

**TITLE****TECHNICAL SPECIFICATION
FOR SEAWORTHY PACKING
FOR EXPORT JOBS**

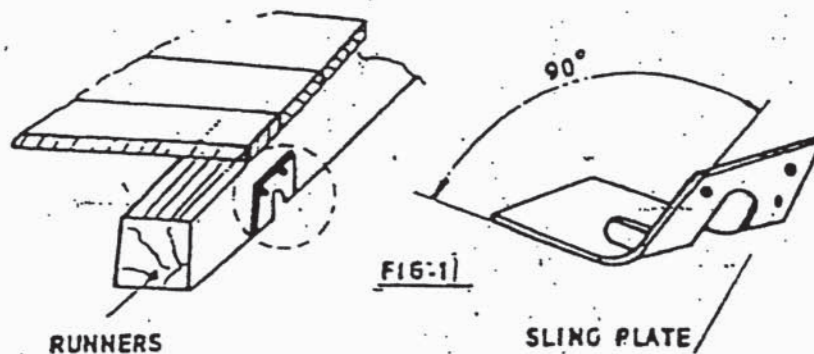
SPECIFICATION NO. PE-TS-888-100-A001

VOLUME II B

SECTION D

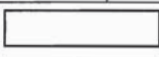
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**ARRANGEMENT OF SLING & PLATE ON
CASES**

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TABLE-1

LOADS	LENGTHS OF SLIDES						
	600	800	1000	1200	1300	1500	2000
	Cross section b x c						
500	50 X 100	50 X 100	50 X 100	50 X 100	75 X 100	75 X 100	100 X 100
800	50 X 100	50 X 100	75 X 100	75 X 100	75 X 100	75 X 100	100 X 100
1000	75 X 100	75 X 100	75 X 100	100 X 100	100 X 100	100 X 110	100 X 150
1500	75 X 100	75 X 100	100 X 100	100 X 100	100 X 100	100 X 150	100 X 150
2000	75 X 100	100 X 100	100 X 100	100 X 150	100 X 150	100 X 150	150 X 150
2500	75 X 100	100 X 100	100 X 150	100 X 150	100 X 150	150 X 150	150 X 150
3000	100 X 100	100 X 150	150 X 150	150 X 150	150 X 150	150 X 150	150 X 150

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Table-2

End and side panels	Width of the panel "W"	Distance between longitudinal support (Dimension "D")						
		600	800	1000	1200	1400	1600	1800
		Cross section b x c				Item 1 to 7		
Fig- 5 to Fig-9	600 to 1200	30 X 100	30 X 100	30 X 100	30 X 130	30 X 130	30 X 130	30 X 130
	1201 to 1600	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130
	1601 to 2000	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130
	2001 to 3000	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	30 X 130	40 X 150
	3001 to 4000	40 X 150	40 X 150	40 X 150	40 X 150	40 X 150	40 X 150	40 X 150

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INDICATION MARKS ON CASES/BOXES/CRATES

Designation	Symbol	Explanation
Fragile, Handle with care		The symbol should be applied to easily broken cargoes. Cargoes marked with this symbol should be handled carefully and should never be tipped over or slung.
Use no hooks		Any other kind of point load should also be avoided with cargoes marked with this symbol. The symbol does not automatically prohibit the use of the plate hooks used for handling bagged cargo.
Top		The package must always be transported, handled and stored in such a way that the arrows always point upwards. Rolling, swinging, severe tipping or tumbling or other such handling must be avoided.
Keep away from heat (solar radiation)		Compliance with the symbol is best achieved if the cargo is kept under the coolest possible conditions. In any event, it must be kept away from additional sources of heat. It may be appropriate to enquire whether prevailing or anticipated temperatures may be harmful.
Protect from heat and radioactive sources		Stowage as for the preceding symbol. The cargo must additionally be protected from radioactivity.
Sling here		The symbol indicates merely where the cargo should be slung, but not the method of lifting. If the symbols are applied equidistant from the middle or center of gravity, the package will hang level if the slings are of identical length. If this is not the case, the slinging equipment must be shortened on one side.
Keep dry		Cargo bearing this symbol must be protected from excessive humidity and must accordingly be stored under cover. If particularly large or bulky packages cannot be stored in warehouses or sheds, they must be carefully covered with tarpaulins.

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Center of gravity		This symbol is intended to provide a clear indication of the position of the center of gravity. To be meaningful, this symbol should only be used where the center of gravity is not central. The meaning is unambiguous if the symbol is applied onto two upright surfaces at right angles to each other.
No hand truck here		The absence of this symbol on packages amounts to permission to use a hand truck on them.
Stacking limitation		The maximum stacking load must be stated as "... kg max.". Since such marking is sensible only on packages with little loading capacity, cargo bearing this symbol should be stowed in the uppermost layer.
Clamp here		Stating that the package may be clamped at the indicated point is logically equivalent to a prohibition of clamping anywhere else.
Temperature limitations		According to regulations, the symbol should either be provided with the suffix "...°C" for a specific temperature or, in the case of a temperature range, with an upper ("...°C max.") and lower ("...°C min.") temperature limit. The corresponding temperatures or temperature limits should also be noted on the consignment note.
Do not use forklift truck here		This symbol should only be applied to the sides where the forklift truck cannot be used. Absence of the symbol on other sides of the package amounts to permission to use forklift trucks on these sides.
Electrostatic sensitive device		Contact with packages bearing this symbol should be avoided at low levels of relative humidity, especially if insulating footwear is being worn or the ground/floor is nonconductive. Low levels of relative humidity must in particular be expected on hot, dry summer days and very cold winter days.

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Do not destroy barrier		A barrier layer which is (virtually) impermeable to water vapor and contains desiccants for corrosion protection is located beneath the outer packaging. This protection will be ineffective if the barrier layer is damaged. Since the symbol has not yet been approved by the ISO, puncturing of the outer shell must in particular be avoided for any packages bearing the words "Packed with desiccants".
Tear off here		This symbol is intended only for the receiver.

FIG-12

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BHEL-PEM-DELHI-INDIA			
CONSIGNEE			
MATERIAL			
CUSTOMER REF.	MO. NO.		
DESPATCH ADVICE NOTE NO.	CASE NO.		
DIMENSIONS(MM) LXBXH		NET WT -KGS	GROSS WT -KGS
SPECIAL INSTRUCTIONS	HANDLE WITH CARE -- KEEP DRY DO NOT DROP -- DO NOT TILT		

FIG-13: MARKING PLATE



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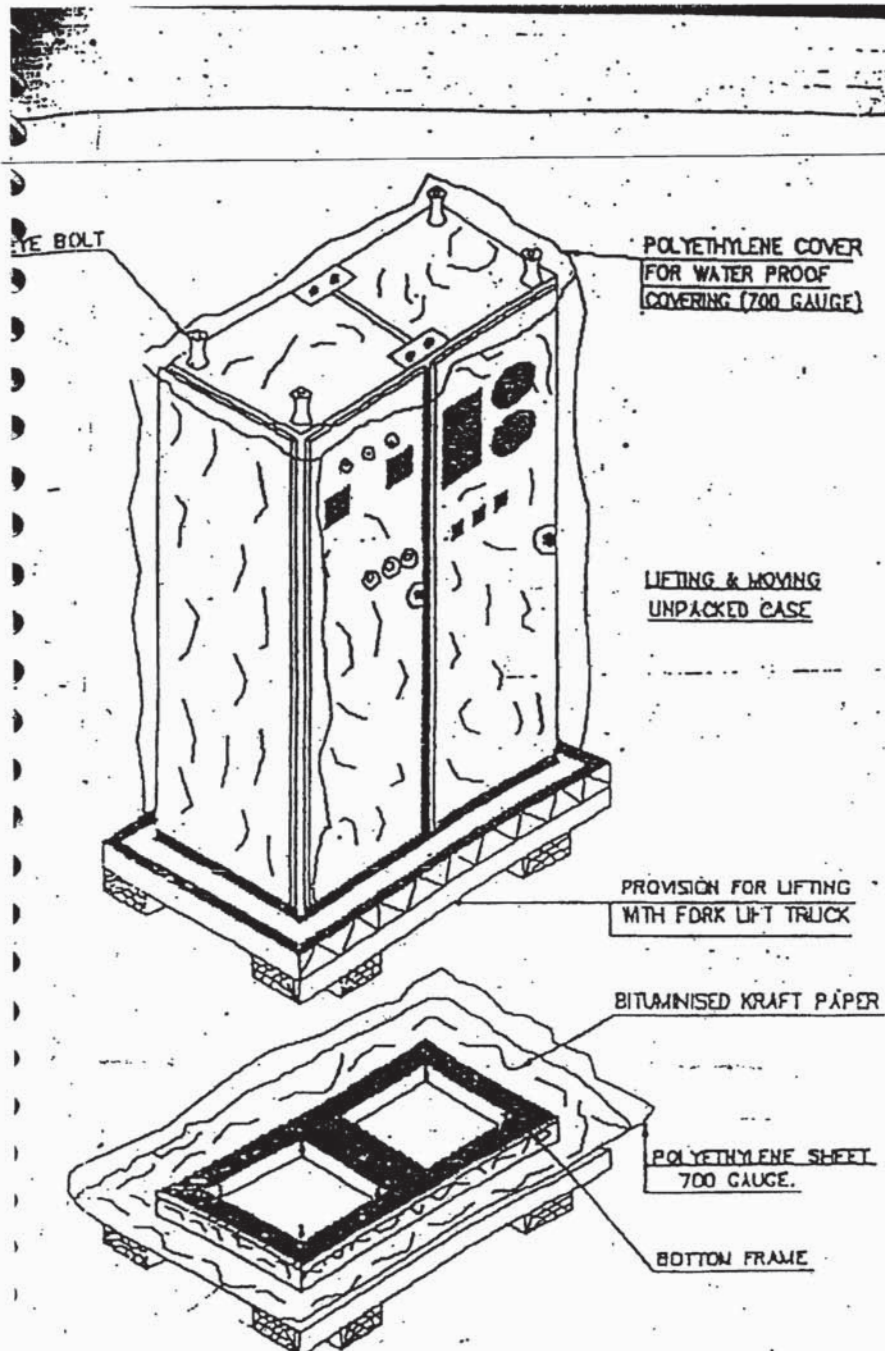


