilled and suitable for the fitting of compression type glands. All apertures which are not required immediately for cable entries shall be blanked off or plugged using suitably sized grommets.

20.16.15. The scope of works shall include for the multicore connections from all devices supplied to a terminal block within the Marshalling Kiosk.

20.16.16. All cable glands shall be fitted with earth tags on the inside of gland plates. These earth tags shall be earthed to an earth bar with green/yellow PVC insulated able with a minimum cross sectional area of 4.0mm^2.

20.16.17. Where multicore / multipair cables are used they shall be identified with suitable reference numbers on both sides of the gland plate at each end of the cable.

20.17. Fuses and Links & MCB's

20.17.1. Fuses, links and miniature circuit breakers (MCB's) shall comply with the companies Design Specification DS 19-06. The use of MCB's is preferred for both ac and dc applications.

20.17.2. MCB's shall comply with BS EN 60898 or BS EN 60947-2 depending upon their application. MCB's for use in direct current systems shall incorporate 2-pole switching to effectively isolate both positive and negative supplies.

20.17.3. Fuses and links shall be suitably rated for use.

20.17.4. Fuses and/or MCB's shall be graded in accordance with BS 7671, noting that in some instances a mixture of HBC fuses to BS 88 and MCB's may be connected in series.

20.17.5. The use of links and sockets is preferred. The system of links and sockets shall be shrouded and touch protected to BS EN 61010-031. The link shall

incorporate a spring-loaded connection. Sockets and links shall have a 4mm diameter. The Company can advise on suitable link/socket systems if required.

20.17.6. Cartridge fuses and links shall be the normal means of protection and isolation for control, indication, telecontrol and alarm circuits. They shall be in accordance with BS EN 60269-1

20.17.7. They shall be at a height which can be easily reached without the need for steps.

20.17.8. The fuse or link shall be capable of easy and complete removal for isolation purposes. Alternative means of isolation shall be subject to Company approval.

20.17.9. Fuses and links shall be clearly labelled immediately adjacent to and readily identified with the fixed part of the fuse/link holder. Labels shall be clearly visible from the normal operating position. All fuses and links shall have engraved labels indicating their function (not merely a reference number).

20.18. Insulating Oil

20.18.1. The transformer and all associated oil-filled equipment shall be supplied complete with the first filling of unused, uninhibited, naphthenic mineral oil complying with IEC 60296 transformer oil. The viscosity shall be as defined by an LCSET of -30°C in IEC 60296.

20.18.2. Oil used shall be demonstrated to be free from any corrosive sulphur, likely to lead to the formation of copper sulphide. The oil shall pass the current "state of the art" test for the detection of corrosive sulphur, e.g. ASTM 1275-B or the equivalent test developed by Cigré. Since research into this problem is still ongoing as at the date of publication of this specification, no firm requirements can be defined.

20.18.3. Oil would normally be delivered to site in tanks or drums. Suppliers shall state their intended method of delivery in their Offer. The method must be agreed in advance and satisfy the Company safety and environmental requirements. The oil in every container, drum or tank must be tested for electrical breakdown and moisture content before adding to the transformer.

20.18.4. Once the transformer has been filled, and before initial energising, a water content test shall be carried out. The test shall be repeated approximately one month after energising. The results of both tests shall be recorded in the transformer Equipment Manual. Initial water content shall be less than 10 ppm.

20.18.5. The PCB content of the oil used must not exceed 5ppm. PCB tests shall be carried out after filling the transformer with oil, and after one month. The results of both tests shall be recorded in the site test file and also provided in the transformer Equipment Manual.

20.19. Locking of Valves and Switches

20.19.1. All valves and operational switches shall be capable of padlocking using the Company Standard padlock.

20.20. Maintenance

20.20.1. The Tenderer shall seek to minimise maintenance requirements (e.g. the use of extended life tapchanger contacts) and must state the method and recommended interval of maintenance when submitting the Offer. Wherever possible the unit shall be designed so that inspection and maintenance activities can be performed by operators standing at ground level.

20.20.2. A full working procedures statement shall be provided, which includes work on transformer and tapchanger, filling, emptying and topping up of oil, inspecting and taking samples from Buchholz relays. This shall include consideration of safe means of access and work and environmental issues, comply with CDM regulations and current working at heights legislation. Risk assessments for these activities shall be developed. Any significant risks identified shall be eliminated or reduced by appropriate design modifications or the production of Method Statements. The latter shall be made available to the Company. (The Company will not accept personal suspension methods of working).

21. AUXILIARY TRANSFORMERS, EARTHING & AUXILIARY TRANSFORMERS AND EARTHING TRANSFORMERS

21.1.Overall Requirements

21.1.1. The Company uses three different earthing and / or auxiliary transformers combinations:

i. Auxiliary transformer

ii. Auxiliary / earthing transformer

iii. Earthing transformer

21.1.2. Main transformers with star connected secondary windings require only an *auxiliary transformer* to provide secure 415volt supplies**.** The secondary star points of the main transformer will be taken directly to the NER earthing arrangements via the tank mounted LV neutral CT.

21.1.3. Main transformers with delta connected secondary windings require an *auxiliary and earthing transformer* to provide secure 415volt supplies and a system neutral point on the secondary side of the transformer.

21.1.4. Main transformers with two separate delta secondary windings shall normally use one *auxiliary and earthing transformer* with a Thompson Strap connection as indicated in 19.15 above.

21.1.5. Some applications for two secondary winding transformers will require system earthing on both windings so an earthing transformer will be required for one winding and an *auxiliary and earthing transformer* for the second winding. The Project Specification will define the requirement.

21.2.EAT's with 66kV or 33kV primary windings

21.2.1. Main transformers with a 66kV or 33kV delta connected secondary winding shall have a dedicated **high** impedance earthing transformer which requires no further Neutral Earthing Resistor (NER). This shall be self protecting - i.e the zero sequence current will be limited by the earthing transformer alone. Each earthing transformer shall be designed to limit the prospective earth fault current to continuous full load current equivalent to the main transformer winding rating up to a maximum of 1000Amps. The project Specification will define the requirements and the manufacturer is required to determine the actual positive and negative phase sequence impedance and state in the tender.

21.2.2. For 33kV cable connections the standard connector is - 700 series 1250A to ANSI/IEEE standard 386 - Table 2 Type E.

21.3.EAT's with 11kV primary windings

21.3.1. Main transformers with 11kV delta connected secondary windings shall have a dedicated **low** impedance earthing transformer which will work in series with the NER. The NER (supplied by others) will limit the earth fault current to a maximum of either 1500Amps or 1000 Amps – see Project Specification for details.

- Earthing transformers for use with 1000 Amp NER's will have an approximate Zero Seq Impedance of 4 to 5 ohms per phase with a 30 second rating at 1000 amps. The actual NER value is 6.35ohms.

- Earthing transformers for use with 1500amp NER's will have an approximate Zero Seq Impedance 4 to 5 ohms per phase with a 30 second rating at 1500 amps. The actual NER value is 4.23 ohms.

21.3.2. A positive sequence impedance of 2.5% should be used for 200kVA output.

21.3.3. The tenderer will state the positive and zero sequence impedance values of the earthing transformer to be supplied, designed to match the actual NER value.

21.3.4. The EAT should be designed to prevent through fault current on the 11kV network having any adverse effect on the secondary output of the transformer. i.e prevent overvoltage and harmonics on the 400v output.

21.3.5. For 11kV cable connections the standard connector is – a 600 series 1250A to ANSI/IEEE standard 386 - Table 2 Type D.

21.3.6. Earthing and Auxiliary transformers shall be finished and painted to colour match the main transformer.

21.3.6.1. Detailed Requirements for Auxiliary Transformers

Table 4

Voltage Ratio	66,000/400/230 or 33,000/400/230 or 11,000/400/230
Vector Group	Dyn11 unless otherwise stated in the Project Specification.
Auxiliary output Continuous Maximum Rating kVA	200
Cooling	ONAN.
Terminals	Primary:- 66kV types – bushings. 33kV and 11kV types - cable boxes suitable for 630mm^2 cables with dry terminations only. Secondary:- Cable via 400A TPN 4 pole fuse switch mounted on transformer (the neutral to be non-switchable) with dry terminations only.

21.3.6.2. Detailed Requirements for Auxiliary & Earthing Transformers

Table 5

Voltage Ratio	66,000/400/230V or 33,000/400/230V or 11,000/400/230V
Vector Group	ZNyn11 (fitted with links to provide ZNyn1)
Impedance	High Impedance self protecting types (no further NER) for 66kV and 33kV units. Low impedance for 11kV units (to be used in series with a NER) detailed in the Project Specification
Continuous Maximum Zero Sequence Rating	1000A or 1500A for 30 secs followed by 100A continuous.
Auxiliary output continuous Maximum Rating kVA	200
Cooling	ONAN.
Terminals	Primary:- 66kV types – bushings. 33kV and 11kV types - cable boxes suitable for 630mm^2 cables with dry terminations only. Secondary:-Cable via 400A TPN 4 pole fuse switch mounted on transformer (the neutral to be non-switchable) with dry terminations only.

