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REPUBLIC OF YEMEN PEC – ME 400 MW MARIB GTPS – II	TENDER DOCUMENT FOR ENGINEERING, PROCUREMENT & CONSTRUCTION (EPC)	7195-GE-SPC-700-001	C	7.6
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(PEC TENDER NO.: 12/2008)

VOLUME IV
SECTION 7.6
CLEANING, PROTECTIVE COATING AND PAINTING

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7.6.0 CLEANING, PROTECTIVE COATING AND PAINTING

7.6.1 General

This specification covers the general requirements related to the cleaning protective coating and painting of equipment, components and system. The components and/or equipment shall be mechanically and /or chemically cleaned during the following stages of the Contract.

- Cleaning in workshop
- Cleaning before painting and/or corrosion protection (application of prime coat)
- Cleaning before erection and during installation.

Cleaning of fabricated component items shall be carried out after fabrication and final heat treatment or welding at manufacturer's works or at site, as appropriate.

For cleaning in workshop and before painting mechanical cleaning as opposed to alternative chemical cleaning is the preferred method for works cleaning except where this is precluded by design or access considerations.

Machined surfaces shall be protected during the cleaning operations.

In the event of the surfaces not being cleaned to the purchaser's satisfaction, such parts of the cleaning procedures or agreed alternatives as are deemed necessary to overcome the deficiencies shall be carried out at the supplier's sole expense.

For reclining small areas, hand cleaning by wire brushing may be permitted. Wire brushes used on austenitic steel bristles.

Austenitic stainless steels, copper and aluminium alloys, cast iron, bimetallic and metallic/plastic items, and components fabricated by spot welding or riveting shall not be chemically cleaned. All weld areas shall be suitably stress relieved before chemical cleaning.

Codes and Standards

Internationally recognized codes and standards with purchasers approval shall be followed for the work covered by this contract.

Surface Preparation Standards

The following standards shall be followed for surface preparations:

- Swedish standard Institution - SIS-05 5900-1967 (Surface preparation standards for painting steel surfaces).
- Steel structures painting council, U.S.A. (Surface Preparation Specifications (SSPC-SP).
- British Standards Institution (Surface Finish of Blast cleaned steel for painting) BS-4232.
- National Association of Corrosion Engineers, U.S.A. (NACE).
- Various international standards equivalent to Swedish standard for surface preparation are given in Table-1.

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The contractor shall arrange, at his own cost, to keep a set of latest edition of the above standards and codes at site.

The paint manufacturer's instruction shall be followed as far as practicable at all times. Particular attention shall be paid to the following:

- a) Proper storage to avoid exposure as well as extremes of temperature.
- b) Surface preparation prior to painting.
- c) Mixing and thinning
- d) Application of paints and the recommended limit on time intervals between coats.
- e) Shelf life for storage.

Any painting work (including surface preparation) on piping or equipment shall be commenced only after the system tests have been completed and clearance for taking up painting work is given by the Engineer, who may, however, at his discretion authorise in writing, the taking up of surface preparation or painting work in any specific location, even prior to completion of system test.

Equipment

All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipment, scaffolding materials, shot/sand blasting equipment & air compressors etc. shall be arranged by the contractor at the site in sufficient quantity at his own cost. He shall arrange at his own cost, for suitable paint thickness measuring instrument like Elkometers acceptable to the Engineer (with calibration facilities).

Mechanical mixing shall be used for paint mixing operations in case of two pack systems except that the Engineer may allow the hand mixing of small quantities at his discretion.

7.6.2 Mechanical Cleaning at Manufacturer's Works

Mechanical cleaning shall preferably be carried out by abrasive blasting. The Owner is prepared to consider alternative methods provided they achieve the necessary surface condition.

Surface condition:

The Metal surfaces shall be clean and free of mill scale, rust, dirt, grease and any other deleterious matter.

Where metal surfaces are to be painted the surface profiles shall conform with the painting specification requirements.

Where this does not apply surfaces shall have a surface texture not coarser than Grade 80 abrasive paper.