FIGURE-14



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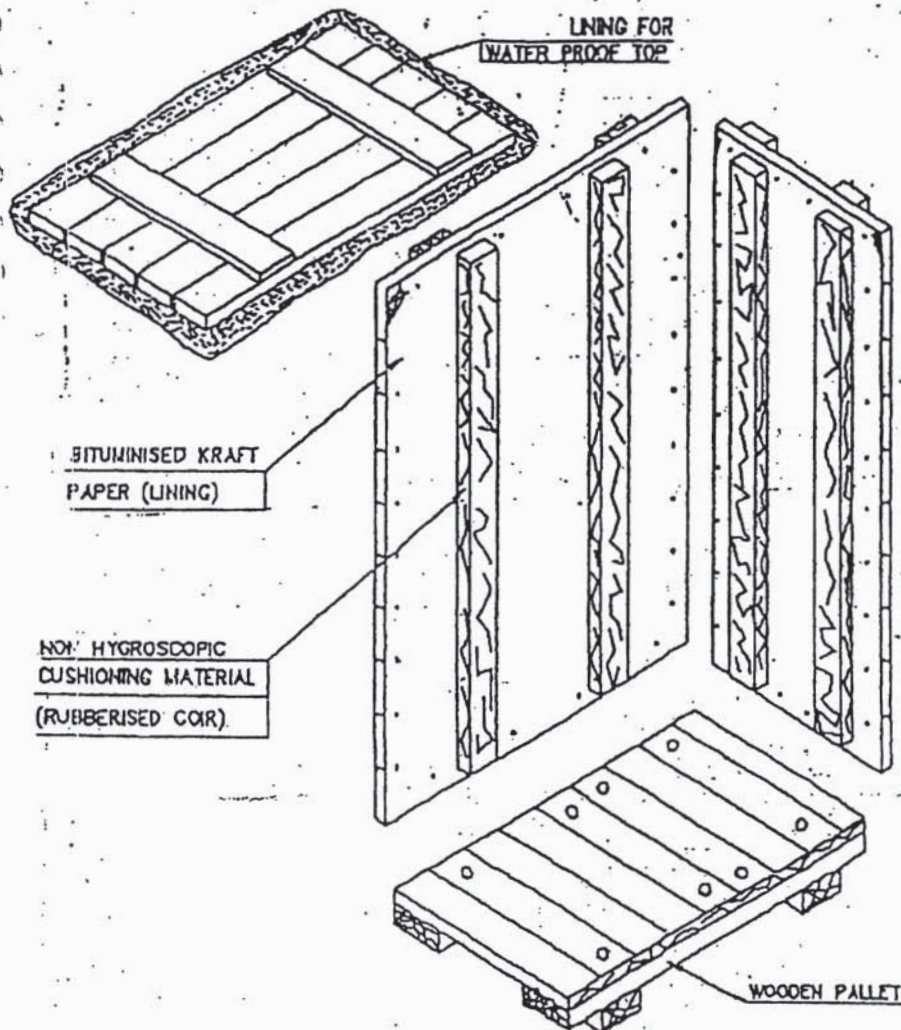
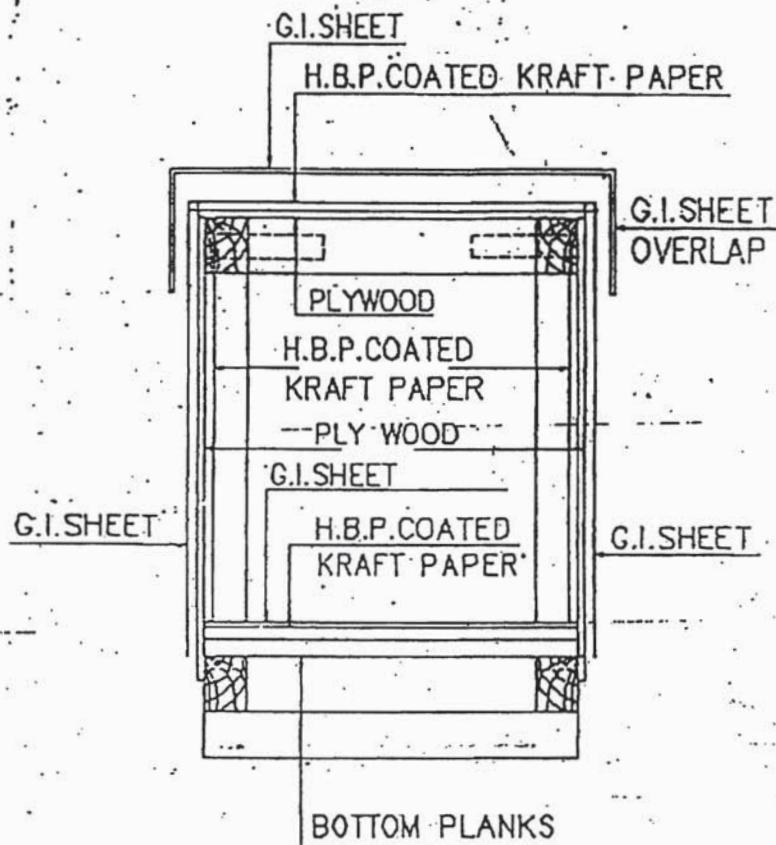


FIGURE-15

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**FIG-16 : CLOSED PACKING CASE WITH G.I.SHEET
SHOWING LAYERS OF PACKING MATERIALS.**

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10.0 TYPICAL PACKING DETAILS/PROCEDURE FOR MECHANICAL ITEMS

10.1 INSULATION MATERIAL (MINERAL WOOL MATTRESSES)

This specification covers the requirements of seaworthy packing and marking for bonded mineral (rock) wool mattresses having metallic hexagonal wire netting as facing on one or both sides.

10.1.1 TYPE OF CONSTRUCTION

Mattress shall be packed in Polythene (of 0.2 mm thickness) all around and sealed to prevent moisture absorption during transit and storage. Further it shall be wrapped with Bitumen coated Polythene bonded/lined Hessian and stitched and then packed in 5 ply DFC carton box.

Silica gel is used for this purpose to protect contents over sufficiently long time from corrosion. Silica gel shall be of indicating type conforming to IS:304-1979 packed in cotton bags placed at different positions inside the packing for absorbing moisture and shall not come into direct contact with the material inside the package. The quantity of silica gel shall be enough for storage period of one year. However, it shall not be less than 4 gms per litre volume of case subject to minimum of 400 gms per case.

Each mattress as well as the packages shall be serial numbered. Also, printed sheets indicating the nominal thickness, density and wire netting details (i.e. material and size) shall be placed below the wire netting.

Following details shall be legibly written on the packages. The details shall also be typed on a sheet of paper & kept in a sealed Polythene cover, inside the packages

- a) Project Name
- b) Purchase Order No.
- c) Sl. No. of package
- d) Size of mattress (Thickness x Length x Width)
- e) Density
- f) Wire netting material and size
- g) Weight of the package

10.2 INSULATION MATERIAL (ALUMINIUM COIL)

Heavy Gauge Aluminium Coil Packaging are done by Eye-to-Sky packaging or by Eye to eye packaging as per the proven practice being followed by manufacturer of Aluminium sheets.

10.2.1 Type of construction for Eye to Sky packaging

- a. Strapping of coil with polyester strap around circumference at one place.
- b. Putting paper I. D. Edge protector.
- c. Wrapping the coil with VCI stretch film after putting silica gel bags (4 nos.) Inside the coil.
- d. Wrapping the coil with HDPE film.
- e. Covering the coil including its build up & bore with masonite / particle board.
- f. Putting metallic I. D on coil.
- g. Putting O.D edge protector (paper) on coil.

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- h. Putting circumferential polyester strap (3 nos.) & eye polyester strap (4 nos.).
- i. After placing the coil on coil tilter ply wood (10mm thick) of suitable size along with wooden pallet is to be put at the bottom side of the coil.
- j. Coil is to be tilted to eye-to-sky position.
- k. Final strapping with metallic strap to unit coil and skid at 2 places with top cover of plywood.
- l. Fixing the coil with wooden blocks at 4 corners.
- m. Labeling 2 nos.(one metallic & one adhesivetype) For specification, net wt. & gross wt.

10.2.2 Type of construction for Eye to Eye packaging

- a. Strapping of coil with polyester strap around circumference at one place.
 - b. Putting paper I. D. Edge protector.
 - c. Wrapping the coil with VCI stretch film after putting silica gel bags (4 nos.) Inside the coil.
 - d. Wrapping the coil with HDPE film.
 - e. Covering the coil including its build up & bore with masonite / particle board.
 - f. Putting metallic I. D on coil.
 - g. Putting O.D edge protector (paper) on coil.
 - h. Putting circumferential polyester strap (3 nos.) & eye polyester strap (4 nos.).
 - i. Placing of coil on wooden skid Coil is to be tilted to eye-to-sky position.
 - j. Final strapping of coil and skid at 2 places with steel strap. Fixing the coil with wooden blocks at 4 corners.
- Labeling 2 nos.(one metallic & one adhesive type) For specification net wt. & gross wt.

10.3 Packing Procedure for Online Tube Cleaning System and accessories

This procedure is applicable for the shipment of Onload Tube Cleaning System and accessories by sea.

10.3.1 Packing details:

- The Packing case shall be made of treated rubber wood. The design of the case shall be as per Annexure IIIA & IIIB.
- The Equipments shall be placed on the wooden base of the Packing case and fastened if required to arrest the movement of the same.
- Equipment shall be covered by Polythene sheet and inside wall surfaces of the wooden cases also shall be covered by polythene sheet.
- All Nozzles shall be closed with plywood dummies.
- All electrical components assembled or loose shall be covered with polythene sheets along with silica gel pack.
- Silica gel desiccants shall be kept inside each case in sufficient quantities in order to absorb the moisture.

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- Thermocol packing shall be made for glass items like Ball vessel sight glass, Vpiece sight glass & pressure gauge.
- Silica gel desiccants shall be kept inside of each case to absorb the moisture.
- A Packing list covered in a polythene envelope shall be fixed inside and outside of each packing case.
- Shipping marks and consignee address shall be painted on the outer surface of the case.
- All handling instruction required for the case like top, sling, rain, handle with care etc, shall be marked on the case as per the symbol attached.
- Machined surface will be applied with Anti rust oil and covered by polyurethane sheet to protect from external oxidation.
- All valves will be closed with dummies to protect the internals and placed in the wooden case which will covered by polyurethane sheet.

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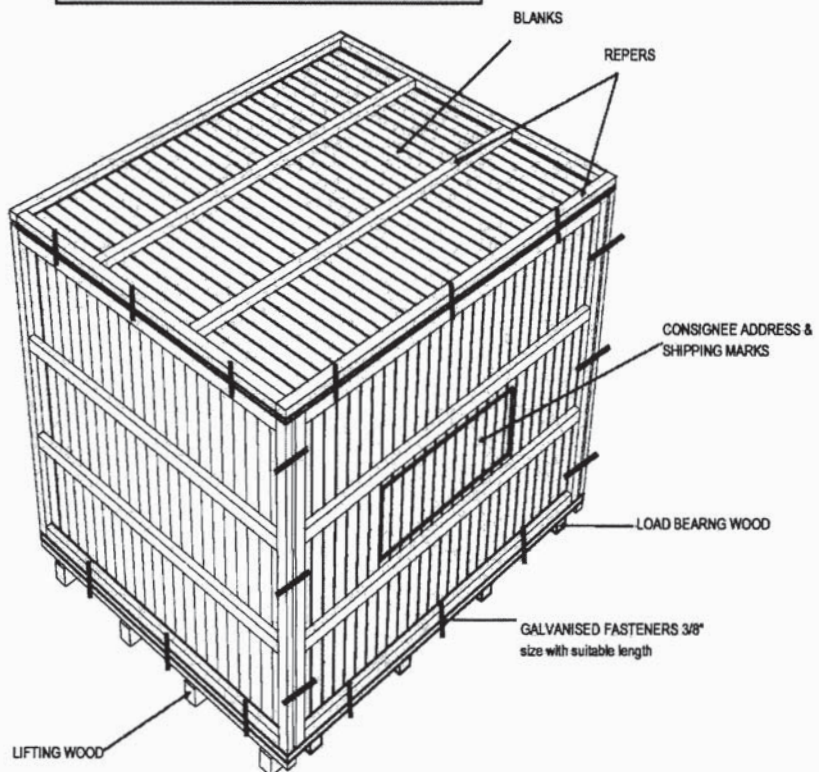
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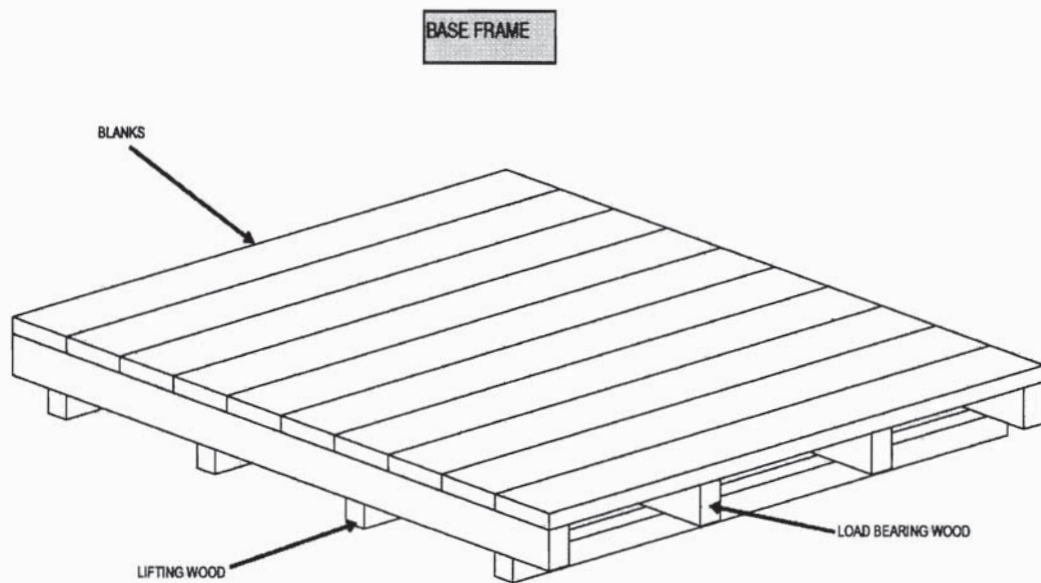
**MODEL: FASTNERS TYPE (BASE, SIDE & TOP
ATTACHED WITH BOLT, NUT & WASHER)**