21.3.6.3. Detailed Requirements for Earthing Transformers

Table 6

Voltage V	66kV or 33kV or 11kV
Vector Group	ZNyn11 (fitted with links to provide ZNyn1)
Impedance	High Impedance self protecting types (no further NER) for 66kV and 33kV units. Low impedance for 11kV units (to be used in series with a NER) detailed in the Project Specification
Continuous Maximum Zero Sequence Rating	1000A or 1500A for 30 secs followed by 100A continuous.
Cooling	ONAN.
Terminals	Primary:- 66kV types – bushings. 33kV and 11kV types - cable boxes suitable for 630mm^2 cables with dry terminations only.

21.1. Primary Cable Type

The primary cable shall be 630mm^2 copper single core XLPE and shall be terminated with separable elbow connectors in the Earthing or Auxiliary transformer cable box. All live metal shall be fully shrouded. The cable screens shall normally be bonded to earth at the main transformer end and kept free of earth (by cutting them short within the termination) at the Earthing/Auxiliary transformer end.

21.1. Secondary Cable Type

The cable connection to secondary side shall be by means of lugs on the feed side of the switchfuse. The terminations shall accommodate a four core SNE cable of 185 mm^2 copper.

21.1. Buchholz Relay

21.1.1. Buchholz relays shall be double element type and of a type approved by the Company. Company approved types are given in the Approved Equipment list Appendix 3. Alternative types will only be accepted if prior approval in writing has been given by the Company. The gas float alarm shall have one pair of contacts and the gas/oil surge device shall have two pairs of contacts all volt free.

21.1.2. Facilities shall be provided for collecting gas samples and bleeding the relay from ground level. It shall also be possible to inject air into the relay to confirm operation of the surge detection element. (Testing by mechanical operation of the surge detection element will not be accepted).

21.1. Pressure Relief Device

21.1.1. A pressure relief device is required, with at least two sets of normally open volt free contacts for trip and simultaneous alarm. Company approved types are given in the Approved Equipment list Appendix 3. Alternative types will only be accepted if prior approval in writing has been given by the Company.

21.1.2. The PRD outlet is to be ducted downwards to within 1000mm of ground level with the open end of the ducting to be vermin proof.

21.1.3. Ducting is to have a removable securable/lockable access cover to enable testing and resetting of PRD and the cover is to be clearly labelled "PRD Test Access".

21.1. Breather

The breather shall be of a dessicant type approved by the Company. Other types will be considered if prior written agreement is obtained from the Company. The dessicant shall not contain Cobalt Chloride. Company approved types of dessicant are given in the Approved Equipment list Appendix 3.

21.1. Current Transformers

21.1.1. See Section 20 for CT general requirements and Appendix A for specific requirements.

21.1.2. Neutral current transformers are required in the 66kV, 33kV and11kV earthing transformers winding neutral connection to be used for LV restricted earth fault differential protection and for standby earth fault protection. The technical specification for the CT is shown in Appendix 1. The P1 markings shall be electrically nearer to the windings than the corresponding P2 markings. Connections from both ends of each CT secondary winding shall be brought out to terminal blocks in a dry terminal chamber. External cables shall connect these terminals to the marshalling kiosk.

21.1.3. The neutral CT's shall be;

- mounted externally to the transformer tank in a dry box
- weatherproof
- accessible for protection testing

21.1. Flux Density

Flux density at normal tap position with rated tap voltage and 50Hz shall be a maximum of 1.9 Tesla.

21.1. Cooling:

Tank mounted radiators are acceptable. Drain and sampling valves are to be provided. Corrugated tank panels will be also be considered.

22. TESTS

22.1. Scope of Tests

22.1.1. The tendered price shall include for all necessary costs to subject each transformer to the appropriate tests at Manufacturer's Works, generally in accordance with IEC 60076 and any additional requirements detailed in this specification. An indication of the testing programme shall be included in the Manufacture and Delivery Schedule. The Tenderer is required to agree the scope and costs of Factory Acceptance Tests and (if applicable) Type Tests and include this information in the Offer. The Company reserves the right to witness any type tests, routine tests and site tests it considers necessary.

22.1.2. A schedule of the required testing giving confirmation of the test dates shall be provided and notified to the Company. The anticipated test dates should be provided as early as possible in the programme, to the Company Technical contact. Once agreed, a minimum of twenty working days notice shall be given of any proposed changes to the Company Technical contact. If necessary the Company Technical contact may defer the proposed dates.

22.1.3. The cost of the appropriate tests as detailed below shall include travel and accommodation for two of the Company representatives to witness such tests. These travel and accommodation costs shall be clearly and separately identified in the Offer and will be subject to adjustment based on actual attendance.

22.1. TYPE TESTS

22.1.1. The Tenderer shall agree with the Company whether Type Tests are required before submitting the Offer. Type Tests shall include

- Temperature rise and cooling
- Noise
- Recurrent Surge Oscillograph for 132kv units only.

22.1.2. If the units offered are of identical design to units which have successfully undergone type tests and are already supplied and proving satisfactory in service within the Company area, further type tests will not normally be required. Previous type test results need to be supplied with the offer.

22.1. Temperature Rise Test:

One transformer of each rating and voltage ratio with its own cooling apparatus shall be tested in accordance with the provisions of IEC 60076.

22.1. Cooling Test:

Transformers with combined natural and forced cooling shall be tested at each specified rating and during these tests, the accuracy of the winding temperature indicators shall be determined.

22.1. Noise Level Test:

22.1.1. Noise levels with and without forced cooling operating in accordance with IEC60076-10. Noise levels shall be measured with the transformer on no load at normal voltage and frequency. Where a transformer has more than one rating, measurements shall be repeated with the cooling system corresponding to each rating in operation.

22.1. Recurrent Surge Oscillograph tests

22.1.1. For new or modified designs of 132kv transformers, in order to determine the most onerous tap position(s) for lightning impulse testing, and to check that internal voltage levels are within design limits**,** RSO measurements are required on all windings and at all tapping positions, with the transformer connections made to be representative of the service condition. These results and a recommendation for the most onerous tap-position shall be submitted for consideration and approval by the purchaser in advance of the commencement of the main test programme. RSO tests shall include measurements on tertiary winding in the loaded and earthed conditions. Where the RSO does not clearly show that one tap position is more onerous than the others, the two extreme tappings and the principal tapping shall be used, one tapping for each of the three individual phases, in accordance with Clause 8 of IEC 60076-3.

22.1. ROUTINE TESTS

Routine tests shall be performed on all units in accordance with IEC 60076, with the addition of;

- Zero Sequence Impedance
- Partial Discharge Tests
- Impulse Tests
- Frequency Response Analysis (this test should be carried out on site)

22.1.1. Dielectric routine tests shall be in accordance with Table 1 of IEC 60076-3. On 132kV transformers lightning impulse tests shall include chopped wave test in accordance with Clause 14 of IEC 60076-3, and shall be carried out

on the most onerous tap position as determined by the recurrent surge oscillograph (RSO) measurements (see Clause 22.6.1 of this specification).

23. COMMISSIONING & SITE TESTING

23.1. Site tests will be in accordance with the Companies requirements for site testing and commissioning. The Tenderer shall provide with the Offer details of the tests he intends to carry out. The Company may require additional tests on site. Test record sheets shall be produced to an agreed basis.

23.1. The following tests shall be carried out as a minimum:

- Core and winding insulation tests including core-lv, core-hv, hv-lv and core-earth. (Earth fault check on arrival to site, before offloading, and also after positioning on the plinth. All measurements to be recorded and compared to previous results, all such tests witnessed/completed to the satisfaction of the Engineer.
- General mechanical checks.
- Ratio and h.v. magnetisation current tests.
- Vector group check.
- Motors - overload protection tests.
- Motor/pumps and motor/fans - Direction of rotation check for correct flow.
- Gas and oil actuated relay device tests.
- Temperature instrument calibration and tests.
- Operational tests on tap change equipment, including continuity test for current flow through tapping cycle for each tap.
- Electric strength tests on insulation oil in the main tank and tapchanger.
- Moisture content and PCB content in the main tank and tapchanger
- DC Resistance Test
- Flick testing of C.T's
- Magnetisation curve of C.T's in situ
- DC Resistance of C.T's

23.1.1. All ancillary equipment including Buchholz, & WTI instruments etc, are to be commissioned to the satisfaction of the Engineer.

- Buchholz relay measurements shall be taken of volume of oil to operate the alarm switch; steady flow to operate trip switch and confirmation of trip operation at low oil level.

23.1. Automatic Voltage Control Equipment

23.1.1. Tests to be carried out on site shall be subject to approval by the Company, to prove compliance with the Specification independently of any tests that may have already been carried out at the manufacturer's works.

23.1.2. At the end of each installation of automatic voltage control equipment, tests shall be carried out, as required, to prove the integrity and compatibility of the automatic voltage control scheme.

23.1. PVC Insulated Auxiliary Cables

23.1.1. Voltage Test - each 600/1000 Volt PVC insulated cable shall after installation and glanding but before connecting tails to equipment terminals be tested at 3.5 kV d.c. During the test the voltage shall be increased gradually to the full value and maintained continuously for 1 minute between conductors and between each conductor and armour without breakdown.

23.1.2. Insulation resistance test - the insulation resistance of each completed cable circuit shall be measured and recorded.

23.1. Current Transformers

23.1.1. Testing shall be carried out in accordance with BS EN 60044-1 and BS EN 185, including, as applicable, the additional tests required for Class Px type current transformers

23.1. Multicore/Multipair Cables

Site Tests shall comply with the requirements of EATS 09-6, issue 6.