Abrasives:

Abrasives containing silica, silicates or slag residues shall not be used for water/steam side surfaces of plant except for cleaning sand castings, where hydro blasting with sand may be used.

For austenitic materials only, abrasives containing 98% or more of alumina, Al_2O_3 , shall be used.

Removal of abrasive and debris:

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After cleaning, abrasive and debris shall be thoroughly removed from components.

7.6.3 Alternative Chemical Cleaning at Manufacturer's Works

The procedure shall comprise:

Pre-treatment
Acid treatment

To achieve cleanliness equivalent to that specified for mechanical cleaning. The procedure to be adopted must meet with the purchaser's approval.

7.6.4 Protection at Manufacturer's Works

As soon as all items have been cleaned and within four hours of the subsequent drying, they shall be given suitable anti-corrosion protection.

All water, air and steam side surfaces shall be protected by the application of approved water soluble corrosion inhibitors, or vapour phase inhibitors that can be subsequently removed by site water washing or steam blowing.

The rate of application of volatile corrosion inhibitors shall be at least 10 grams per square metre or 35 grams per cubic metre, whichever is the greater, except for pipes up to 300 mm diameter for which the minimum application rates shall be 5 grams per square metre.

Immediately after the protective treatment has been applied all vessels and pipes shall be suitably sealed off by discs or caps or approved alternatives to prevent ingress from the surrounds. Cylindrical plugs shall not be driven into the ends of pipes. These protective covers shall not be removed until immediately before final connection is made to the associated equipment.

7.6.5 Weather Conditions

Painting shall be done only when the surface temperature is above 5°C. surface temperature must be at least 3°C above dewpoint to ensure that condensation does not occur on the surface.

Reasonable protection against precipitation, corrosive fumes and vapours shall be exercised for the painting of outdoor parts.

Precautions shall also be taken against solar radiation to ensure that the specified dry film thickness of priming or finish coats is obtained.

Any prime coat exposed to excess humidity, rain, dust etc., before drying, shall be permitted to dry and the damaged area of primer shall be removed and the surface prepared and primed again.

Sheltered or unventilated horizontal surfaces on which dew may collect require more protection, and to achieve this an additional top coat of paint shall be applied.

7.6.6 Surface Preparation

In preparing any surface to be coated, all loose paint, dirt, grease, rust, scale, weld slag or spatter or any other extraneous material shall be removed and defects repaired, so as to obtain a clean, dry, even surface to receive the priming or finishing coat (s) as called for in the

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painting schedules. Sharp edges should be rounded, especially when tank linings have to be applied.

All machined surfaces, including flange faces, shall be suitably covered to prevent damage during surface preparation.

All surfaces should be blast cleaned whenever possible.

Surface preparation methods

Bare steel surfaces should be prepared by one of the methods described below in order of preference and in accordance with Swedish Standard SIS 05 59 00 or Steel Structures Painting Council, SSPC, Vis 1, or DIN 55928, section 4.

(a) White metal blast cleaning: Sa 3 or SSPC - SP 5

Sa 3 Blast cleaning to bare metal. Mill scale, rust and foreign matter must be removed completely. Subsequently, the surface is cleaned with vacuum cleaner, clean dry compressed air or a clean brush. It must then have a uniform metallic colour and correspond in appearance to the prints designated Sa 3.

(b) Near white metal blast cleaning Sa 2 1/2 or SSPC - SP 10

Sa 2 1/2. Very thorough blast cleaning. Mill scale, rust and foreign matter shall be removed to the extent that the only traces remaining are slight imperfections in the form of spots or stripes. Subsequently, the surface is cleaned with a vacuum cleaner, clean dry compressed air or a clean brush. It must then correspond in appearance to the prints designated sa 2 1/2.

Mechanical cleaning should only be used when procedures (a) and (b) are not practicable.

(c) Commercial Blast Cleaning Sa 2

Sa 2 Blast cleaning until atleast two-thirds of each element of surface area is free of all visible residues. This method of Blasing is suitable for steel required to be painted with conventional paints for exposure to mildly corrosive atmesphere for longer life of the paint systems.