This Type of case to be used for
following items:

1. BALL SEPERATOR
2. BALL COLECTOR SKID



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MODEL: FASTNERS TYPE - WITHOUT TOP





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MODEL: NAILING TYPE
(FRAME & INSIDE REEPER NAILED)

THIS TYPE OF CASE TO BE USED FOR THE
FOLLOWING ITEMS:

1. PUMP SKID
2. CONTROL PANEL
3. LOOSE ITEMS, TOOLS & TACKLES
4. DPMS, BRM
5. SPARES
6. CLEANING BALLS
7. CABLES & ACCESSORIES

Shipping marks & Consignee
Address

BLANKS

LIFTING WOOD

BLANKS

REEPERS

BLANKS

REEPERS

LOAD BEARING WOOD

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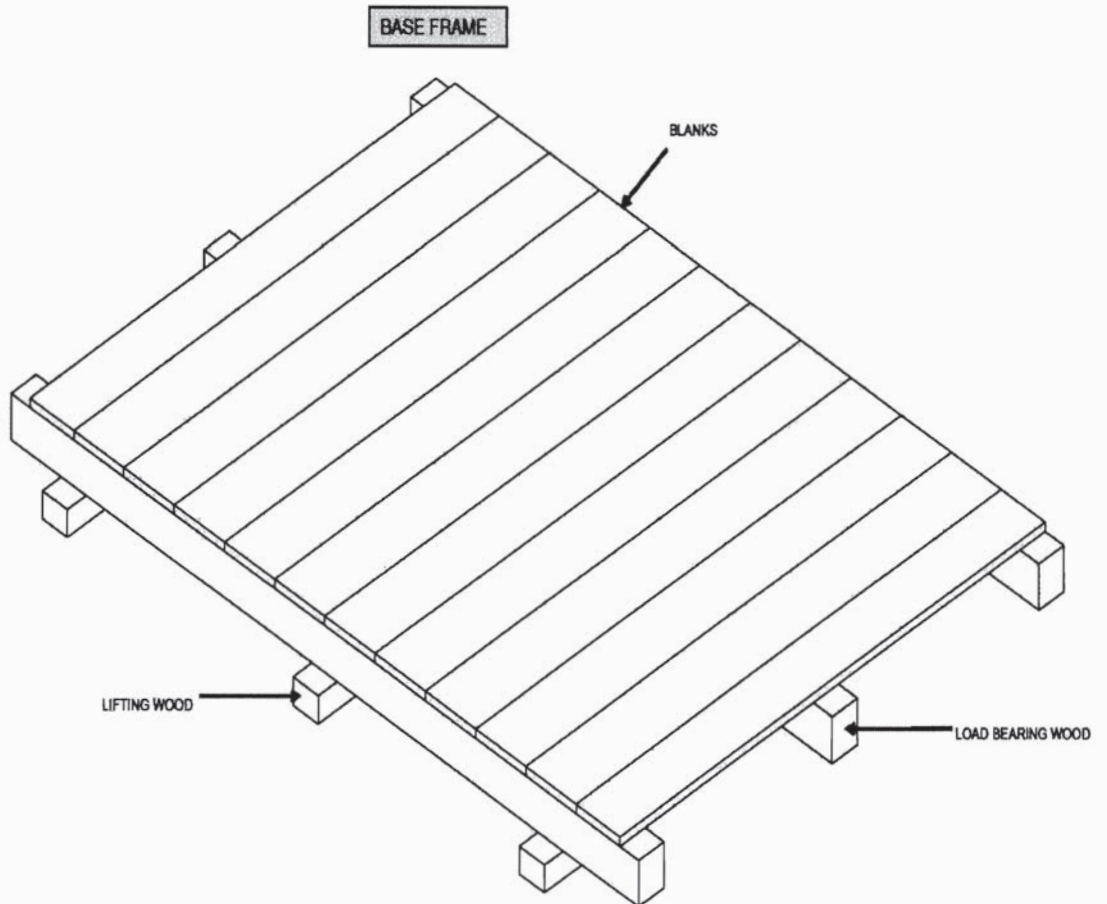
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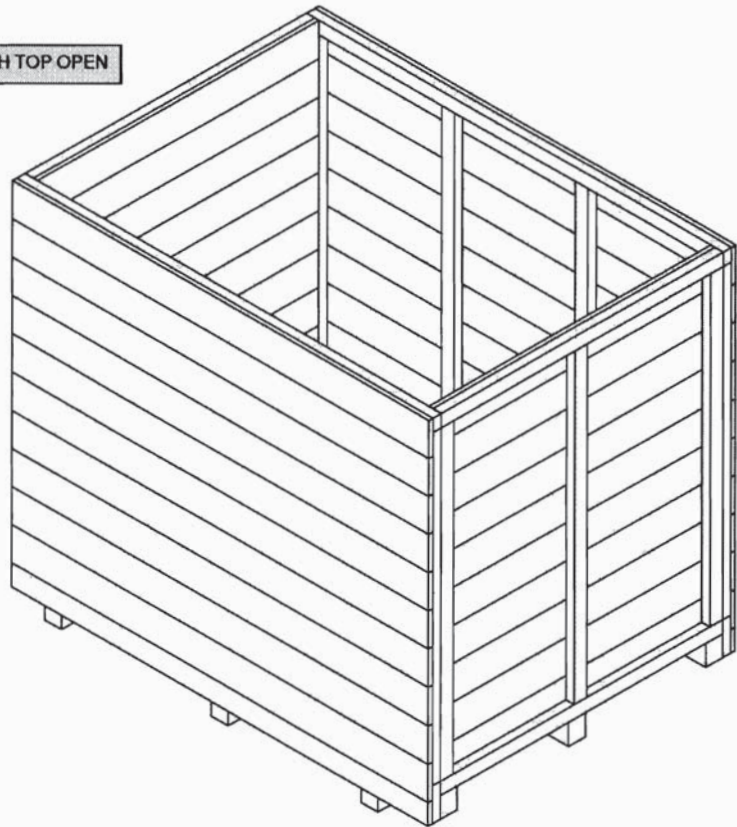
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NAILING TYPE MODEL WITH TOP OPEN



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10.4 PACKING OF LOOSE ITEMS

Loose mechanical, electrical and C&I items e.g. valves, fittings, pressure/temperature gauges/switches, circuit breakers, relays etc shall be individually wrapped using polyethylene sheets/U foam/ thermocol sheets/air bubble sheets depending upon the items and then packed in wooden boxes. The left out spaces and top of the boxes shall be filled with rubberized coir to get proper cushioning effect, Special attention shall be paid to relays, instruments etc for arresting the movements of their operating mechanism during transportation.

The construction of wooden packing cases shall be as per clause 9.3.1 retaining its all features concerning strength of the box. The construction of wooden packing case for electrical and C&I items shall be as per fig-16.

Inner surface of 6 sides of the box shall be lined with bitumen coated hessian polyethylene kraft paper. Rubberized coir of min. 25mm thickness and 100 mm width shall be nailed to inner surfaces of bottom and 4 sides of the boxes.

11.0 PACKING OF ELECTRICAL ITEMS

11.1 CABLES

11.1.1 Type of Equipment
All type of cables..

11.1.2 Type of Construction

New or practically new cable drums made of steel and painted with epoxy resin paint are to be used. Cable ends are carefully protected before packing. Over the cables polyethylene sheet shall be wrapped and then sealed properly. Cable drum can be put in wooden crates for ease in transportation and handling. (Wooden cable drum is also acceptable, however vendor to furnish constructional details for approval).



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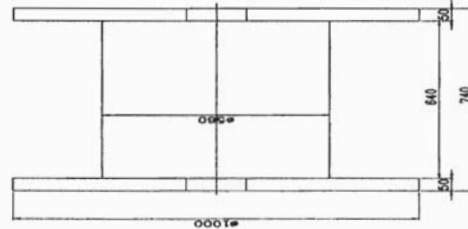
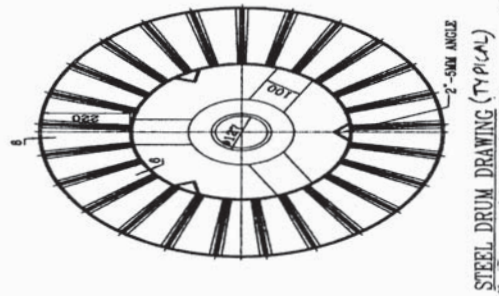
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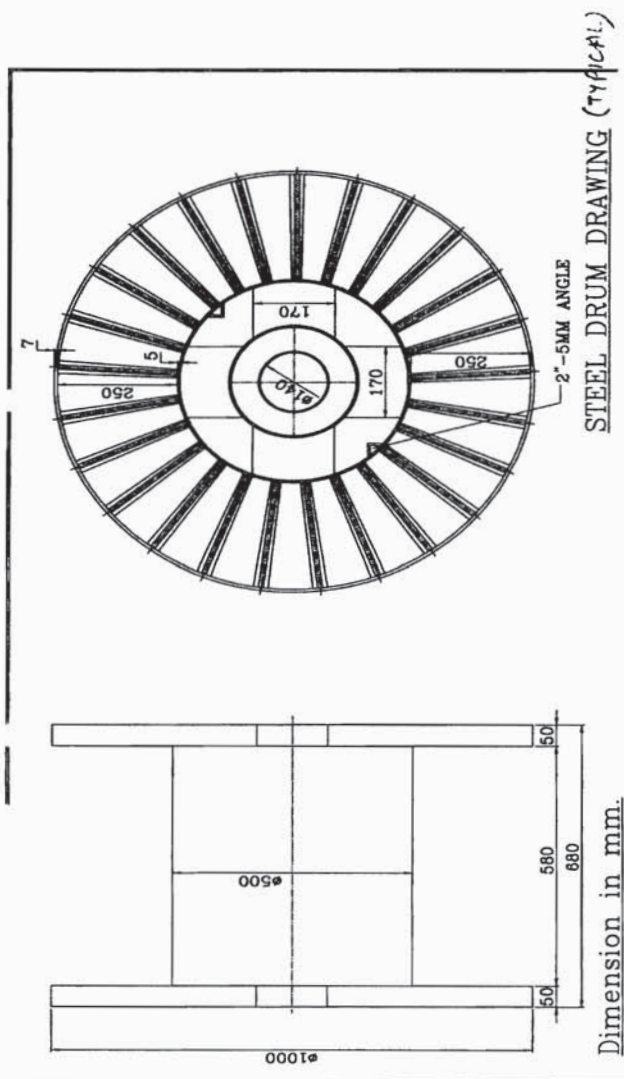
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Dimension in mm.

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11.2 PACKING OF CABLE TRAYS & ACCESSORIES AND CABLE TRAY SUPPORT MATERIAL

11.2.1 Cable trays can be packed in wooden boxes as per fig 1 to 11 or in steel boxes. Details of steel box construction is as indicated below.

- 1) All Dimensions are in "mm" unless otherwise stated.
- 2) Packing Box shall be fabricated using 50x50x6mm MS Angle, 50x3mm Flat, 2.5 mm thick C Channel, 1mm & 1.6mm Thick sheet.
- 3) Finish of Packing Box Shall be Galvanized.
- 4) Angle & Channel Section forming part of the Main frame shall be welded thoroughly with each other to give a rigid structure.
- 5) Sheet Section and Flat section shall be bolted/ Riveted/ Welded suitably to the Main frame stated in '4' above.