24. DELIVERY, INSTALLATION AND HANDOVER

24.1. Delivery and installation will be by prior arrangement only. Delivery shall include all off-loading and any necessary temporary storage.

24.1. Site Specific Risk Assessments and Method Statements for the delivery, off-loading, installation, testing and commissioning will be submitted by the successful Tenderer to the Company at least 15 working days before the activity commences on site.

24.1. Delivery

24.1.1. Prior to delivery, the Tenderer shall visit site and satisfy himself of any constraint regarding delivery. The tendered price shall include for the provision of all equipment necessary for the safe and proper delivery and off loading of the equipment.

24.1.2. The delivery arrangements will be detailed in the Project Specification.

24.1.3. The anticipated delivery date should be provided as early as possible in the programme, to the Contract Delivery Manager. Once agreed, a minimum of 20 working days notice shall be given of any proposed changes. If necessary the Contract Delivery Manager may defer the proposed dates.

24.1. Installation

24.1.1. The Tenderer will comply with the CDM Regs (The Construction Design and Management Regulations).

24.1.2. The role of CDM Co-ordinator and Principal Contractor will be carried out by others, but the Contractor shall fully comply with Principal Contractor's safety regime and may be required to provide the following if requested;

- method statements describing all potential safety risk during the site installation work and methods used to minimise such risk to an acceptable level agreed by the Principal Contractor.

- information relating to any potential hazardous materials to be used during site installation for inclusion by the Principal Contractor in the Safety Plan.

24.1.3. Where installation is required as part of the contract, the Company requires the Tenderer to study any site layout drawings provided, visit site and acquaint himself with any access or installation difficulties. A design and installation strategy must be developed to accommodate any site constraints. The tendered price shall include for the provision of all equipment necessary for the safe and proper installation of the equipment.

24.1.4. The scope of any installation work will be detailed in the Project Specification.

24.1. Handover

24.1.1. At the point of handover to the Company for putting into service, the Tenderer shall submit a signed Handover Certificate to the Company. This will be deemed the take-over date for the equipment.

25. DOCUMENTATION

Information required from Tenderer with the Offer

- A detailed specification.
- A General Arrangement drawing. The Tenderer shall specify any special civil requirements.
- Details of any significant considerations and procedures that may have an impact on Health and Safety matters.
- Where the equipment small wiring uses a numbering system other than EATS 50-19, a wiring schedule and schematic diagram showing the internal connections, functions and internal numbering at the equipment multicore terminal block(s).
- An indicative Plant Manufacture and Delivery Schedule.

Information required from Tenderer immediately after Award of the Contract

- A detailed Plant Manufacture and Delivery Schedule for comment or approval by the Company.
- Estimated magnetisation curves for Current Transformers within ten working days of contract placement.
- Progress reports on Plant Manufacture in writing on a monthly basis.

The Company reserves the right, from time to time, to visit the Tenderer's works to confirm manufacturing progress against the agreed programme.

Information required from Tenderer before delivery

- A complete set of working drawings required for completion of the works covered by the Project Specification. These will include general arrangement, schematic diagrams, wiring diagrams, on or before the agreed dates in the Plant Manufacture and Delivery Schedule.
- Test results on or before the agreed dates in the Plant Manufacture and Delivery Schedule.
- Current Transformer measured magnetisation curves at least ten working days before delivery to site.

- One hard copy of the operating and maintenance manual(s), containing copies of installation and maintenance procedures, all relevant test data and one print of final record drawings, before the plant arrives on site. Two CD copies of the same information shall also be supplied at the same time. The manuals shall clearly indicate any special considerations and procedures for installation, commissioning, use, maintenance, and disposal in respect of Health and Safety issues, environmental regulations and other statutory obligations.

- The successful Tenderer shall complete plant data templates generated by the Companies asset register and send completed templates to the Company at least ten working days before the first delivery of equipment.

Information required from Tenderer after Installation

- "As installed" records, drawings and a contribution to the Health & Safety File, as required by the CDM Regulations, shall be provided not later than twenty working days after handover.

- Health and Safety information is stored in a number of different locations. To accommodate this, the Health and Safety File is divided into discrete sections and contributions to the relevant sections are required.

The full list of sections is given below.

The Tenderer is required to select the appropriate sections from the list below, relevant to the Offer.

a)Description of Project

A brief description of the work undertaken for this project.

b)Residual Hazards

A detailed list of residual hazards, except electrical hazards. The document shall contain information as to how the hazards have been dealt with.

c)Structural Principles

A list of key structural principles. The document should contain details of structural and loading calculations and safe working loads for roads, floors, roofs, bridges and culverts if applicable.

d)Hazardous Materials

A detailed list of hazardous materials on site. The document should contain all details of any necessary precautions for the safe use, maintenance or removal of the materials in the future.

e)Dismantlement

A schedule of dismantlement procedures. The document should list each significant piece of apparatus and detail how the item should be safely dismantled or removed in the future.

f)Operation and Maintenance Manual

An Equipment Manual should be provided for each significant piece of apparatus. The document should provide the information necessary to allow safe operation and maintenance. In particular the document should list recommended methods of safely working at heights (where appropriate) for all normal activities associated with the apparatus. This should take into account fault investigation where reasonably foreseeable.

g)Buildings and Plant Drawing

The Substation Buildings and Plant Drawing shall be updated and approved, by a suitably qualified or experienced person, as being accurate. Where one does not exist, a Substation Buildings and Plant Drawing shall be produced for the entire site.

h)Drainage Layout Drawing

The Substation Drainage Layout shall be updated and approved, by a suitably qualified and experienced person, as being accurate. Where one does not exist, a Substation Drainage Layout shall be produced for the entire site.

i)Substation Circuit Record

The Substation Circuit Record drawing shall be updated and approved, by a suitably qualified and experienced person, as being accurate. Where one does not exist, a Substation Circuit Record shall be produced for the entire site.

j)Electrical Clearance Drawing

For any open terminal equipment a scale drawing should be prepared showing all electrical clearances, in accordance with BS7354 as amended by the Company Design and Construction manual, to demonstrate that the appropriate clearances have been achieved. This drawing should show a plan view and sections appropriate to the layout. Where one does not exist, an Electrical Clearance Diagram should be prepared for the entire site. For some existing equipment on the site, however, actual measured clearances can not be obtained. The drawing shall clearly identify where clearances for existing apparatus have been calculated.

k)Other 'As Installed' Drawings

All other as installed drawings shall be provided once approved by a suitably qualified or experienced person as being accurate. The drawings shall be file referenced in accordance with the Company standard. To prevent inadvertent duplication of numbers, prior to the updating of the as installed drawings, the substation index shall be requested from the Company Network Data Services department. All new drawings shall be suitably indexed and the proposed final index returned to NDS for acceptance. Once the proposed index has been accepted, all drawings should be suitably file referenced and copies returned to the Project Manager.

l)Construction phase Drawings

All construction phase drawings not included in the as installed drawings shall be indexed in the most convenient manner for the Principal Contractor and two copies provided. A printed copy is not required.

m)Commissioning results

Copies of all commissioning results should be provided as Microsoft Word documents, suitably indexed. This document should also include the actual sequence of the tests undertaken, and by whom, together with the date (and if appropriate, the time) the test was undertaken.

26. CONTRACT DRAWINGS

26.1. Electrical symbols on drawings shall comply with BS 3939 or any other convention approved in writing by the Company in advance.

26.1. Contract drawings shall be submitted to the Contract Delivery Manager as paper prints. The Tenderer shall supply any further paper copies required by the Company.

26.1. Drawings shall also be provided in MicroStation (*.DGN) or AutoCAD (*DWG) format. All other files shall be provided as a Microsoft Word documents. Other, commercially available, formats for the electronic version, such as Acrobat Reader (*.PDF), may be accepted by prior agreement. All contract specific drawings are to include the contract reference and the project title. Contract drawings shall be provided on duplicate CD's

26.1. The Company does not as such approve Contract Drawings. If time permits the Company may make comments on the submitted drawings. Such comments may not necessarily be complete, since they are in any event only offered as assistance to the Tenderer.

26.1. All contract drawings shall be provided by the dates detailed in the Project Specification and the agreed Plant Manufacture and Delivery Schedule.

26.1. All wiring diagrams and diagrams of connections shall be point to point and shall incorporate the internal components of all equipment used. Wiring diagrams shall show items of equipment and terminal blocks for connection of external cables approximately in their physical position and in relation to external equipment. Space shall be allowed for the addition of information relating to the external multicore cables.

26.1. Schematic diagrams should show both transformer and control/relay panel connections on the same diagram wherever possible. On all schematic diagrams relays must have their contacts shown adjacent to the coil.

26.1. No drawing shall relate to more than one transformer unless otherwise agreed in writing.

27. OPERATION AND MAINTENANCE MANUALS

27.1. General

27.1.1. An Equipment Manual should be provided for each significant piece of apparatus. The document should provide the information necessary to allow safe operation and maintenance. In particular the document should list recommended methods of safely working at heights (where appropriate) for all normal activities associated with the apparatus. This should take into account fault investigation where reasonably foreseeable.

27.1.2. The manuals shall alert the Company to any hazard inherent in the equipment or likely to arise in the implementation of operating and maintenance procedures.