(d) Near white metal blast cleaning P Sa 2 1/2 DIN 55928

Very thorough blast cleaning. Very adhesive coatings remain. From all other surface mill scale and rust are to be removed to such an extent that the only traces remaining are slight imperfections in the form of spots or stripes. Further treatment see Sub b).

The adhesivity of residual coatings in the transition zone has to be tested even after the application of the primer.

(e) very thorough mechanical scraping and wire burshing St 3

St 3 very thorough scraping and wire-burshing - machine brushing - grinding - etc. are to be preferred. Surface preparation as for st 2. But much more thoroughly. After the removal of dust, the surface must have a pronounced metallic sheen and correspond to the prints designated St. 3.

(f) Thorough scraping and wire brushing: St 2

St 2 Thorough scraping and wire-brushing - machine brushing - grinding - etc. The treatment shall remove loose mill scale, rust and foreign matter. Subsequently, the surface is cleaned

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with a vacuum cleaner, clean dry compressed air or a clean brush. It should then have a faint metallic sheen. The appearance must correspond to the prints designated St 2.

Table-1 (Surface Preparation Standards)

Surface preparation method	SIS 055900	DIN 55928, Part 4	BS 4232 only for blasting	SSPC-Vis
blasting acc.to item (a)	Sa 3	first quality	white metal	SP 5
blasting acc. to item (b)	Sa 2 1/2	second quality	near white	SP 10
blasting acc.to item (c)	Sa 2	Third quality	Commercial Blast	SP 6
derusting acc to item (f)	St 2	—	Hand tool/ power tool Cleaning	SP 2
acc. to items (e)	St 3	—	Power tool Cleaning	SP 3
Flame jet cleaning	F1	—	Flame cleaning	SP 4
Pickling	Be	—	Pickling	

Steel structures to be blast cleaned have to be free of pitting and other severely corroded places in accordance with B.S. 4232 and SIS 055900.

The abrasives used for blast-cleaning shall be graded flint, grit, shot or silica sand and shall be such that they will produce an average keying profile on the blast-cleaned surface of not more than 40 microns.

An air pressure of 7 bar g at the nozzle shall be used.

After blast-cleaning, all accumulated grit, sand, dust, etc., must be removed leaving the surface clean, dry and free of mill scale, rust grease and other foreign matter.

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In the event of rusting after completion of the surface preparation, the surface must be cleaned again in the manner specified.

Oil, grease, soil, cement, salts, acids or other corrosive chemicals shall be cleaned from steel surfaces, by the use of solvents, emulsions or cleaning compounds. The final wiping shall be with clean solvent and clean rags or brushes. There shall be no detrimental residue left on the surface.

Primed areas which suffer damage must be spot blasted on site to a degree of cleanliness P Sa 2 1/2 before touching up.

Protective coating must be applied as quickly as possible after the completion of surface preparation no matter what cleaning method has been used.

No blast-cleaned surface shall be allowed to remain uncoated overnight.

Steel work protected by shop primer after arrival on site must be cleaned of salt, sand, oil etc. before the first coat of paint is applied on site. Shop primer damaged during transport must be rectified by blast-cleaning and coating before application of the site coats.

Wood surfaces shall be sanded clean. All nail holes shall be puttied and sanded before priming.

Concrete: If a protective coating is required, concrete shall be allowed to cure before painting.

7.6.7 Rub Down and Touch up of Primer

The shop coated surfaces shall be rubbed down thoroughly with emery paper to remove all dust, rust and other foreign matters, washed, degreased, then cleaned with warm fresh water and air dried. The portions, from where the shop coat has peeled off, shall be touched up and allowed to dry before applying a coat of primer. The compatibility between shop coat and field primer should be ascertained from the paint manufacturer. In case degreasing with white spirit is not effective, the surface should be finally wiped clean with aromatic solvent like xylol or light naphtha.