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- 6) Welding Portion on galvanized surfaces shall be painted with Zinc Rich Paint.
- 7) Dispatch details such as consignor/consignee address, contract and case details, 'country of origin, port of delivery, stacking instructions shall be written on one of the side of boxes. An anodized aluminium plate as per details and specifications given in page 3 of 5 shall be provided on the boxes
- 8) One copy of packing slip wrapped in polythylene bag covered with suitable aluminium .packing slip holder to be nailed on the external surface of the box. One more copy 9f the packing Slip wrapped in polythylene bag to be kept inside the box at the prominent place.
- 9) **INDICATION MARKS ON THE BOXES:** Markings shall be provided on the boxes indicating position of Boxes for handling, storage and nature of consignment. For guidelines referred page 4 of 5. The ink issued for this purpose as well as for marking dispatch instruction shall be indelible/non-washable marking ink.
- 10) Each item as mentioned in BOQ shall be packed & supplied as a set comprising of required numbers of associated fasteners & hardware etc



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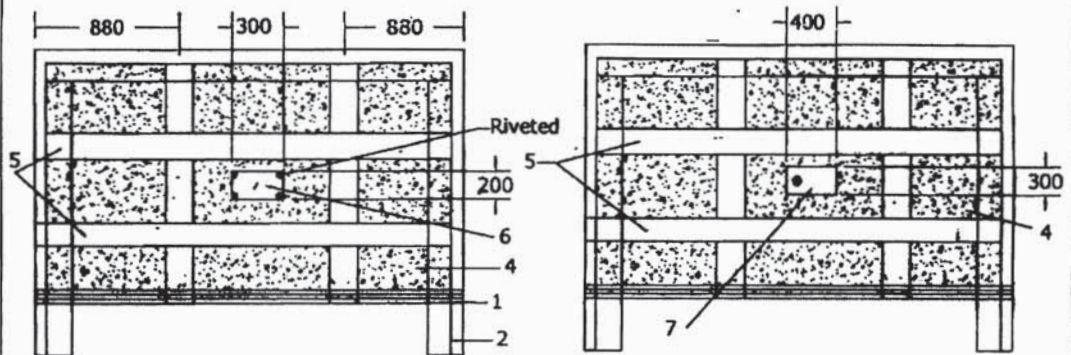
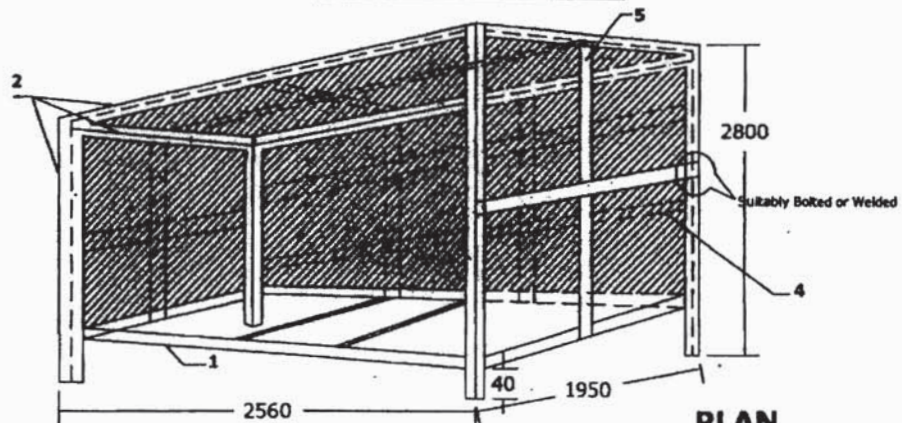
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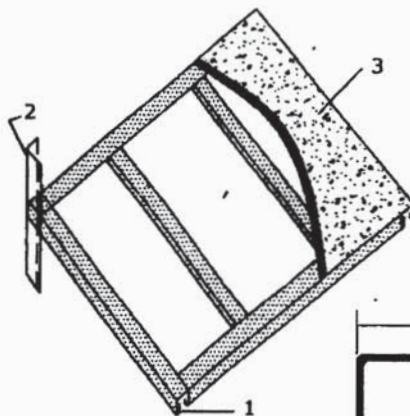
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STEEL PACKING (TYPICAL DETAILS)



FRONT SIDE OF BOX

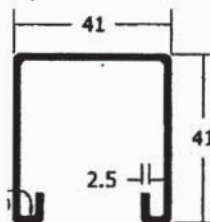
BACK SIDE OF BOX



BOTTOM FRAME ARRANGEMENT

Note:

1. "C" Channel to be used on Bottom Frame.
2. 50x50x6 Angle to be used Vertically on four sides of the Box and Horizontally on four sides on the top Frame.
3. 1.6mm thick sheet (plain) on Bottom Plate.
4. 1.0mm thick sheet to cover top & four sides of BOX.
5. 50x3 Flat as additional cross members to be used Horizontally & Vertically on top & Four Sides of Box.
6. Anodised Aluminium Plate for Marking.
7. Hinged Inspection Window.



DETAILS OF "C" CHANNEL

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11.3 PACKING FOR STATION LIGHTING SYSTEM

Aspects of packing specific to equipments / items of station lighting system are given here. All other instructions / aspects as per the main specification of export packing which are not covered here shall also be applicable.

11.3.1 For LIGHTING TRANSFORMER, DISTRIBUTION BOARDS, LIGHTING PANELS,

- Construction of packing case for LIGHTING DIATRIBUTION BOARDS, LIGHTING PANELS, TRANSFORMER . shall be EITHER as per FIGURE 1,2,3,5,6,7,8,9,10,11 OR FIGURE 14,15,16.
- Each Panel/Transformer shall be individually covered with double polythene sheet of thickness 175 microns minimum.
- All the 6 inner surfaces of packing shall be nailed with bitumen coated hessian polythene craft paper. Wherever 2 pieces of craft paper are used, the joint shall have minimum overlap of 20mm.

For the top frame it shall be project on all sides by 100mm and shall be nailed on sides .

- The gap between the panels and packing case shall be filled with rubberized coir of thickness 50mm minimum and width 100mm. The distance between two consecutive supports of rubberized coir shall be less than 500mm.
- Silica get packed in cotton bags shall be placed at different positions inside the packing.
- Packing case shall be finally covered with GI sheet of thickness 0.4mm minimum.

11.3.2 For LUMINARIES, RECEPTACLES. EMERGENCY LIGHT, 240/24V TRANSFORMER, CEILING FAN, SWITCH BOARDS, FLEXIBLE CONDUIT, WIRES, EARTH WIRE. JUNCTION BOXES, ERECTION COMMIOSSIONING SPARES, RECOMMENDED SPARES , ERECTION MATERIAL AND CONSUMBALES

- Construction of packing case for THE ABOVE MATERIAL shall be as per FIGURE 1to11.
- Items placed inside the case shall be covered with double polythene sheet of thickness 175 microns minimum.
- All the 6 inner surfaces of packing shall be nailed with bitumen coated hessian craft paper. wherever 2 pieces of craft paper are used, the joint shall have minimum overlap of 20mm. For the top frame it shall be project on all sides by 100mm and shall be nailed on sides.
- Silica get packed in cotton bags shall be placed at different positions inside the packing.

11.3.3 For CONDUIT PIPE

As per international practice pipes are shipped in open bundles with metal strapping. Packing as per attached figure A shall be provided which is described as following:

- Each bundle shall be wrapped with 2 layers of 175 microns thick polythene sheet.
- Then bundle will be wrapped with bitumen coated hessian craft paper.
- Bundle shall be strapped with steel straps.
- An anodized aluminium packing description plate as per Figure No. 13 shall be provided.

11.3.4 For POLES

Poles will be wrapped with 2 layers of minimum 175 microns thick polythene sheet and then with bitumen coated hessian craft paper, packed as per Figure – C i.e. bundling.

11.3.5 For STRUCTURAL STEEL

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Structural steel will be different sizes and shapes. Hence it will be packed as per Figure No. B and described as following :

- a) Each bundle shall be wrapped with 2 layers of 175 microns thick polythene sheet.
- b) Then bundle will be wrapped with bitumen coated hessian craft paper.
- c) Bundle shall be strapped with steel straps.
- d) An anodized aluminium packing description plate as per Figure No. 13 shall be provided.

**TITLE****TECHNICAL SPECIFICATION
FOR SEAWORTHY PACKING
FOR EXPORT JOBS**

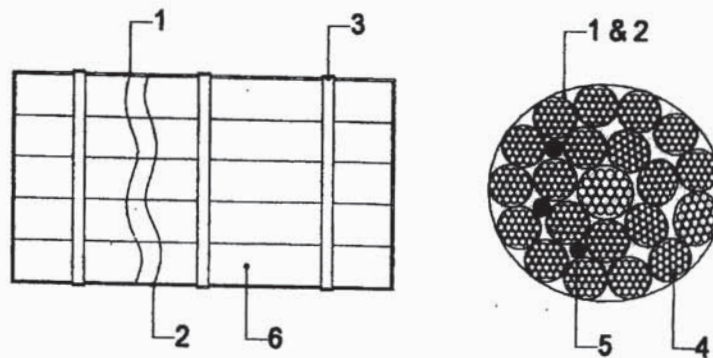
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PACKING PROCEDURE FOR CONDUIT PIPE**FIGURE "A"**

- 1) LAYER OF BITUMEN COATED HESSIAN KRAFT PAPER.
- 2) LAYER OF POLYTHENE SHEET.
- 3) METAL STRAPPING.
- 4) CONDUIT PIPES.
- 5) SILICA GEL POUCHES.
- 6) BUNDLES OF CONDUIT PIPES.

**TITLE****TECHNICAL SPECIFICATION
FOR SEAWORTHY PACKING
FOR EXPORT JOBS**

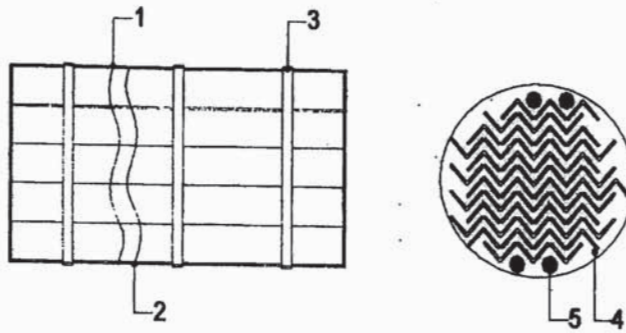
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PACKING PROCEDURE FOR STRUCTURAL STEEL**FIGURE "B"**

- 1) LAYER OF BITUMEN COATED HESSIAN KRAFT PAPER.
- 2) LAYER OF POLYTHENE SHEET.
- 3) METAL STRAPPING.
- 4) STRUCTURAL STEEL.
- 5) SILICA GEL POUCHES.



TITLE

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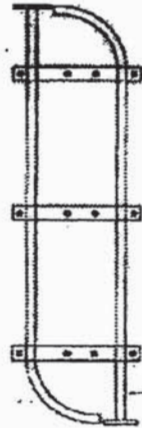
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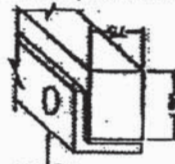
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packing procedure for poles



POLES WRAPPED WITH POLYTHENE SHEET &
EXTINGUISHER COATED HESSIAN CLOTH



TOP WOODEN BATTEN TO BE
FIXED WITH 10x80x6 MM L ANGLE
OF IT FOR TIGHTENING THE PACK
25 MM DIA



BOTTOM WOODEN BATTEN TO BE
FIXED ON 10x80x6 MM ANGLE

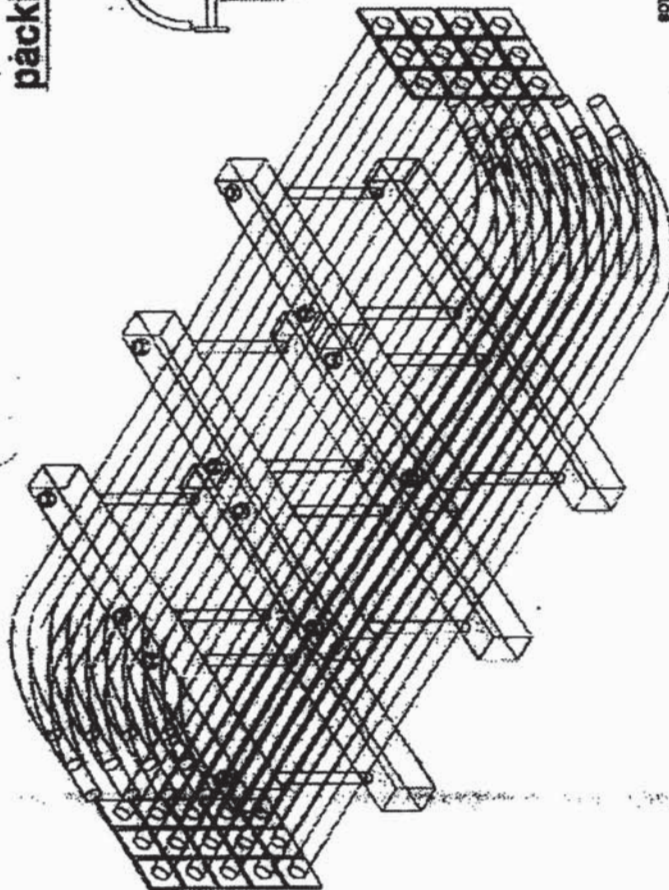


FIGURE "C"

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11.4 PACKING FOR DC BATTERY

The packing procedure for seaworthy packing of DC Battery is defined below, which is capable of withstanding impacts, compression, vibration, toppling, sea water spray, prevention against rust, temperature and extreme atmospheric conditions. Aspects of packing specific to equipments / items of DC Battery are given here. All other instructions / aspects as per the main specification of export packing which are not covered here shall also be applicable.