27.1.3. Manuals shall contain all fully completed manufacturers' drawings; works test certificates / schedules and site test schedules.

27.1.4. Equipment manuals shall be provided in triplicate on a substation-by-substation basis in the following formats: -

- One paper version
- Two electronic versions

The following information would typically be expected to be included within an equipment manual;

- Index
- Technical data
- Application guidance
- Installation guidance
- Commissioning guidance
- Operation guidance
- Maintenance guidance
- Disposal guidance
- Recommended spare parts
- Diagrams and illustrations

a)Index

The index shall be clear and concise and contain references to main topics, diagrams and illustrations. For large manuals it should include a main index and a sub- index.

b)Technical Data

Technical data shall assemble in a concise format relevant technical details of a component or system. It shall provide quick reference to the essential facts and omit all reference to general descriptions, operating and maintenance principles and instructions and the like.

The data should include details of the equipment both for individual items and for the overall system.

c)Application Guidance

Application guidance shall contain information and instructions on how to apply the equipment to an electricity distribution network.

d)Installation Guidance

Installation guidance shall contain procedures and instructions on how to install the equipment. The guidance shall contain as a minimum: -

- Step-by-step procedures for installation
- A list of any special tools or other equipment required

e)Commissioning Guidance

Commissioning guidance shall contain procedures and instructions on how to commission the equipment. The guidance shall contain as a minimum: -

- Step-by-step procedures for commissioning
- Checks to be made, including the limits of operation and other tolerances
- A list of any special tools, test equipment or test instruments required

f)Operation Guidance

Operation guidance shall include step-by-step instructions on how to operate the equipment both with regard to individual items and to the overall system under all patterns of normal and abnormal conditions.

g)Maintenance Guidance

Maintenance guidance shall contain procedures and instructions on how to maintain the equipment. The guidance shall contain as a minimum: -

- Step-by-step procedures for maintenance
- Checks to be made, including the limits of operation and other tolerances
- A fault diagnosis guide (where appropriate)
- A list of any special tools, test equipment or test instruments required
- Recommended frequencies of routine or overhaul requirements

h)Disposal Guidance

Disposal guidance shall contain procedures and instructions on how to safely dispose of the equipment at the end of its useful life. The guidance shall contain as a minimum: -

- Safety requirements, in particular management of any residual hazard
- Environmental requirements, in particular management of environmentally hazardous components

i)Recommended Spares

This section shall comprise the spare part details and full ordering procedures for each item of equipment and shall include: -

- Spare parts list together with referenced sectional drawings from which the manufacturers descriptive name and part number can be clearly identified
- Details of suppliers' address, spare part ordering procedures
- Details of all appropriate plant item reference numbers including serial numbers, type reference numbers, original order numbers etc as required for the immediate and correct supply of spare parts from various original equipment manufacturers

j)Diagrams and Illustrations

There shall be sufficient diagrams and illustrations to complement the descriptions contained within the previous sections, and which collectively clearly describe the equipment. Where related systems are shown on composite diagrams, individual systems shall be identified by colour or some other unambiguous form of coding.

27.1. Manual Format

Electronic copies of equipment manuals shall be supplied in Adobe Acrobat Reader (*.pdf) Release 5 or later format.

A single Adobe Acrobat Reader file encompassing an entire manual is acceptable if sufficient bookmarks are provided to allow a reader to 'jump' within the file to the start of each section. Where bookmarks are not provided separate Adobe Acrobat Reader files shall be prepared for each discrete section of a manual.

Electronic copies of equipment manuals shall be supplied on CD-ROM.

The CD-ROM shall have a permanent adhesive label designed specifically for use on CD-ROMs. The label shall include the following information: -

- Title
- Substation
- Project
- Date
- Contract Reference

27.1. Paper Format

Equipment manuals shall be supplied in A4 size format on white paper of a quality not less than $80gm^{-2}$ either in a bound 'book' or loose leaf form.

Manuals supplied in loose leaf form shall be four-hole punched and inserted within a four-ring white presentation type binder. Each binder shall contain transparent pockets on the spine and front cover for inserting labels.

The insertion of more than one manual per binder is acceptable.

Where all the manuals will not fit inside a single binder the manuals shall be divided into conveniently sized volumes and each volume shall be placed inside a separate binder.

Each binder shall contain complete manuals only and shall be labelled with an appropriate volume number.

Subject dividers shall be provided to segregate binders into individual sections.

Labels shall be inserted into the transparent pockets on the spine and front cover which shall include the following information: -

- Title
- Substation
- Project
- Date
- Contract Reference

28. TERMS and CONDITIONS

28.1. General Terms and Conditions

The Companies' Standard Terms and Conditions shall apply. Specific Terms and Conditions

28.1.1. In the event of any item failing to complete a witnessed test to the agreed programme, the costs of the additional or extended attendance by the Company representatives to witness repeated or re-scheduled tests shall be borne by the Tenderer.

28.1.2. All equipment supplied under this Contract shall remain the responsibility of the Contractor until a Taking-over Certificate is issued by the Company. The Company will not accept any claims for loss of or damage to tools or other equipment etc. left on site.

28.1.3. All equipment supplied under this contract shall be free from any defect whatsoever for a minimum of 5 years.

29. APPENDICES

Appendix 1 – Transformer Specification Summary
Appendix 2 – Project Specification
Appendix 3 – Company Approved Equipment List
Appendix 4 – Sketch of Secondary Cable Arrangement
Appendix 5 – Drawing of Standard Transformer Arrangements
Appendix 6 – Technical Schedules to be completed by manufacturer

30. LIST OF SUPPORTING DOCUMENTS

1. Drawing of Company Standard Transformer Types
2. Schematic Drawing of Voltage Control for Single Secondary Transformer
3. Schematic Drawing of Voltage Control for Double Secondary Transformer
4. Company Approved Equipment List
5. Company Telecontrol Standard
6. Company Interlocking Standard

APPENDIX 1 - TRANSFORMER SPECIFICATION SUMMARY

Company Type	A	B	C	D	E	F	G	H	I	J	K
Nominal Voltage kV	**66/11.5/11.5**	**132/33**	**132/33**	**132/33**	**132/11**	**132/11**	**Not in use**	**132/11/11**	**132/11/11**	**132/66**	**132/66**
Nominal Rating MVA	30/60	22.5/45	45/90	30/60	15/30	15/30		30/60	30/60	30/60	45/90
Vector Group	Yyn0yn0	YNd1/ YNd11	YNd1/ YNd11	YNd1/ YNd11	YNd1/ YNd11	YNyn0		YNd1d1/ YNd11d11	YNyn0yn0	YNd1/ YNd11	YNd1/ YNd11
Short Circuit MVA Primary Secondary	3500 350	5000 1500	5000 1500	5000 1500	5000 350	5000 350		5000 350	5000 350	5000 2500	5000 2500
BIL kV Primary Secondary	325 95	550 170	550 170	550 170	550 95	550 95		550 95	550 95	550 325	550 325
Nominal Impedance on CMR Base	33% HV/LV1+LV2 on 60 MVA 20% HV/LV on 30 MVA HV 13% on 30 MVA LV each 7% on 30 MVA [Alternative 24% on 30MVA 40% on 60MVA]	10% on 45MVA	20% HV/LV on 90 MVA [Alternative 13.5%]	14% on 60MVA	28% HV/LV on 30 MVA	28% HV/LV on 30MVA		40% HV/LV1+LV2 on 60 MVA 24% HV/LV on 30 MVA HV 16% on 30 MVA LV each 8% on 30 MVA	40% HV/LV1+LV2 on 60 MVA 24% HV/LV on 30 MVA HV 16% on 30 MVA LV each 8% on 30 MVA	12% HV/LV on 60 MVA	18% HV/LV on 90MVA
Primary Terminals	Bushings	Bushings	Bushings	Bushings	Bushings	Bushings		Bushings	Bushings	Bushings	Bushings
Primary Neutral	Not Brought Out	Bushing for Solid Earth	Bushing for Solid Earth	Bushing for Solid Earth	Bushing for Solid Earth	Bushing for Solid Earth		Bushing for Solid Earth	Bushing for Solid Earth	Bushing for Solid Earth	Bushing for Solid Earth