7.6.8 Non Compatible Shop Coat Primer

The compatibility of finishing coat should be confirmed from the paint manufacturer. In the event of use of primer such as zinc rich epoxy, inorganic zinc silicate etc., the paint system shall depend on condition of shop coat. If the shop coat is in satisfactory condition showing no major defect, the shop coat shall not be removed. The touch up primer and finishing coat(s) shall be identified for application by Engineer.

Shop coated (coated with primer & finishing coat) equipment shall not be repainted unless paint is damaged.

Shop primed equipment and surfaces shall only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer unless otherwise specified. If shop primer is not compatible with field primer then shop coated primer shall be completely removed before application of selected paint system for particular environment.

For package units/equipment, shop primer shall be as per the paint system given for particular environment.

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In case of existing paint, compatibility between finishing coat and new selected finish coat shall be ascertained before application of finish coat. In case the coat is selected for upgrading existing alkyd coating to high performance coating, then surface preparation can be by manual/mechanical means to remove loose rust, peeled off/damaged paint, but sound old coating need not be removed. It should be touched with red oxide zinc chromate primer wherever it has peeled off before application of tie coat. The tie coat shall be applied after 7 days of curing of red oxide zinc chromate primer. If new paint system is not suitable to upgrade existing coating then complete paint shall be removed by mechanical or blast cleaning before application of new coating system.

7.6.9 Paint Materials

Plant and equipment shall be painted according to the colour scheme followed in Phase-I

7.6.10 Storage

All paints and painting material shall be stored only in rooms to be provided by the contractor and approved by Engineer for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separated from adjacent buildings. A signboard bearing the words "PAINT STORAGE - NO NAKED LIGHT - HIGHLY INFLAMMABLE - DANGER - NO SMOKING" shall be clearly displayed outside. All paints should be stored in the safest manner so that no container rolls down and causes accidents. The shelf life of the paints should be ensured so that the paint materials are not in storage and use after the date of expiry.

7.6.11 Preparation of Coating Materials

All container shall remain un-opened until required for use.

Primers and paints which have livered, gelled or otherwise deteriorated shall not be used.

The oldest primer or paint of each kind shall be used first.

All ingredients in any container shall be thoroughly mixed before use, and shall be agitated frequently during application to keep the primer in suspension.

Primer or paint mixed in the original container shall not be transferred until all settled pigment is incorporated into the body of the liquid.

Mixing in open containers shall be done in a well ventilated area.

Primer or paint shall be mixed in a manner ensuring the breakdown of all lumps, complete dispersion of pigment and uniform composition.

Two-component primers shall be mixed in accordance with the manufacturer's instructions.

Thinners shall not be added to primers or paints unless necessary for proper application according to the manufacturer's instructions.

When use of thinners is permitted, it must be added to the primer or paint during mixing.

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7.6.12 Application

Health and safety of work

The supplier has to check all painting work to be carried out according to the specification of the paint supplier further to all relevant prescriptions and regulations concerning the health and safety of work.

The paint supplier has to present a written specification including at least the flash point of the paints, ventilation requirements, handling precautions such as inhalation, eye and skin protection, and first aid procedure, storage requirements, spill or leak procedure, fire precaution, waste disposal.

7.6.13 Safety Requirements

Protection of the blast cleaner operator's eyes and respiratory system should be given prime consideration in any open blast cleaning operation. Airfed helmets, respiratory filters, air conditioned hoods etc. should be provided in sufficient number to the blast cleaning operators to avoid the harmful effect of blast cleaning abrasives. Also, an automatic shut-off device which will shut-off the air supply to the blasting machine should be installed which will prevent the dangerous whipping of an operating blast hose if an operator becomes disabled.

Methods

Temporary corrosion protections are to be completely removed prior to applying the definite one.

All prime coatings shall be applied by brush or airless spray or a combination of these methods, as approved by the coating manufacturer.

All doors, windows, stairways, handrails (if painted), bolts, flanges and equipment supports shall be finish painted by brush.

Spray guns should not be used outside in windy weather or near surfaces of a contrasting colour unless the latter is properly protected.