The packing procedure consists of various stages namely primary packing, cushioning, securing, desiccant, outside packing box, Runners/ sliders/ transverse bars of plywood, etc., provided for each movement.

- a) The packing boxes shall be made up of plywood boxes (thickness 9mm min.) with blocks at the bottom of the box for provision for handling the boxes using the forklift. The packing boxes sizes are generally standardized to half-euro size (capable of handling equipment's weight).
- b) Rubberized coir of 25mm thickness shall be provided as cushioning material at the bottom and thermocole of 20mm shall be provided inside on all four sides. Other than this polyethylene film wrap or cover also will be provided. Left out spaces to be filled with rubberized coir/ thermocol to get cushioning effect.
- c) Silica gel in dust free air permeable cotton/paper bag shall be placed in the packing boxes for storage period of 1 year as per IS 304 (1979)
- d) While packing the cells, transit caps (polypropylene) of red and blue shall be used for big size cells for ensuring that cells does not get damaged during the transport due to vibrations etc.
- e) The battery accessories shall be packed with suitable precautions as follows:
 - i) Copper connectors shall be packed after making bunches with lead wire seals to avoid misplacement.
 - ii) Hardware items shall be packed in polyethylene bags (Thickness $\geq 0.175\text{mm}$) with item slip
 - iii) Battery rack shall be packed in dismantled condition, wrapped with polyethylene sheet
 - iv) For Ni-Cd type battery, electrolyte in solid form for dry cells shall be packed in cans with KOH, LiOH being packed separately.
 - f) Galvanized Steel straps are provided for binding the packing box sides.
 - g) The handling instructions shall be marked in indelible/ non-washable ink, indicating the upright position.

11.5 PACKING OF SERVICE TRANSFORMERS(OIL FILLED) & ACCESSORIES

This instruction is applicable for packing of transformers (oil filled), its accessories and components so as to ensure safe delivery to end user. Aspects of packing specific to equipments / items of transformers(oil filled) are given here. All other instructions / aspects as per the main specification of export packing which are not covered here shall also be applicable.

11.5.01 PACKING DETAILS :

- a) Items shall be packed in case / crates as per the shipping list.
- b) All fragile items and small items shall be packed in cases and to be marked as "Fragile, handle with care Fragile items".
- c) Fragile accessories are to be first packed in their original boxes (VENDOR's packing). Very

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- d small / delicate items such as glass thermometer, door keys shall be packed in separate box.
- e In case original box is found damaged, suitable alternate box or packing method using felt or foam sheet and polythene wrap to be used.
- e These boxes are then placed in identified wooden boxes. Inside of such boxes are lined with a layer of polythene sheet, packing wool / grass and another layer of polythene sheet before placing the boxes. All boxes are then wrapped with this polythene sheet before closing the box. Fragile items shall not be placed loose, one above the other inside the case.
- f All wiring cables, connection flats of non-ferrous materials, CTs, valves bellows shall also be packed.
- g Items like CTs, Oil communicating bushings, insulators, wired equipments and housings such as RTCC Panel, M. Box, Drive Mechanism, thermometers, gauges shall be wrapped in polythene from all around.
- h Buchholz relay and OSR relay openings will be blanked using covers, before putting them in the box
- i Items shall be carefully lowered and arranged inside the crate / case and each item shall be locked from all sides in such a way to avoid its movement in any way. Wooden stoppers and separators shall be provided for this and nailed to the crate / case wood.
- j Wooden planks and batons in contact with fragile items shall be provided with kit foam at the locations of contact.
- k Oil communication bushings shall be packed in separate case on V or U shape wooden felted supports, as in case of condenser bushings.
- l While placing and arranging the items inside the crates / cases, these shall be verified for correctness and then the packing note shall be signed. The cover top of the crate / case shall then be closed.
- m The main equipment like transformer tank shall be packed suitably to prevent any damage during transit / storage. Support structures like frame, header supports etc. shall be crated. Conservator headers shall also be crated. Radiators pipe work and other instruments & components shall be packed in cases. All the cases shall be lined with polythene from inside.

11.6 ALTERNATIVE PACKING CASES FOR CONTROL PANELS AND SWITCH GEARS

For Control and switch gear panels, construction of wooden packing cases may be provided as per fig 14 & 15 and as detailed below.

Thickness of planks for all sides, binding and jointing battens shall be at least 25 mm. Width of the plank shall be at least 125mm and that of binding and jointing planks shall be at least 100mm.

Top frame shall be suitable so that it does not collapse due to sandwiching between slings while lifting. Longitudinal and traverse bars for the bottom wooden pallet to be suitably selected.

Diagonal bracings shall be as per cl 9.3.1.3 and all other requirements shall be as per clauses 9.3.1.4 to 9.3.1.6.

12.0 Containerization

As required by BHEL, the VENDOR shall stuff the GOODS into 20 or 40 foot containers (dry, open top, flat racks, etc.).

The maximum inside dimensions of containers are to be considered:

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- 40 foot containers: 11.80 m x 2.20 m x 2.05 m
- 20 foot containers: 5.80 m x 2.20 m x 2.05m
-

The present definition of containerization is valid for sea containers only. Vendor to check the size of containers before start of packing of equipment.

12.1 Protection of Cases/Crates

Since shipping containers are in general not water tight, packing in contact with the floor of the container shall be raised in order to prevent it from being damaged by the accumulation of water.

12.2 Mechanical Constraints

The mechanical constraints for "general use" closed containers are of a different nature (height of "stacking" being limited inside the containers), the packing for the GOODS may be of a lighter structure. However, it is necessary that the packing be appropriate so as to protect the GOODS on site during the storage period, as required after discharging of the GOOD'S from the containers.

Note:

It is the responsibility of the VENDOR to ensure that the cases/crates are stowed, secured and fastened inside the container. The VENDOR will take all necessary precautions to conform to the maximum weight allowed and the centre of gravity of the container. The securing and fastening of the cases/ crates can be carried out by nailing timbers on the bottom or on the vertical sides of the container.

13.0 Other Services to be provided by Vendor

In addition to the packing and shipping documents, VENDOR must also carry out the following services, which shall be included in his quotation:

Carriage of VENDOR's sub-contracted equipment and material, which must be re-grouped in VENDOR's or PACKER's workshops, whilst waiting for packaging.

BHEL reserves the right to postpone the shipping of the GOODS. In this event, any storage and insurance costs during the first ninety (90) days shall be borne by the VENDOR.

Loading, including lifting, securing, lashing, and stowing, of all cases, crates, or packages onto means of transportation such as, but not limited to, trailers, containers, etc.

14.0 Responsibilities and Guarantees

VENDOR is responsible for the choice of category for packing according to the transport facilities used, and on the basis of the present document. In case of doubt or disagreement regarding the choice, VENDOR must inform BHEL prior to packing and await BHEL's approval. All phases of packaging, marking, loading, etc. will be subject to BHEL inspection.

BHEL reserves the right to reject the packing when the packing does not conform to these instructions and/or when the packing does not ensure perfect protection of the GOODS. VENDOR is responsible for the weights and dimensions declared, and the marking of the packages.

The documents must be in strict conformity with the packing contents.

The packing specified in these "Packing, Marking and Shipping Instructions" is guaranteed for a twelve (12) months storage period after delivery on site.

VENDOR is responsible for providing storage recommendation adapted to the GOODS. According to this guarantee, VENDOR is held responsible in the event of goods becoming

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useless, damaged or broken, as a result of poor packing and/or stowing, or due to corrosion, subsequent to insufficient or inadequate protection. All direct or indirect costs resulting thereof, will be back-charged to VENDOR.

SECTION 'II'

STANDARD TECHNICAL
SPECIFICATION

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1.00.00 SCOPE

1.01.00 This specification covers the design, manufacture, inspection & testing, packing at manufacturer's works and delivery to site of mineral oil filled service Transformers complete with all fittings & accessories for satisfactory operation at site.

1.02.00 TERMINAL POINTS

1.02.01 HV bushings with terminal connector for bus duct/ cable glands & lugs in case of cable connection.

1.02.02 LV bushings with terminal connector (3 Phase + 1 Neutral) for bus duct/ cable glands & lugs in case of cable connection.

1.02.03 For HV Earthing : (Applicable in case of star connection of HV) - neutral earth bus-bar brought near the base of transformer/ Cable glands & lugs in case of cable connection.

1.02.04 For LV Earthing : - neutral earth bus-bar brought near the base of transformer.

1.02.05 Transformer earthing pads.

1.02.06 Terminals of marshalling box for external connection to equipment supplied by the purchaser.

2.00.00 APPLICABLE STANDARDS & CODES FOR TRANSFORMERS

Specification for power transformers	IEC: 60076
Fluids for electro-technical applications - Unused mineral insulating oils for transformers and switchgear	IEC: 60296
Bushing for alternative voltage above 1000 volts	IEC: 60137

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Current transformers	IEC: 61869-2
Classification of insulating material for electrical machinery & apparatus in relation to their thermal stability in service	IEC: 60216
Classification of degrees of protection provided by enclosures of electrical equipment	IEC: 60529
Method of high voltage testing	IEC: 60060/ IEC: 60076-3/ IEC: 60270
Guide for loading of oil immersed transformers	IEC: 60076-7
Noise level	NEMA, STANDARD-TR1
IEC standard voltages	IEC: 60038
Terminal and tapping markings for power transformers	IEC: 60616

2.01.00 The equipment shall comply with all currently applicable safety codes and statutory regulations of India as well as of the locality where the equipment is to be installed including Indian Electricity Act, Indian Electricity Rules and Bureau of Indian Standards.

3.00.00 TECHNICAL REQUIREMENTS

DESIGN AMBIENT TEMPERATURE SHALL BE 45°C.