APPENDIX 1 - TRANSFORMER SPECIFICATION SUMMARY

Company Type	A	B	C	D	E	F	G	H	I	J	K
Nominal Voltage kV	**66/11.5/11.5**	**132/33**	**132/33**	**132/33**	**132/11**	**132/11**	**Not in use**	**132/11/11**	**132/11/11**	**132/66**	**132/66**
Secondary Terminals	Cable box with 6 sockets for each secy winding	Cable box or boxes	Cable box or boxes	Cable box or boxes	Cable box with 6 sockets	Cable box with 6 sockets		Cable box or boxes with 6 sockets for each secy winding	Cable box or boxes with 6 sockets for each secy winding	Bushing	Bushing
Secondary Neutral	Connector Socket for cable to NER	Provided by Earthing Tx	Provided by Earthing Tx	Provided by Earthing Tx	Provided by Earthing Tx	Connector Socket for cable to NER		Provided by Earthing Transformer	Connector Socket for cable to NER	Provided by Earthing Tx	Provided by Earthing Tx
Transformer main protection **Transformer backup protection** **Feeder Back Up Protection** **Feeder/ Busbar Main Protection**	800/1 Class Px B 800/1 Class 5P20 1200/600/1 5P20 1200/600/1 Class Px A	400/1 Class Px B 400/1 Class 5P20 1200/600/1 5P20 1200/600/1 Class Px A	500/1 Class Px B 500/1 Class 5P20 1200/600/1 5P20 1200/600/1 Class Px A	400/1 Class Px B 400/1 Class 5P20 1200/600/1 5P20 1200/600/1 Class Px A	200/1 Class Px B 200/1 Class 5P20 1200/600/1 5P20 1200/600/1 Class Px A	200/1 Class Px B 200/1 Class 5P20 1200/600/1 5P20 1200/600/1 Class Px A		400/1 Class Px B 400/1 Class 5P20 1200/600/1 5P20 1200/600/1 Class Px A	400/1 Class Px B 400/1 Class 5P20 1200/600/1 5P20 1200/600/1 Class Px A	400/1 Class Px B 400/1 Class 5P20 1200/600/1 5P20 1200/600/1 Class Px A	500/1 Class Px B 500/1 Class 5P20 1200/600/1 5P20 1200/600/1 Class Px A
HV Winding Temperature "L2" phase only	656/5 Class 3	246/5 Class 3	492/5 Class 3	328/5 Class 3	164/5 Class 3	164/5 Class 3		328/5 Class 3	328/5 Class 3	328/5 Class 3	492/5 Class 3
HV Neutral CTs REF	Not Brought Out	400/1 Class Px B	500/1 Class Px B	400/1 Class Px B	200/1 Class Px B	200/1 Class Px B		400/1 Class Px B	400/1 Class Px B	400/1 Class Px B	500/1 Class Px B

APPENDIX 1 - TRANSFORMER SPECIFICATION SUMMARY

Company Type	A	B	C	D	E	F	G	H	I	J	K
Nominal Voltage kV	**66/11.5/11.5**	**132/33**	**132/33**	**132/33**	**132/11**	**132/11**	**Not in use**	**132/11/11**	**132/11/11**	**132/66**	**132/66**
LV Winding Temperature "L2" phase only	1506/5 Class3	787/5 Class3	1575/5 Class3	1050/5 Class3	1575/5 Class3	1575/5 Class3		1575/5 Class3	1575/5 Class3	525/5 Class3	787/5 Class3
LV Neutral CTs REF **STBY E/F**	2000/1 Class Px B 2000/1 Class 5P10	2000/1 Class Px B 2000/1 Class 5P10	2000/1 Class Px B 2000/1 Class 5P10	2000/1 Class Px B 2000/1 Class 5P10	2000/1 Class Px B 2000/1 Class 5P10	2000/1 Class Px B 2000/1 Class 5P10		2000/1 Class Px B 2000/1 Class 5P10	2000/1 Class Px B 2000/1 Class 5P10	800/1 Class Px B 800/1 Class 5P10	800/1 Class Px B 800/1 Class 5P10
Max Noise dB(A)	65	65	65	65	65	65		65	65	65	65
Max Iron Loss KW **Max Copper loss KW @ CMR**	20 400	15 250	30 300	20 280	10 200	10 200		20 380	20 380	20 220	30 250

Note: Primary Bushing CTs (bottom of list is closest to winding)

APPENDIX 2 - PROJECT SPECIFICATION

A suitably authorised Company's representative shall complete this section before proceeding to tender. The Tenderer shall complete all remaining sections at enquiry stage.

Project Details

	Company	Supplier Comments
Project Title		
Delivery Address		
Delivery Date Required		
Project Reference Number		

Contact Details

	Company Representative Details		Manufacturer / Supplier details	
	Name	**Contact Details**	**Name**	**Contact Details**
Contract Delivery Manager				
Procurement Contact	**Brian Stanbridge**	**brain.stanbridge@central-networks.co.uk 07710 012177**		
Technical Contact	**Zhao Ma**	**Zhao.ma@central-networks.co.uk 07989 700217**		
Address for General Correspondence				
Address for Invoicing	**Jill Graham, jill.graham@central-networks.co.uk Settlements Officer, Infrastructure Services, Central Networks, Pegasus Business Park Castle Donington, Derbyshire, DE74 2TU**			

Technical Options

	Options	Company Notes	Supplier Comments
A	POWER TRANSFORMERS		
A1	Number of power transformers required:		
A2	Substation Name		
A3	Transformer nameplate designation(s):		
A4	Main Transformer Type: (State A,B,C,D, E, F, H, I , J or K) State Voltage ratio: State Power Rating: State Impedance:		
A5	Vector Group(s):		
A6	Vector Group connection required on delivery:		
A7	Thompson strap connected: Yes /No/ NA		
A8	Line drop compensation CT required: Yes /No (CT normally supplied in switchgear)		
A9	HV co-ordinating rods: Inboard / Outboard		
A10	Extended HV turrets to accommodate future noise enclosure: Yes / No		
A11	Cooler handing (Looking at HV bushing side): LHS / RHS		

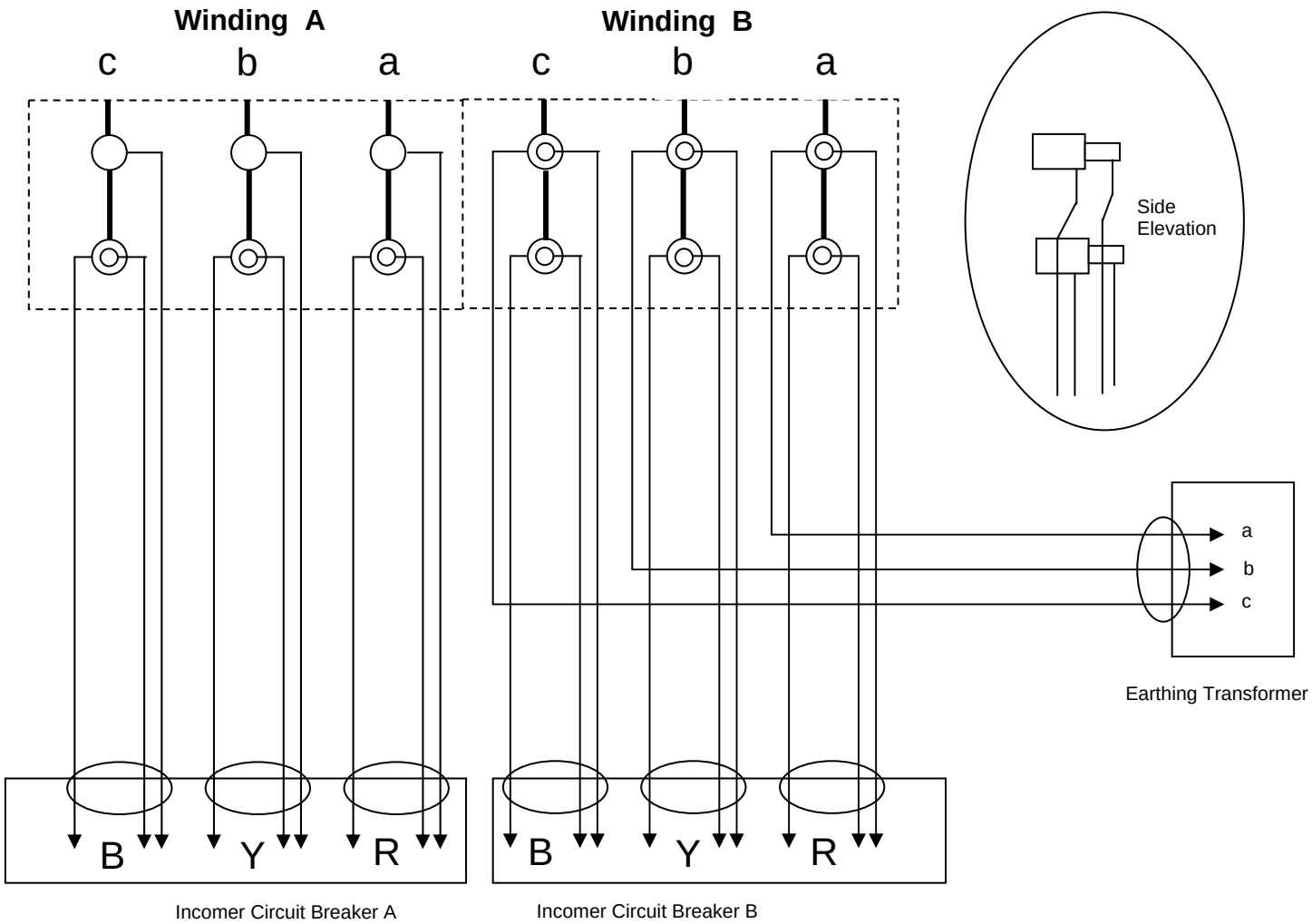
	Options	Company Notes	Supplier Comments
B	EARTHING / AUXILIARY TRANSFORMERS		
B1	Number of Earthing / Auxiliary transformers (EAT) required		
B2	Earthing / Auxiliary Transformer (EAT) nameplate designation(s):		
B3	Earthing / Auxiliary transformer (EAT) ratio:		
B4	EAT Vector Group connection required: ZNyn11 or ZNyn1		
C	EARTHING TRANSFORMERS		
C1	Number of Earthing transformer (ET) required.		
C2	Earthing Transformer (ET) nameplate designation(s):		
C3	ET Vector Group connection required. ZNyn11 or ZNyn1		
D	FURTHER INFORMATION FOR EARTHING / AUXILIARY TRANSFORMERS & EARTHING TRANSFORMERS		
D1	EAT and ET Impedance - High / Low (High for 66kv and 33kv, Low for 11kV types)		
D2	For high impedance ET's and EAT's: Maximum zero phase sequence current.		
D3	For Low impedance ET's and EAT's: NER to be used on 11kV secondary systems - 1000Amp or 1500Amp		