All cold-spray painting shall be done using standard equipment in accordance with accepted standards and methods.

Care has to be taken not to connect spraying devices for nitro and backelite paints simultaneously to oil based paints.

Paint applied to items that are not be painted shall be removed at the supplier's expense, leaving the surface clean, unstained and undamaged.

7.6.14 Dry Film Thickness (DFT)

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To the maximum extent practicable the coats shall be applied as a continuous film of uniform thickness and free of pores. Overspray, skips, runs, sags and drips should be avoided. The different coats shall not be of the same colour.

Each coat of paint shall be allowed to harden before the next is applied. For epoxy paint the hardening time normally is 12-14 hours. Suppliers' recommendations regarding hardening time of epoxy paints must be followed.

Particular attention must be paid to full film thickness at edges.

The minimum total dry film thickness of the paint systems shall be as recommended in the following table. The dft is given in microns (millionths of a metre).

7.6.15 Protective Coatings and Paint Systems

The type and number of protective coats for any item requiring painting are to be in accordance in the attached tables "Paint Systems" (Annex-1).

Alternative to the 'paint system' specified, are to be presented on the schedule Departure from Specification, as indicated elsewhere.

Generally, all parts shall receive the specified prime coat (s) at the supplier's works to ensure that no corrosion occurs during transport to the site and storage at the site.

Parts which cannot be damaged during transport shall receive the full number of coats.

7.6.16 Colour Code for Piping

The colour code scheme is intended for identification of the individual group of the pipeline. The system of colour coding consists of a ground colour and colour bands superimposed on it. The colour coding for the identification of pipelines should comply with the requirements of Phase-I.

Ground Colour shall be applied throughout the entire length for uninsulated pipes. For insulated pipes, on the metal cladding or on the pipes of material such as non-ferrous metals, austenitic stainless steel etc. Ground colour coating of minimum 2m length or of adequate length not to be mistaken as colour band shall be applied at places requiring colour bands. Colour band(s) shall be applied at the following location.

- At battery limit points
- Intersection points & change of direction points in piping ways.
- Other points, such as midway of each piping way, near valves, junction joints of service appliances, walls, on either side of pipe culverts.
- For long stretch/yard piping at 50 M interval.
- At start and terminating points.

Identification Sign

Flow direction shall be indicated by an arrow in the location stated in Para a,b,c & d and as directed by Engineer.

Colours of arrows shall be black or white and in contrast to the colour on which they are superimposed. The size of the arrows shall confirm to relevant standards.

Product names shall be marked at pump inlet, outlet and battery limit in a suitable size as approved by Engineer.

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Colour Bands

The width of colour band shall conform to the requirements of Phase-I

Whenever it is required by the Engineer to indicate that a pipeline carries a hazardous material, a hazard marking of diagonal stripes shall be made as per the requirements of Phase-I

7.6.17 Identification of Vessels, Piping etc.

Equipment number shall be stenciled in black or white on each vessel, column, equipment & machinery (insulated or uninsulated) after painting. Line number in black or white shall be stenciled on all the pipe lines of more than one location as directed by Engineer, size of letters printed shall be as per applicable codes & standards

Identification of storage tanks: The storage tanks shall be marked as detailed in the respective drawing.

7.6.18 Inspection and Testing

All painting materials including primers and thinners brought to site by the contractor for application shall be procured directly from manufacturer as per specifications and shall be accompanied by manufacturer's test certificates. Paint formulations without certificates are not acceptable.

Engineer at his discretion, may call for tests for paint formulations. Contractor shall arrange to have such tests performed including batchwise test of wet paints for physical & chemical analysis. All costs thereof shall be borne by the contractor.

The paints shall be tested as per applicable codes & standards approved by the Owner.

The painting work shall be subject to inspection by Engineer at all times. In particular, following stagewise inspection shall be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

- a. Surface preparation
- b. Primer application
- c. Each coat of paint

In addition to above, record should include type of shop primer already applied on equipment e.g. Red oxide zinc chromate or zinc chromate or Red lead primer etc.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra coat to owner.