3.01.01 Design Parameter and Operating Capabilities

1.	Duty	Continuous
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4.	Maximum flux density	The maximum flux density in any part of the core and yokes of transformer at normal voltage and frequency shall be such that the flux density in over-voltage condition (combined voltage and frequency at 110% of rated V/f) shall not exceed.1.9 tesla
5.	Design flux density	Shall be limited to maximum 1.7 Tesla in the core at rated condition and at principle tap
6.	Short time withstand current capacity	Shall withstand mechanical and thermal effects of through fault current for 2 seconds without any damage
7.	Over voltage operation	i. 110% rated voltage continuous ii. 125% rated voltage for 1 minute iii. 140% rated voltage for 5 seconds
8.	Voltage variation	i. $\pm 10\%$ of nominal tap (CFVV) ii. Continuous operation at any tap position (Constant kVA)
9.	Frequency	50 Hz (+3%, -5%)
10.	Combined variation (Voltage & Frequency)	10% (absolute sum)
11.	Overload capacity	As per IEC 60076-part 7 , No loading limit imposed by bushings, taps etc
12.	Current density	Maximum 3.0 Amperes per sq mm for HV and LV windings and at all tap positions
13.	Temperature rise for top oil	55 deg C measured by thermometer over 45 deg C ambient
14.	Temperature rise for winding	60 deg C measured by resistance method over 45 deg C ambient
15.	Bushing Rated Current	i. HV and LV bushing: Shall be more than full load current at extreme tap

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		ii. Neutral bushing: Same as corresponding phase bushing rated Current
16.	Harmonic suppression	Designed for suppression of 3rd, 5th, 7th harmonic voltages and high frequency disturbances
17.	Noise level	As per limits specified by NEMA TR1
18.	Radio influence voltage (only applicable for HT Auxiliary Transformer)	Maximum 250 microvolt
19.	Auxiliary supply AC	415V +/-10%, 50Hz +5/-3%, 3 ph, 4 wire
20.	Control supply DC	220 V DC (+10% to –15%), 2 wire

3.02.00 Construction

3.02.01 Tank

1.	Material	Low carbon steel of adequate thickness
2.	Construction	As per manufacturer design
3.	Welding	i. Shall be Double sided welding ii. Shall be stress relieved as per BS 5500 iii. Shall be free from undercut, overlap, crack and porosity iv. Shall be tested by DP test before painting
4.	Tank Design	i. Tank shall be designed to withstand full vacuum (760mm of Hg) for filling of oil by vacuum. ii. Tank shall be designed to withstand internal gas pressure of 35 kN/m ² over normal hydrostatic pressure of oil

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5.	Movement / lifting	i. Jacking pads (at min 500mm height), lifting eyes/lugs and pulling lugs shall be provided to facilitate movement of the transformer ii. All heavy removable parts shall be provided with eye bolt for ease of handling iii. The transformer base shall be designed to permit skidding of the complete transformer
6.	Wheel	i. Bidirectional wheels with suitable locking arrangement
7.	Tank cover	i. Shall be sloped to prevent retention of rain water ii. shall not distort when lifted with lifting eyes iii. Pockets for thermometer and for bulbs of OTI, WTI shall be located in the position of maximum oil temperature iv. Thermometer pocket shall be fitted with a captive screwed top to prevent ingress of water v. Shall be possible to remove these bulbs without lowering the oil in the tank
8.	Inspection cover	i. Shall be provided of sufficient size for access to leads, windings, bottom terminals of bushings and taps. ii. Lifting lugs shall be provided on the bolted cover. iii. Fitted with weatherproof, hot oil resistant rubberized cork gasket with metallic stoppers to prevent over compression iv. Weight shall not be more than 25kg
9.	Phase turret	Shall be made from non-magnetic material
10.	Sediment	Adequate space shall be provided at the bottom of the tank for collection of sediment
11.	Materials in contact with oil	i. Shall be such as not to contribute to the formation of acid in oil ii. Shall not be galvanized or cadmium plated

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3.02.02 Core

1.	Material	Silicon steel laminations CRGO grade M4 or better.
2.	Construction	i. Core or shell type ii. Bolt less core clamping would be preferable
3.	Laminations	i. Shall be free of all burrs and sharp projections ii. Each sheet shall have an insulating coating resistant to the action of hot oil ii. Oil ducts shall be provided where necessary to ensure adequate cooling
4.	Insulation	Shall withstand 2 kV rms for 1 minute in air between core to core-bolt & core to clamp plate
5.	Assembly	i. Core and coil shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer or under short circuit stresses. ii. Completed core and coil assembly of core type units shall be so assembled that the axis and the plane of the outer surface of the coil stack shall not deviate from the vertical plane by more than 25 mm.
6.	Internal earthing	All internal metal parts of the transformer, with the exception of individual laminations, core bolts and their individual clamping plates shall be earthed.
7.	Lifting lug	Core shall be provided with suitable lifting eyes/lugs for lifting complete core and winding assembly

3.02.03 Winding

1.	Material	i. Conductor material shall be Electrolytic grade Copper, Free from scales and burrs.
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		ii. All other materials used in coil assembly shall be chemically stable at hot transformer oil and shall be of proven track record.
2.	Design	Windings shall be designed to reduce to a minimum out of balance forces at all voltage ratios.
3.	Insulation	i. Kraft paper ii. Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive shall be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil
4.	Insulation requirement	ii. All windings for system voltages lower than 66 kV shall be fully insulated iii. All neutral points shall be insulated for the voltages specified as per IEC
5.	Joints	i. Permanent current carrying joints in the windings and leads shall be welded or brazed. ii. Clamping bolts for current carrying parts inside oil shall be made of oil resistant material which shall not be affected by acidity in the oil. Steel bolts, if used, shall be suitably treated
6.	Transpose	The conductors shall be transposed at sufficient intervals in order to minimize eddy currents and equalize the distribution of currents and temperatures along the windings
7.	Leads	i. Shall be rigidly supported to prevent injury from vibration or short circuit stresses ii. Guide tube shall be used where practicable
8.	Coil assembly	i. Shall be suitably supported between adjacent sections by insulating spacers and barriers. ii. Bracing and other insulation used in assembly of the winding shall be arranged to ensure free circulation of the oil and to reduce the hotspot of the winding.

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3.02.04 Bushing

1.	Type	Rated below 52KV voltage class shall be solid porcelain
2.	Construction	Shall be homogeneous, non porous, uniformly glazed to brown colour and free from blisters, burns and other defects
3.	Design	i. Shall be such that stresses due to expansion and contraction in any part of the bushing shall not lead to deterioration ii. Cantilever strength shall be in accordance with IEC 60137
4.	Mounting	Bushings shall be so located on the transformers that minimum clearances as required for the BIL shall be realised between live parts and live parts to earthed structures.
5.	Metal part	All exposed ferrous metal parts shall be hot dip galvanized
6.	Suitability for bus duct temperature, if applicable	i. Shall be Suitable for bus duct conductor temperature of 105 deg C (for silver joints) or 90 deg C (for plain joints) ii. Shall be Suitable for bus duct enclosure temperature of 80 deg C
7.	Connectors	Bushings shall be provided with terminal connectors of approved type and size as per relevant IEC suitable for fixing to 11 KV cables

3.02.05 Terminal details

1.	Marking	The physical position of the terminals and the markings shall be as per IEC 60076
2.	HV terminal	i. Shall be brought out through top cover/side wall mounted bushings. ii. Shall be of sufficient size to accommodate cables and to allow easy termination iii. Shall be provided with non-magnetic material gland plate iv. Cable box shall have degree of protection IP52
3.	Cable Box	i. Cable box(es) shall be provided with suitable air-insulated disconnecting chamber so that if required, transformer can be removed from its position without disconnecting the cables in the

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		cable box(es). Independent supporting arrangement shall be provided for cable box(es) for this purpose. Supporting arrangement shall be supplied along with required hardware & foundation bolts etc. ii. Inverted rain canopy shall be provided for HV Cable box
4.	LV terminal	Shall be brought out through side wall mounted bushing with matching flanges around each bushing for connection non-phase segregated bus-duct .
5.	LV Neutral	Two (2) nos. neutral terminals shall be provided on LV side. One neutral terminal shall be part of phase connection arrangement bus-duct throat/ LV cable-box (as applicable). Other neutral terminal shall be in a separate box and brought to tank bottom by means of earthing bar of 50 X 6 mm of copper, supported on porcelain insulators mounted on transformer tank. The neutral earthing bar brought to the tank bottom for connection to station earth shall be provided with holes and suitable connecting hardware. This earthing bar shall have fork type arrangement at the end.
6.	Flange dimension	Shall match with busduct flange
7.	Connector	i. Flexible connector supplied by bus duct vendor ii. Palm size of bushing to match with bus duct connector
8.	Drain	Shall be given near flange to drain leakage of oil / water from bus duct or bushing flange with stopcock arrangement

3.02.06 Bushing CT

1.	Type	Cast-resin type, Class-E insulation, rated continuously for 120% of rated current
2.	CT parameters	During detailed engineering

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3.	Accuracy class of CT for i) REF protection ii) Standby Earth Fault protection iii) WTI CT	Class PX Class 5P20 Class 3.0 or better
4.	Mounting	i. CT removal shall be possible without removing tank cover ii. Location of CT shall be inside the turret
5.	Terminal box	One weatherproof terminal box for each bushing

3.02.07 Off Circuit Tap Changer (OCTC)

1.	Tapping	Shall be provided on the HV winding
2.	Design	i. Tap changer shall provide full rated kVA on taps, above and below rated voltage ii. Winding including the tapping arrangement shall be so designed to maintain electromagnetic balance between the winding at all voltage ratios
3.	Rating	i. Shall be rated more than max rated current at extreme tap ii. Shall be rated to withstand the through fault current of the transformer
4.	Contacts	Shall be silver plated and held in position under strong contact pressure to ensure low contact drop and avoid pitting
5.	Arrangement	i. Tap changing shall be effected by a 3-phase gang operated switch ii. Shall be such that the switch can be operated at a standing height from ground level
6.	Locking	i. Operating handle shall have provision for pad-locking at any tap position

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		ii. Design shall be such that the lock cannot be inserted unless the contacts are correctly engaged iii. One potential-free contact shall be provided to trip the supply in case the Lock is disengaged
7.	Tap position indication	Shall be provided with a mechanical tap position indicator

3.02.08 Auxiliary Equipment

1.	Buchholz relay	i. Shall be designed for seismic zone as specified ii. Shall be of double float type with alarm contact which closes on gas accumulation and trip contact which closes on oil surge iii. Shall be provided with a test cock connected with copper pipe to operating level (1.25m) from ground iv. Shall be located between conservator and tank, provided with shut off valves on both sides
2.	OTI	i. Shall be mounted inside marshalling box ii. Shall have 150mm Dial thermometer marked in °C iii. Shall be provided with adjustable alarm and trip contacts and a maximum reading pointer and resetting device iv. Accuracy class shall be ± 1.5 % or better
3.	WTI	i. Shall be mounted inside marshalling box ii. Shall have 150mm Dial thermometer marked in °C iii. Shall be provided with four adjustable contacts (two for cooler control and two for alarm and trip) and a maximum reading pointer and resetting device iv. Shall include Temperature sensing element, Image coil, Current transformer, Calibration device v. Shall have ambient temperature compensation vi. Accuracy class shall be ± 1.5 % or better
4.	Pressure relief device	i. Shall be spring operated ii. Shall operate at a static pressure of less than the hydraulic test pressure of transformer tank iii. Shall be of sufficient size for rapid release of pressure

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		iv. Shall also give a visual indication of valve operation by raising a flag v. Shall be provided with micro switch for actuating trip vi. Micro switch shall have IP 55 protection vii. The flag and the switch shall remain operated until they are reset manually
5.	Magnetic oil level gauge	i. Shall be visible from ground ii. Contact for low level alarm iii. Oil level at 30°C shall be marked on the gauge
6.	Contact rating for all devices	i. Buchholz relay – 2 A , 240 V AC/DC ii. MOGL – 5 A, 240 V AC , 0.5 A , 240 V DC iii. PRV – 5 A , 250 V AC , 0.4 A , 250 V DC iv. WTI/OTI – 5 A , 250 V AC , 0.5 A 220 V DC

3.02.09 Cooling equipment

1.	Capacity	i. Shall have minimum two numbers of tank mounted radiator banks.
2.	Radiator	i. Shall be detachable type with top and bottom isolation ii. Shall be provided with drain and air release plug iii. Shall be provided with lifting lugs iv. Shall be designed to withstand the vacuum and pressure conditions that of main tank

3.03.00 Conservation and oil preservation system of main tank

1.	Mounting	Conservator shall be provided in such a position as not to obstruct the electrical connections to the transformer
2.	Capacity	Shall have capacity between highest and lowest visible levels of 7.5% of the total cold oil volume in the transformer and cooling equipment
3.	Sealing system	i. Shall be provided with conventional single compartment conservator with dry air filling the space above the oil