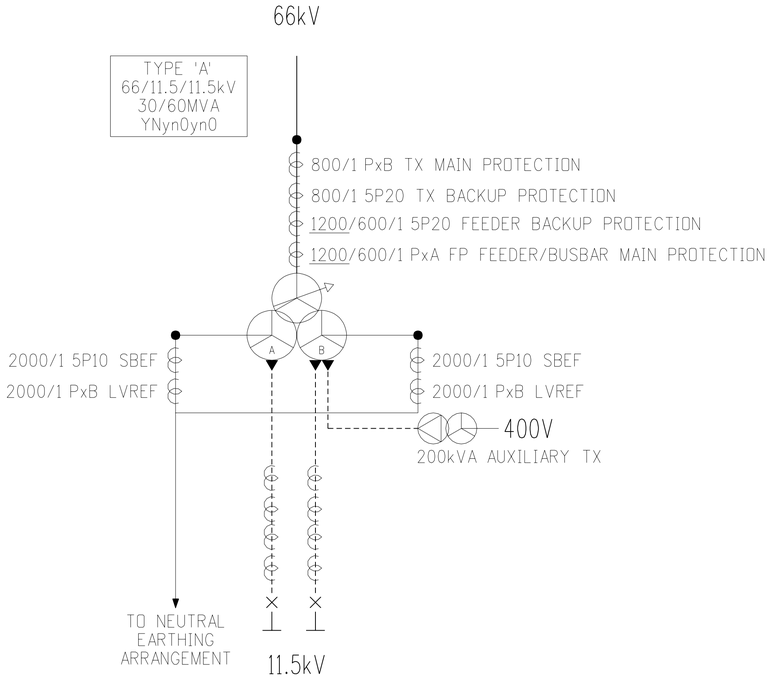
	Options	Company Notes	Supplier Comments
E	AUXILIARY TRANSFORMER ONLY		
E1	Auxiliary transformer required: Yes / No		
E2	Auxiliary transformer ratio:		
F	GENERAL		
F1	Is a free standing Indoor Standby AVC panel required (normally supplied by others)? Yes /No		
F2	Plant manufacturing and delivery schedule is required by:		
F3	Drawings to be submitted by:		
F4	Type tests required (first of a new type?): Yes / No		

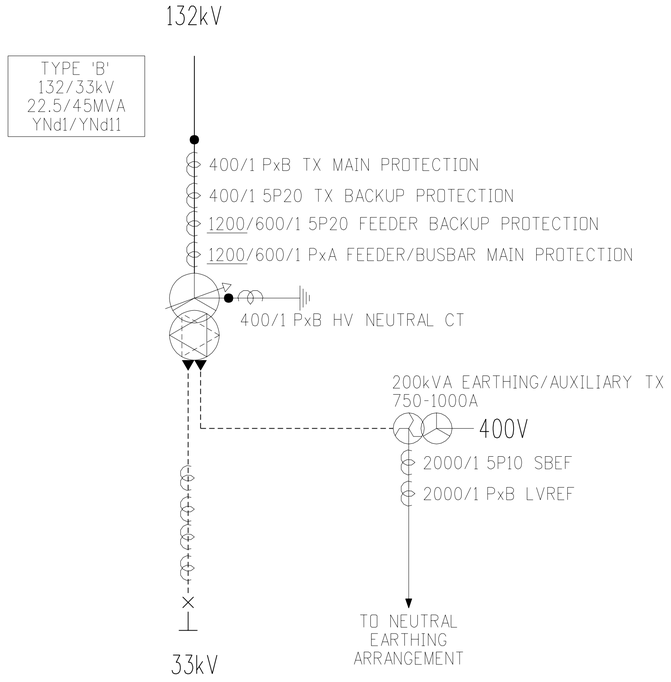
APPENDIX 3 - COMPANY APPROVED EQUIPMENT

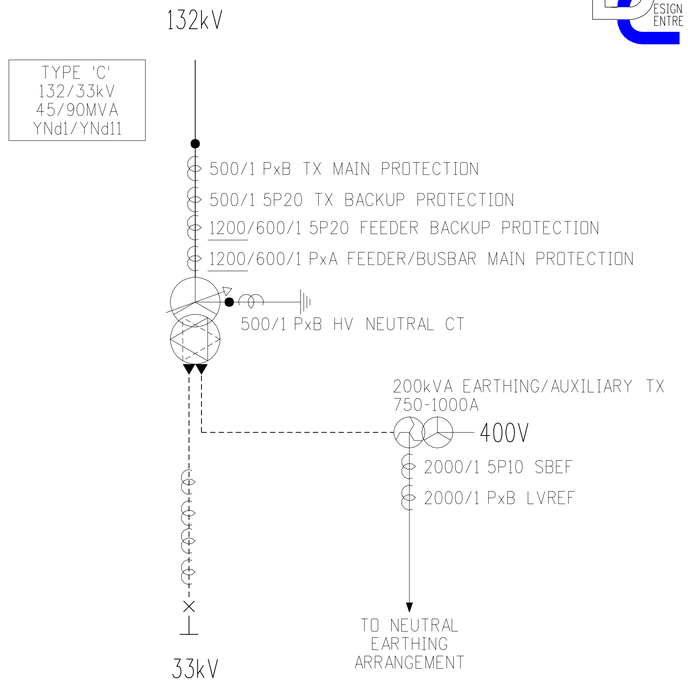
Equipment	**Manufacturer**
Buchholz Relays	P&B Weir – Double Element Reed Switch Type
Dessicant Breathers	Brownell
Anti Vibration Pads	McClellan, Whitby Chandler, Sylomer S600
Dessicants	Envirogel
Oil Suppliers	Nynas, Technol
Pressure Relief Devices	Qualitrol type 208-007-04
Rise In Pressure Sensing Devices	RS2001 type flow detector
Stackable Connectors	NEXAN Euromold, Langley, RTE K675LR/N/630/KM11-2 P2.
Winding Temperature Indicators	Ashridge 852 Plus

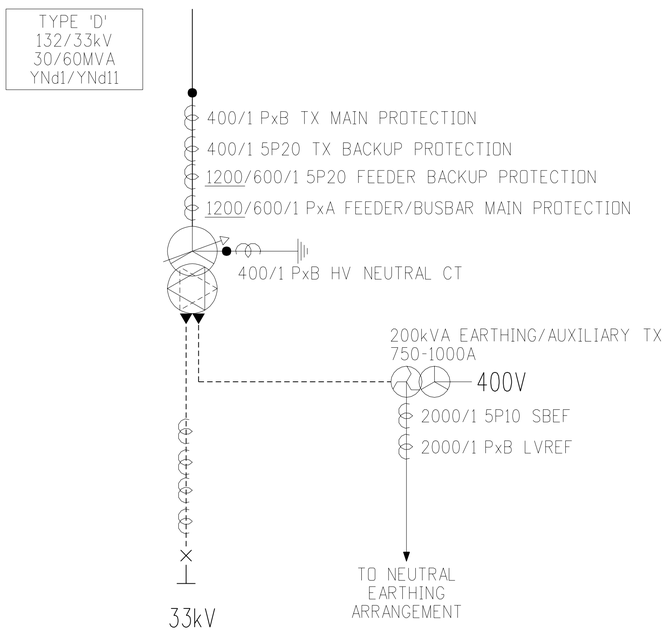
APPENDIX 4 - Arrangement of Single Core Cables for Double Delta Secondary Transformers (With Thompson Strap Installed)