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	(conventional) for transformers less than 6.3 MVA	ii. Top of the conservator shall be connected to the atmosphere through a breather in which silica gel is dehydrating agent
4.	Breather	i. Shall be mounted at 1200mm above ground level ii. Body and oil cup is made out of transparent yet unbreakable UV proof polycarbonate plastic iii. Top and bottom are made of CRCA sheet and joined with body by specially designed rubber gaskets and studs

3.04.00 Valves

1.	Material	i. Gun metal for Valves up to 100mm dia ii. Gun metal or cast iron Valves above 100mm dia
2.	Type	i. Full way with internal screw opening when turned anti clockwise direction ii. Shall be provided with flanges having machined faces and drilling of valve flanges shall confirm to IS 3639
3.	Required	Locking and position indication
4.	Gland packing	Teflon rope or nitrile rubber
5.	Oil sampling valve	Suitable for fixing 10 mm rubber hose
6.	Internal surface	Treated with one coat of oil resistant varnish
7.	External surface	Two coats of red oxide zinc chromate primer followed by two coats of glossy finish paint as per IS 2932, shade red
8.	All hardware	Electro galvanized

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3.05.00 Marshalling Box

1.	Purpose	i. MB shall house all auxiliary devices except those which must be located directly on the transformer ii. All auxiliary devices mounted on transformer and requiring electrical connections shall be cabled to MB iii. To receive and distribute two number power supplies
2.	Construction	i. Made of sheet steel minimum 2mm thick ii. Shall be dust tight, vermin and weather proof confirm to IPW 55 with rain canopy, provided with neoprene rubber gaskets.
3.	Accessories	i. Thermostat controlled space heater ii. Panel light with door limit switch iii. 6/16 amp power socket iv. Removable undrilled cable gland plate
4.	Alarm, Trip and Indication	i. All indicating lamps shall be LED cluster type ii. Annunciator shall be microprocessor based iii. Bidder shall provide signals for local indication as well as for purchaser's remote use as specified in Annexure, Remote Signal Requirement
5.	Mounting	i. Shall be tank mounted type and have a sloping roof ii. Indicating instruments and other control equipment shall be mounted at 1200mm height with transparent glass window
6.	Terminal Blocks	i. Shall be segregated for CT, control and AC/DC power circuits ii. Terminal blocks shall be of stud type, suitable for ring-type lugs only iii. Shall be of nylon 66 material, 1100V grade, 10Amp iv. Control terminal shall be suitable for 2 nos. 2.5 mm ² stranded copper conductor v. Power terminal shall be suitable for copper conductor vi. 20% extra terminals shall be provided for each terminal block vii. Clearance with cable gland plate shall be minimum 200 mm
7.	Internal Wiring	i. Shall be done with flexible, 600/1000V grade PVC wires in wire-ways ii. Minimum 2.5 mm ² for power circuits and 1.5mm ² for control circuit.

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3.06.00 Earthing

1.	Earthing pad	i. Two earthing pads shall be provided on the opposite side of equipment, Main Tank, Cable Box, MB & Radiator Banks ii. Complete with two tapped holes, bolts and spring washers iii. Shall be suitable for copper conductor
2.	Jumper	All gasketed joints shall be provided with minimum two (2) numbers copper strip jumper of adequate size for continuity of earth connection

3.07.00 Transformer insulating oil

1.	Oil	New unused uninhibited naphthenic based mineral oil with properties complying with IEC 60296
2.	Appearance	Shall be clear and transparent and free from suspended matter or sediments
3.	Supply	i. Shall be supplied separately in non-returnable drum suitable for outdoor storage ii. Drum shall be coated from inside with suitable coating (like, epoxy lacquer of phosphate) resistant to insulating oil

3.08.00 Rating and Diagram Plate (Bi-Lingual with Bengali inscription first followed by English)

1.	Rating & diagram plate of stainless steel material with details as listed	i. Manufacturer's name, serial number, Year of manufacture ii. Rated voltage, current, frequency iii. Rated power in MVA, Type of cooling iv. Vector group symbol, Winding connection diagram v. Basic insulation level vi. Impedance at principal tap vii. Top oil and winding temp rise viii. OCTC tap range ix. Weight of radiator, Transport weight of tank, Total weight x. Volume of oil in tank & radiator xi. BCT details xii. Purchaser name, PO number xiii. All necessary slinging and stacking instructions xiv. Valve and air vent point schedule with instructions
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4.00.00 FITTINGS & ACCESSORIES:

1. Transformer shall be provided with, but not restricted to following minimum fittings and accessories for satisfactory operation:

- a) Conventional type conservator with drain valve and oil filling hole.
- b) Magnetic oil level gauge with low-level alarm contact.
- c) Prismatic & toughened glass oil level gauge.
- d) Gaskets
- e) Gasket protection covers.
- f) Silica gel breather with oil seal.
- g) Double float type Buchholz relay with alarm and trip contacts with suitable gas collecting device with two shut-off valve on both side.
- h) Pocket on tank cover for thermometer.
- i) Protected type mercury in glass thermometer.
- j) Dial type (150 mm) Oil temperature indicator (OTI) with two sets of electrical potential- free contact rated for 2A, 220V DC, for alarm and trip purpose. The OTI shall be provided with anti-vibration mounting. OTI shall have maximum reading pointer along with resetting device. For remote oil temperature metering, an independent 4-20 mA should be made available.
- k) Dial type (150 mm) Winding temperature indicator (WTI) with two sets of electrical potential- free contact rated for 2A, 220V DC, for alarm and trip purpose. The WTI shall be provided with anti-vibration mounting. WTI shall have maximum reading position along with resetting devices. For remote winding temperature metering, an independent 4-20 mA should be made available.
- l) Drain Valves.

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- m) Sampling devices.
- n) Filter valves.
- o) Earthing terminals – 2 Nos.
- p) Rating & Diagram plates.
- q) Valve schedule plate.
- r) Two sets of lifting lugs (one for transformer with oil and other for tank cover).
- s) Jacking pads.
- t) Skids and pulling eyes on both sides.
- u) Air release devices.
- v) Inspection cover.
- w) Oil filling hole and cap.
- x) Tank mounted marshalling box
- y) Detachable, flat, bidirectional rollers with 90 deg. swivel mechanism.
- z) Clamping arrangement for rollers.
- aa) Ground support for cable box.
- bb) Neutral CT secondary box.
- cc) Haulage facilities.
- dd) Two nos. spring operated pressure relief devices with extension pipe to bring oil to plinth level along with electrically insulated contact for alarm and tripping for all transformers.
- ee) Gas collection device along with all accessories.

5.00.00 QUALITY ASSURANCE/TEST REQUIREMENTS

- 5.01.00 After award of contract, vendor shall submit manufacturing QP for BHEL/ Ultimate Customer's Approval. In case vendor has reference QP agreed with ultimate customer, the same can be submitted for specific project, for BHEL/ ultimate customer's approval. There shall be no commercial or delivery implication to BHEL on account of QP approval.
- 5.02.00 All materials, components and accessories of the transformers shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved quality plan. Tests shall be performed in presence of Purchaser's

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representative. The bidder shall give at least fifteen (15) days advance notice of date when the tests are to be carried out.

- 5.03.00 Successful bidder shall furnish List of sub-vendors/ makes of items for BHEL/BHEL's customer approval at contract stage. This shall not have any commercial implication to BHEL.
- 5.04.00 For acceptance of short circuit reports for tests carried out earlier on similar transformers, successful bidder shall furnish the following documents for BHEL/ BHEL's customer acceptance without any commercial/ delivery implication to BHEL.
- 5.04.01 Calculations and design considerations to prove ability to withstand the dynamic effects of short circuit.
- 5.04.02 Short circuit test report of previously tested similar transformer for validation by comparison. Criteria for similarity of transformer for acceptance of Short circuit test report shall be as given in Annexure-B of IEC-60076-5.
- 5.05.00 Test certificates of all the type tests in line with IEC 60076 (listed below), conducted on same or an identical transformer, carried out at recognized test laboratory shall be submitted for BHEL/BHEL's customer approval. If type test reports are not satisfactory / acceptable to customer / BHEL, these tests shall be conducted by bidder without any techno-commercial implication to BHEL.
- 5.06.00 The workshop tests on complete transformer shall include and not limited to the following routine test, in accordance with IEC 60076, to be carried out on all transformers. The cost of carrying out these tests are deemed to be included in the unit price of transformer.
1. Measurement of winding resistance
 2. Measurement of voltage ratio and check of phase displacement
 3. Measurement of short-circuit impedance and load loss
 4. Measurement of no-load loss and current
 5. Dielectric routine tests (IEC 60076-3)
 6. Leak testing with pressure for liquid-immersed transformers (tightness test)
 7. Check of the ratio and polarity of built-in current transformers.

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8. Check of core and frame insulation for liquid immersed transformers with core or frame insulation
9. Transformer oil analysis according to IEC 60296, IEC 60567 and according IEC 62535 for detection of potential corrosive sulphur in mineral oils.
10. Transformer tanks, conservators, oil pipework and air cooled cooling plant shall withstand without leaking or permanent distortion, the application for 24 hours of a pressure which is such that the test pressure at any point in the equipment is twice the working pressure at that point or 0.7 kg/cm² plus the working pressure at the point or 0.3 kg/cm² plus the pressure exerted at that point when the pressure relief is opened slowly by oil pressure whichever is the greatest.
11. Pressure test of radiators.
12. Tank Vacuum & Pressure Test
13. Oil Leakage Test
14. Pressure relief device, Buchholz relay, oil, winding meters, oil level indicator, dry cool breather, dissolved gas analyser test / check.

5.07.00 Type Tests to be conducted on one transformer of each rating and not limited, in line with IEC 60076, as listed below:

1. Temperature-rise type test (IEC 60076-2).
2. Dielectric type tests (IEC 60076-3).
3. Determination of sound level (IEC 60076-10) for each method of cooling for which a guaranteed sound level is specified.
4. Measurement of no-load loss and current at 90 % and 110 % of rated voltage
5. Short-circuit withstand test (IEC 60076-5) (SPECIAL TEST).

Note: Charges for carrying out short circuit test shall be payable based on actual invoice from designated laboratories (CPRI, BHOPAL/ CPRI, BANGLORE / ERDA, VADODARA) with an additional lump sum amount of 5% of ex-works price of transformer being tested to cover handling costs (transportation, insurance etc.).

5.08.00 Special Tests to be performed on each Transformer, in line with IEC 60076, are as listed below. The cost of carrying out these tests (except short circuit test

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mentioned at sr. no. 5 of clause 5.07.00 above) are deemed to be included in the unit price of transformers.:

1. Dielectric special tests (IEC 60076-3).
2. Winding hot-spot temperature-rise measurements.
3. Determination of capacitances windings-to-earth, and between windings.
4. Measurement of dissipation factor ($\tan \delta$) of the insulation system capacitances.
5. Determination of transient voltage transfer characteristics (Annex B of IEC 60076-3).
6. Measurement of zero-sequence impedance(s) on three-phase transformers.
7. Measurement of DC insulation resistance each winding to earth and between windings.
8. Vacuum deflection test on liquid immersed transformers.
9. Pressure deflection test on liquid immersed transformers.
10. Vacuum tightness test on site on liquid immersed transformers.
11. Measurement of frequency response (Frequency Response Analysis or FRA).
12. Check of external coating (ISO 2178 and ISO 2409 or as specified).
13. Measurement of dissolved gasses in dielectric liquid.
14. Mechanical test or assessment of tank for suitability for transport (to customer specification).
15. Determination of weight with transformer arranged for transport. For transformers by measurement.

5.09.00 Additional Checks to be done for each Transformer is as listed in Annexure-VI.

6.00.00 SPARES AND SPECIAL TOOLS & TACKLES

6.01.00 Commissioning spares are those, which may be required during commissioning of the equipment. Bidder to furnish list of commissioning spares along with technical offer as per Annexure-I of Section-I, Volume-II.

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6.02.00 O & M spares are those which are required for satisfactory & trouble free operation of equipment. List of O & M spares enclosed as Annexure-VIII of section-II, volume-II are the minimum requirement to take care of the extended warranty. Any additional items required to meet the extended warranty requirement are deemed to be included by the bidder in bid price. O & M spares shall be quoted as per BOQ-cum-price schedule as part of NIT.

6.03.00 List of Mandatory spares is enclosed as per Annexure-VII of section-II, volume-II. Mandatory spares shall be quoted as per BOQ-cum-price schedule as part of NIT.

7.00.00 O & M MANUAL

7.01.00 O & M manuals for the installation, operation and maintenance of transformers shall be furnished at least three months before despatch of equipment.

7.02.00 Draft manual should first be submitted for purchaser's approval. The manual should contain minimum following details:

- a) General description of equipment.
- b) Approved Technical Data Sheet
- c) Salient constructional features.
- d) Technical leaflets of fittings/ important parts.
- e) All drawings.
- f) Type and routine test certificates.
- g) Instructions to be followed on receipt of equipment at site & for storage.
- h) Instructions for foundation arrangement.
- i) Erection procedures and checks.
- j) Pre-commissioning checks.
- k) Commissioning procedures.
- l) Withdrawal arrangement/ material handling instructions.
- m) Operation instructions.
- n) Maintenance instructions.
- o) Trouble-shooting.
- p) Safety instructions.

ANNEXURE-VI

Surge Protection Equipment

The surge protection equipment shall be tested in accordance with IEC 60099.

AC Switchgear for voltages above 1 kV

IEC 62271

High-voltage switchgear and control gear

IEEE C37.013

IEEE standard for AC-High-Voltage generator circuit breakers on a symmetrical current.

At least the following tests shall be performed in the manufacturer's workshop on the individual apparatus and on the complete installation, respectively, all in accordance with IEC Standards:

- Visual inspection
- Power frequency HV tests
- Dielectric tests of the auxiliary circuits
- Measurement of the main contacts resistance with dc
- Temperature rise test on circuit breakers (type test certificate)
- Test of mechanical endurance (type test certificate)
- Measurement of the contact opening period (type test certificate)
- Functional tests of the control circuits
- Check of the operational sequence
- Measurement of the instrument transformer's angle and ratio errors (according to IEC-standards 60044)
- Check of the denominations.

Note 1: All MV switchgear shall be type tested according IEC 62271-1, IEC 62271-100 and IEC 62271-200 including internal arc classification IAC = AFLR. Related type test certificates shall be provided with the Tender. If the test has already been carried out on similar type switchgear, type test certificates may also be accepted.

Note 2: All GIS above 52 kV shall be tested according IEC 62271-1, IEC 62271-203.

Note 3: Generator circuit breakers shall be tested according IEEE Std C37.013.

High voltage fuses

IEC 60282 High voltage fuses

IEC 60644 Specification for high voltage fuse links for motor circuit applications

Oil-immersed power transformers

IEC 60076 Power transformers

IEC 60214 On-load tap-changers

IEC 60404-2 Magnetic materials

a) Tanks

- Inspection of weld preparations, approved crack detection of major strength welds.
- Hydraulic test and vacuum test
- Visual and dimensional checks
- Certification of test results.

b) Cores

- Material
 - Checks on flatness
 - Checks for absence of burrs such as may be caused by slitting, cropping and punching
 - Electrical insulated tests
 - Visual and dimensional checks.
- Assembly
 - Inspection during assembly stage, whilst core is still horizontal
 - Visual and dimensional checks on complete core
 - Checks on straightness of clamps
 - Checks on clamp welding
 - High voltage tests between core packets, clamps and belts in all relevant combinations
 - Check actual weight of core steel in magnetic circuit against design weight
 - Check that all block and sheet insulation and all spacers are in position
 - Check earthing of core packets to clamps.

c) Windings

- Windings
 - Copper checks
 - Fewest possible number of welds
 - Quality of weld and finishing
 - Insulation on copper
 - Check for correct material
 - Check correct application to conductor
 - Visual and dimensional checks
- Winding of turns
 - Checks during winding of different Sections of winding
 - Checks on positions of starts and finishes of Sections
 - Checks on correct directions of windings of turns (Polarity)
 - Visual checks
- Assembly of windings together
 - Check on relative positions and numbers of leads
 - Check that vertical and horizontal coolant ducts are clear and to full design dimensions
 - Visual checks
- Assembly of windings on core

- Visual and dimensional checks.

d) Leads

- Checks on disposition, insulation and support of tapping leads
- Checks on insulation support and positioning of bushing leads and provision for connection to bushings
- Checks on lead connections (crimping, brazing etc.)
- Checks on interphase connections
- General visual checks.

e) Insulation

- Checks on arrangement of petalling
- Checks on inter-phase and earth barriers
- Checks on shields
- Checks on clearance and creepage distances
- General visual checks.

f) Coolant flow ducts

- Check that vertical and horizontal passages are clear and to full design dimensions
- General visual checks.

g) Current transformers, links and connections

- Check that built-in current transformers are in the correct leads
- Check that the connections and alternative connections are clearly marked and that the marked ratios are correct.

h) Assembly of transformer in Tank

- Check insulation between transformer and tank
- Check security of fixing of transformer in tank and of any packing used
- Check electrical clearances between tank and leads and windings
- Checks for cleanliness and freedom from debris of inside of tank
- General visual check.

i) Valves

- Check action of valves after welding into position (especially butterfly valves)
- Checks for leaks under pressure.

j) Paint work

- Checks for preparation of surfaces
- Checks for use of correct paint system
- Visual checks on general finish.

k) Conservator

- Check for leakage
- Check capacity
- Visual checks.

l) Bushings

- Check against standards
- Check that routine tests have been done
- Checks for leakage when mounted on transformer
- Checks for distortion, flaws and chips.

m) Tap-changers (on-load and off-circuit as appropriate)

- Inspection on completion of manufacture, including a review of manufacturer's stage test records and procedures
- Mechanical and electrical checks in the manufacturer's works
- Tests in accordance with the appropriate IEC or other standard as applicable
- Check ten complete cycles from end to end of the range
- Check five cycles on full current
- Check five cycles at full voltage
- Check transmitters for correct number of steps and impedance values
- Check interlocks
- Check warning, alarm and trip contacts
- Visual and dimensional checks.

n) Pumps and fans

- Checks for direction of rotation against motor terminal markings
- Visual and dimensional checks.

o) Heat exchangers

- Checks on radiators for leaks
- Checks on radiators for paint finish and inner cleanliness
- Checks on oil-to-water heat exchangers for leaks at manufacturer's works
- Checks on oil-to-water heat exchangers for cleanliness of oil chambers and passages
- General visual and dimensional checks.

p) Processing

- Checks on pressures and temperatures with manufacturer's process charts available.

q) Control cubicles, kiosks and terminal boxes

- Checks on functioning of contactors, overloads isolators and general operation of control circuits for cooling gear
- Checks on operation of circuits for thermometers, thermal images, pressure relief valves, oil and gas operated relays, flow detectors, heaters, lights and power output sockets
- Checks on wiring arrangements and terminal boards
- Checks on weather sealing of doors, cable glands and other external features
- Visual and dimensional checks.

r) Workshop tests on complete transformer

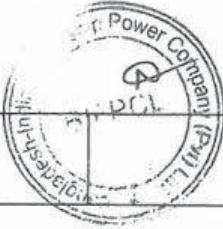
The following routine test in accordance with IEC 60076:

- Measurement of winding resistance
- Measurement of voltage ratio and check of voltage vector
- Measurement of impedance voltage, short circuit impedance and load loss
- Measurement of no-load loss and current at U_r , $1.05 \times U_r$ and $1.1 \times U_r$
- Dielectric routine tests in accordance with IEC 60076-3
- Transformers having $U_r \leq 300$ kV will be tested to Method 1
- Test on on-load tap changers
- Insulation resistance
- Separate source voltage withstand test
- Induced over voltage test & PD test
- Frequency response analysis.

The above tests shall be carried out on all transformers.

The following tests in accordance with IEC to be carried out as type tests (type tests shall not be repeated if type test certificates of an identical transformer issued by a recognized test laboratory are available):

- Temperature rise test including direct measurement of hot-spot temperature
- Measurement of the harmonics of the no-load current
- Dielectric type tests in accordance with IEC 60076-3
- Measurement of zero sequence impedance
- For the above type tests, test certificates may be accepted at the discretion of the Employer/Engineer, in place of tests on the first transformer of each basic type excepting the generator transformer. In the case of generator transformers the type tests must be carried out
- Noise measurements.

**ANNEXURE-VII****LIST OF BASIC MINIMUM SPARES****LIST OF MANDATORY SPARES FOR OIL FILLED TRANSFORMERS/REACTOR**

Sr. No.	ITEMS DESCRIPTION	GT	ST	SUT (if applicable)	UT	Aux. Trans. (for each rating)	REACTOR
1.	HV Bushing with metal parts and gaskets (See Note 1)	3 No.	3 No.	3 No.	3 No.	3 No.	3 No.
2.	HV Neutral bushing with metal parts and gaskets	2 No.	1 No.	1 No.	-	1 No. (if applicable)	1 No.
3.	MV Bushing with metal parts and gaskets (See Note 1)	-	-	-	-	-	-
4.	LV bushing with metal parts and gaskets (See Note 1)	3 No.	3 No.	3 No.	3 No.	3 No.	-
5.	LV Neutral bushing with metal parts and gaskets	-	1 No.	1 No.	1 No.	1 No. (if applicable)	-
6.	WTI with contacts	2 No.	1 No.	1 No.	1 No.	1 No.	1 No.
7.	OTI with contacts	2 No.	1 No.	1 No.	1 No.	1 No.	1 No.
8.	Pressure relief device	2 No.	1 No.	1 No.	1 No.	1 No. (if applicable)	1 No.
9.	MOG	2 No.	1 No.	1 No.	1 No.	1 No.	1 No.
10.	Buchholz relay complete	2 No.	1 No.	1 No.	1 No.	1 No.	1 No.
11.	Oil surge relay	-	1 No.	1 No.	1 No.	-	-
12.	Set of gaskets (See Note 2)	1 Set	1 Set	1 Set	1 Set	1 Set	1 Set
13.	Set of valves	2 No. of each type/size	2 No. of each type/size	2 No. of each type/size	2 No. of each type/size	2 No. of each type/size	2 No. of each type/size
14.	Cooler fan with motor	2 No.	2 No.	2 No.	2 No.	-	-
15.	Oil Pump with motor	2 No.	-	-	-	-	-
16.	Oil flow indicator	2 No.	-	-	-	-	-
17.	Set of OLTC/OCTC contacts	-	1 Set (OLTC)	-	1 Set (OLTC)	-	-
18.	Air cell for conservator	1 No.	1 No.	1 No.	1 No.	1 No. (if applicable)	1 No.
19.	Neutral Grounding Resistor w/o supporting structure	-	-	-	1 No. each type (as applicable)	-	-

Note 1: Each mandatory spare OIP bushing shall be provided with suitable "stand".

Note 2: 1 set consists of gaskets required for 1 No. transformer for the following

- (a) protection and monitoring devices
- (b) cooler circuit
- (c) largest inspection cover, if applicable
- (d) HV/LV turret, if applicable
- (e) OLTC inspection cover, if applicable

MAITREE STPP
(2 X660 MW)
EPC PACKAGE

TECHNICAL SPECIFICATION
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ANNEXURE-VIII- O & M SPARES

1.06.00 TRANSFORMER

Sr. No.	ITEMS DESCRIPTION	Transformer (For each type/rating)
1.	HV Bushing with metal parts and gaskets	6 Nos.
2.	LV bushing with metal parts and gaskets	6 Nos.
3.	LV Neutral bushing with metal parts and gaskets	2 Nos.
4.	WTI with contacts	2 Nos.
5.	OTI with contacts	2 Nos.
6.	Pressure relief device	2 Nos.
7.	MOG	2 Nos.
8.	Buchholz relay complete	2 Nos.
9.	Set of gaskets (See Note 1)	2 SET
10.	Set of valves	4 Nos. of each type/size
11.	Air cell for conservator	2 Nos.

Note 1: 1 set consists of gaskets required for 1 No. transformer for the following

- (a) Protection and monitoring devices
- (b) Cooler circuit
- (c) Largest inspection cover, if applicable
- (d) HV/LV turret, if applicable