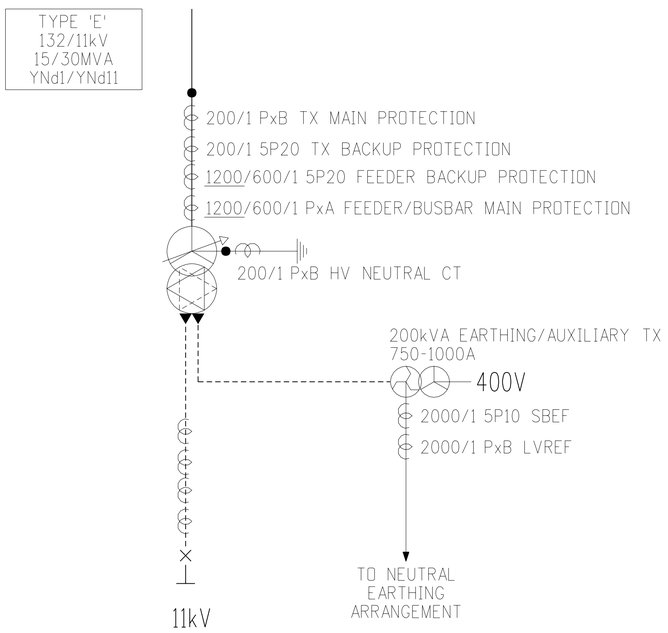








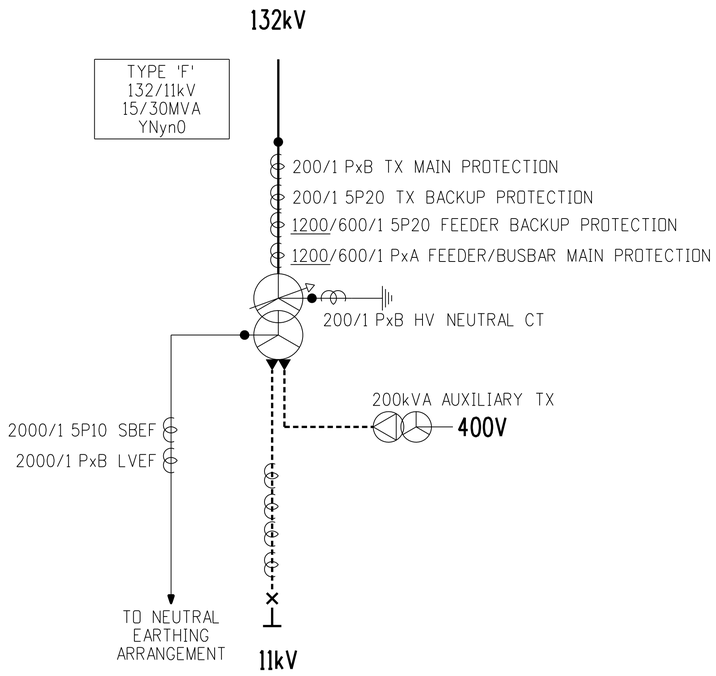


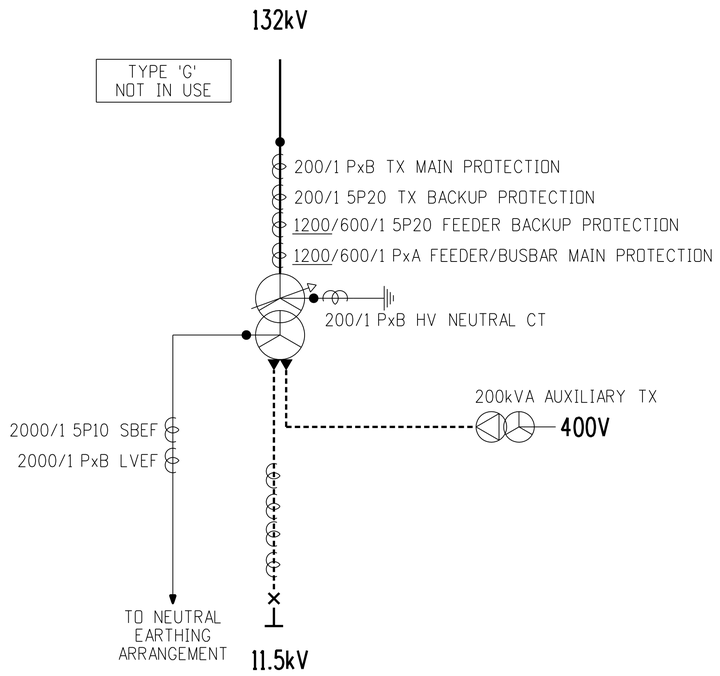


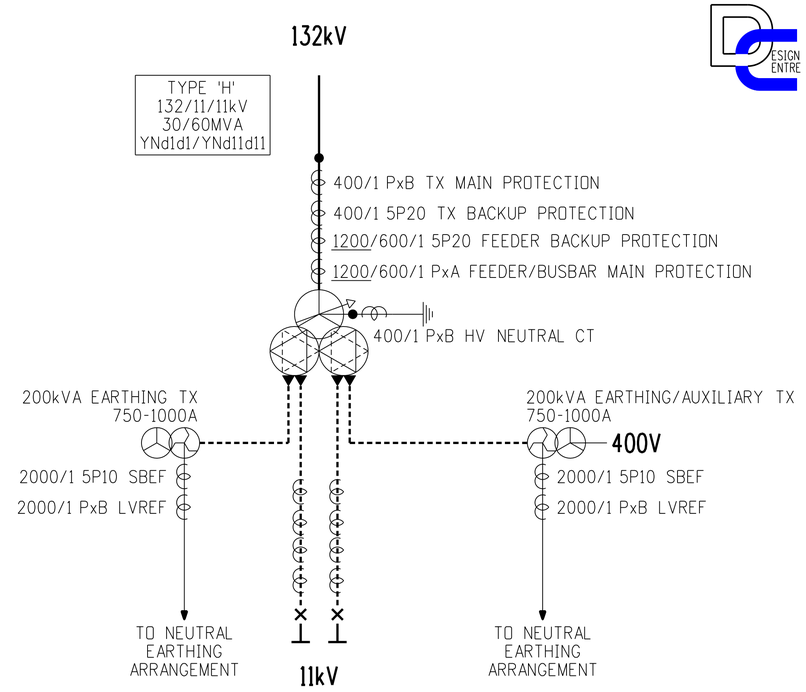
ISSUE	DATE	ISSUE	DATE	ISSUE	DATE	SCALE	N.T.S.	Central Networks (A company of E.ON)
-	-	-	-	A	28/03/07	DATE	14/12/06	
				C.T. RATIOS CHANGED TO MATCH C.N. TX SPECIFICATION.		DRAWN	D.C.W.	TITLE: CENTRAL NETWORKS GRID TX SPEC. STANDARD TRANSFORMER ARRANGEMENT. SHEET 1.
						CAD BY	E.J.K.	
						CHECKED	-	DRG No: E100/100 SHT 1
						APPROVED	-	

DRG No: E100/100 SHT 1

A1

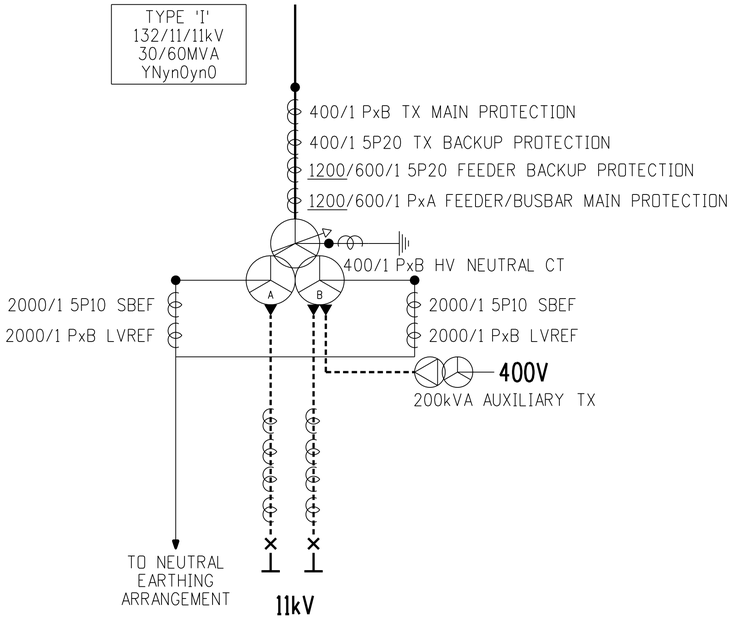


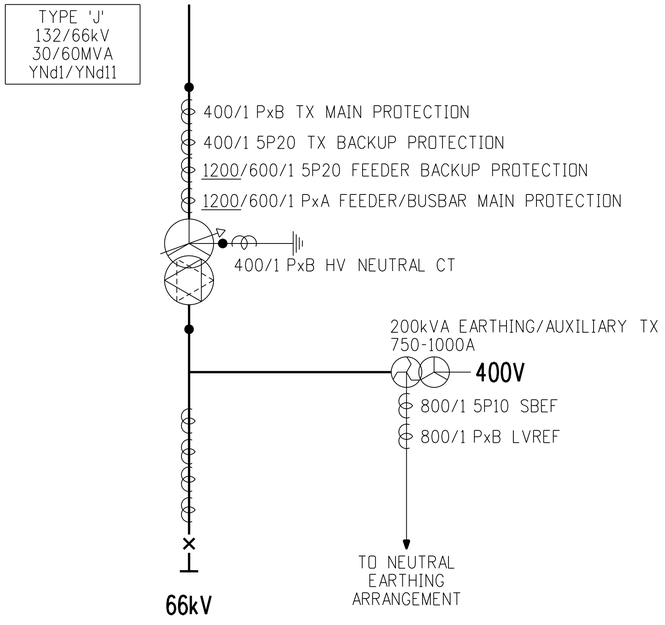


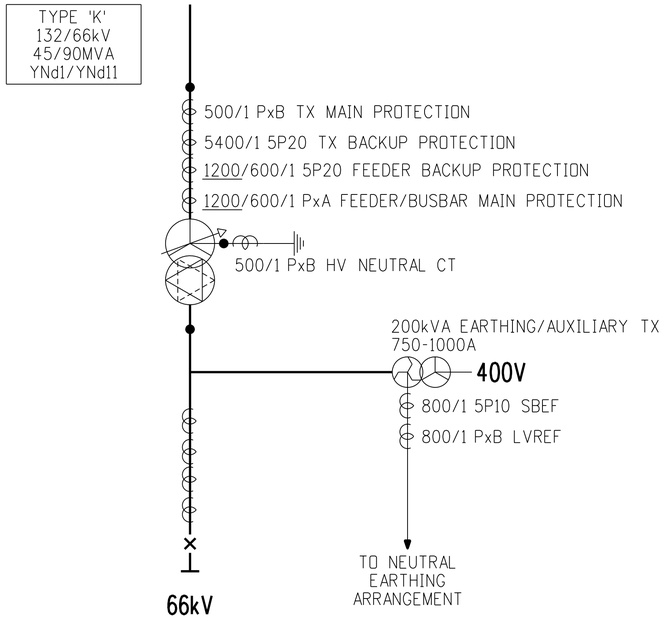


NOTE.

ONLY ONE EARTHING TRANSFORMER REQUIRED IF THOMPSON STRAP USED.







ISSUE	DATE	ISSUE	DATE	ISSUE	DATE	SCALE	N.T.S.	Central Networks A company of E.on
-	-	B	15/02/08	A	28/03/07	DATE	14/12/06	
		TRANSFORMER TYPE 'G' NOT IN USE. DCW/EJK		CT RATIOS CHANGED TO MATCH C.N. TX SPECIFICATION.		DRAWN	D.C.W.	TITLE: CENTRAL NETWORKS GRID TX SPEC. STANDARD TRANSFORMER ARRANGEMENT. SHEET 2.
						CAD BY	E.J.K.	
						CHECKED	-	DRG No: E100/100 SHT 2
						APPROVED	-	

DRG No: E100/100 SHT 2

A1

APPENDIX 6 - TECHNICAL SCHEDULES TO BE COMPLETED BY THE MANUFACTURER

Item	Description	Details
	MAGNETIC CIRCUIT	
1	Core construction: (a)Taped/Banded/Bolted limbs (b)Taped/Banded/Bolted yokes (c)Number of limbs (d)Number of limbs wound	
2	Insulation of: (a) Core bolts (b) Core bolt washers (c) Side plates (d) Core laminations	
3	Whether tank or other flux shields are incorporated Yes/No (If "YES" a full description to be supplied with the Tender)	
4	Flux density in the core: (a) Maximum value at rated voltage, 50 Hz, normal tap: (i) wound limbs Tesla (ii) yokes Tesla (iii) shields associated with magnetic circuit Tesla (iv) tank shields Tesla (b) Maximum value under any condition of voltage and frequency specified in the Schedules in Part D: (i) wound limbs Tesla (ii) yokes Tesla (iii) shields associated with magnetic circuit Tesla (iv) tank shields Tesla	
	WINDINGS	

Item	Description	Details
5	Winding types eg interleaved disc, helical etc: (a) HV windings (b) LV windings (c) Tapping windings (as applicable) (d) Winding sequence,ie Core/___/___/___/___	
6	Arrangement of tappings (Linear, Coarse/Fine, Reversing)	
7	Type of tap changer: (a) Neutral end (b) Line end (c) Separate tank design (d) In-tank design in separate tank	
8	Conductor material for : (a) HV windings (b) LV windings (c) Tapping windings (as applicable)	
9	Conductor insulation: (a) HV windings (b) LV windings (c) Tapping windings	
10	Oil circulation (ie Natural/Partially directed/Directed: (a) To the windings: (i) HV windings (ii) LV windings (iii) Tapping windings (b) Through the windings: (i) HV windings (ii) LV windings (iii) Tapping windings	
11	Short circuit capability: (a) Potential axial thrust for worst fault condition of each winding: (i) HV windings tonnes	

Item	Description	Details
	(ii) LV windings tonnes (iii) Tapping windings tonnes (b) Coil clamping short circuit withstand capacity: (i) HV windings tonnes (ii) LV windings tonnes (iii) Tapping windings tonnes	
12	Current density in windings (at normal tapping position): (a) HV windings (at rated power) A/mm^2 (b) LV windings (at rated power) A/mm^2 (c) Tapping windings (at rated power) A/mm^2	
	PERFORMANCE CHARACTERISTICS	
13	No-load loss at rated voltage, 50 Hz and normal tapping (excluding cooling plant loss) kW (Guaranteed parameter)	
14	Magnetising current (not guaranteed) at: (a) 90% voltage Amps (b) 100% voltage Amps (c) 110% voltage Amps	
15	Cooling plant loss kW	
16	Load losses at rated power and 75°C (a) On normal tapping: (i) HV/LV (guaranteed parameter) kW (b) On tapping for maximum loss: Tap position number (i) HV/LV kW	
17	Maximum volts per step as seen by on-load tap changer at system highest voltage (a) At maximum tapping kV/step kV (b) At minimum tapping kV/step kV	
18	Impedance voltage at rated power and 75°C: (a) On normal tapping:	

Item	Description	Details
	HV/LV %	
	(b) Impedance on minimum tapping:	
	Tap position number	
	HV/LV %	
	(c) Impedance on maximum tapping:	
	Tap position number	
	HV/LV %	
19	Demonstrable zero phase sequence impedance at 75°C and on normal tapping, referred to HV side, at 10% full load current in each phase winding (tertiary terminal open circuit):	
	(a) HV-N (HV- /N) Ω/phase	
	[Connect A-B-C: a-b-c open circuit: supply ABC to YN]	
	(b) HV-LV//N Ω/phase	
	[Connect A-B-C: Connect a-b-c-YN: supply ABC to YN]	
20	Calculated zero phase sequence impedance at 75°C and on normal tapping, referred to HV side, assuming rated voltage (single phase) applied between line terminals and neutral:	
	(a) Z_H Ω/phase (approx)	
	(b) Z_L Ω/phase (approx)	
21	Hottest spot winding temperature, most onerous tap position (ambient air temperature 20°C): Tap No.	
	(a) At rated power (tertiary windings not loaded):	
	(i) HV °C	
	(ii) LV °C	
22	Maximum observable oil temperature (ambient air temperature 20°C):	
	(a) At rated power :	
	(i) top oil °C	
	(ii) at inlet to cooler °C	
	(iii) at outlet from cooler °C	
	(b) At ONAN rating:	
	(i) top oil °C	
23	Anticipated hottest spot winding temperature:	
	(a) Emergency cyclic loading conditions:	
	(i) HV °C	

Item	Description	Details
	(ii) LV °C (b) With 1.3 pu loading for 8 hours at 20°C ambient temperature with pre-load of 0.65 pu °C	
24	Percentage of sum of load and no-load losses, at rated power, that will be supplied during temperature rise tests %	
25	Calculated winding capacitance: (a) Approximate series capacitance of each phase winding: (i) HV pF (ii) LV pF (b) Approximate shunt capacitance to earth of each phase winding with core and tank earthed: (i) HV to earth with LV winding unearthed pF (ii) LV to earth with LV winding unearthed pF (c) Approximate capacitance HV to LV phase winding with LV winding un-earthed pF	
26	Guaranteed sound power level: (a) main unit dB(A) (b) cooler bank dB(A)	
	TANK AND COOLER	
27	Tank material	
28	Thickness of tank: (a) sides mm (b) base mm (c) cover mm	
29	Whether tank base suitable for air cushion equipment	
30	Thickness of radiator plates and/or cooling tubes. mm	
31	Total oil required, including cooling system litres	
32	Volume of oil to be removed to effect in-situ change of: (a) HV bushing litres (b) LV bushing litres (c) Fitting of bushing turret litres	

Item	Description	Details
33	Total volume of conservator(s) litres	
34	Volume of oil in (each) conservator between highest and lowest visible levels litres	
35	Height of oil above pad level at maximum level in the conservator(s) metres	
36	Total number of oil pumps	
37	Output of each oil pump under service conditions: (a) quantity litres/sec (b) head metres head of oil (approx)	
38	Continuous rating of each oil pump motor shaft kW	
39	Starting current of each pump motor Amps	
40	Rated normal output of each fan (a) Quantity m^3/s (b) Head mm water gauge	
41	Total number of fans	
42	Nominal diameter of fans mm	
43	Speed of fans rpm	
44	Continuous rating of each fan motor shaft kW	
45	Starting current of each fan motor Amps	
46	Maximum temperature of tank surface, measured from ground level: (a) at rated power and at 20°C ambient: (i) above 2.6 metres °C Location (ii) below 2.6 metres °C Location (b) under cyclic load at 10°C ambient: °C Location	
	GENERAL	
47	Filling medium for transport	
48	Total weight as installed for service, including cooling plant, all	

Item	Description		Details
	fittings and oil:		
	(a) quotation estimate	tonnes	
	(b) final design calculation	tonnes	
49	Weight arranged for transport:		
	(a) excluding vehicle	tonnes	
	(b) including vehicle	tonnes	
50	Weight of each individual cooler, including oil	tonnes	
51	Weight of each bushing insulator:		
	(a) HV	kg	
	(b) LV	kg	
	(c) Neutral	kg	
52	Tanks, conservators and oil filled compartments:		
	(a) permanent deflection after vacuum test:		
	(i) tank	mm	
	(ii) conservator	mm	
	(iii) other oil filled compartments [specify]	mm	
	(b) Permanent deflection after oil pressure test:		
	(i) tank	mm	
	(ii) conservator mm		
	(iii) other oil filled compartments [specify]	mm	