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7.6.19 Primer Application

After surface preparation, the primer should be worked by brush application to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer.

The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer before application of successive coats.

The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring.

Elcometer for measuring the Dry film thickness of each coat, surface profile gauge for checking of surface profile in case of sand blasting, Holiday detectors and pinhole detectors for checking the painted surface discontinuities should be provided by the contractor.

At the request of Engineer, the contractor shall make arrangements for paint manufacturer to provide expert technical service at site as and when required. This service should be free of cost and without any obligation to the Purchaser, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations.

Final inspection shall include measurement of paint dry film thickness, check of finish and workmanship. The thickness should be measured at as many points/locations as decided by the Engineer and shall be within + 10% of the dry film thickness.

7.6.20 Guarantee

The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.

The contractor shall produce test reports from the manufacturer regarding the quality of the particular batch of paint supplied. The Engineer shall have the right to test wet samples of paint at random for quality of the same. Batch test reports of the manufacturer's for each batch of paints supplied shall be made available by the contractor.

7.6.21 Scope of areas to be Painted and Painting Systems

The paint system adopted shall be suitable for Coastal and Marine environment as given in Annex - 1.

Primers and finish coats for any particular paint system shall be from same manufacturer in order to ensure compatibility.

7.6.22 Galvanizing

Galvanizing works shall conform in all respect to applicable standards and shall be performed by the hot dip process, unless otherwise specified.

It is essential that details of steel members and assemblies which are to be hot-dip galvanized should be designed in accordance with applicable standards.

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Vent-holes and drain-holes should be provided to avoid high internal pressures and air-locks during immersion, which may cause explosions, and to ensure that molten zinc is not retained in pockets during withdrawal.

Careful cleaning of welds is necessary before welded assemblies are dipped. The welds and the surrounding metal should be cleaned separately, preferably by blast-cleaning, because the usual preliminary pickling cannot be relied on to remove the welding slag.

All defects of the steel surface including cracks, surface laminations, laps and folds shall be removed in accordance with relevant applicable standards. All drilling, cutting, welding, forming and final fabrication of unit members and assemblies shall be completed, where feasible, before the structures are galvanized. The surface of the steelwork to be galvanized shall be free from paint, oil, grease and similar contaminants. The weight of zinc coating per unit area has to be noted in the manufacturing documents.

Structural steel items shall be initially grit-blasted to B.S. 4232, second quality, (Sa 21/2) or by pickling in a bath and the minimum average coating weight on steel sections 5 mm thick and over shall be 900 g/m².

On removal from the galvanizing bath, the resultant coating shall be smooth, continuous, free from gross surface imperfections such as bare spots, lumps, blisters and inclusions of flux, ash or dross.

Galvanized contact surfaces to be joined by high-tensile friction-grip bolts shall be roughened before assembly so that the required slip factor is achieved. care shall be taken to ensure that the roughening is confined to the area of the mating faces.

Bolts, nuts and washers, including general grade high-tensile friction grip bolts shall be hot dip galvanized and subsequently centrifuged. Nuts shall be tapped up to 0.4 mm oversize after galvanizing and the threads oiled to permit the nuts to be finger-turned on the bolt for the full depth of the nut. No lubricant, applied to the projecting threads of galvanized high-tensile friction-grip bolt after the bolt has been inserted through the steelwork, must be allowed to come into contact with the mating faces of the steelwork,. A local remelting of the galvanized parts to achieve the nuts to be finger turned on the bolt is to be done as per the relevant standards.

Protected slings must be used for offloading and erection. Galvanized work which is to be stored at the works or on site shall be stacked so as to provide adequate ventilation to all surfaces to avoid wet storage staining (white rust).

Small areas of the galvanized coating damaged in any way shall be restored in accordance with relevant standards.

- Cleaning the area of any weld slag rust and other impurities and by thorough wire brushing to give a metallic clean surface.
- application of suitable number of coats of zinc-rich paint containing more than 90 % w/w of zinc in dried film. The dry film thickness shall exceed at least 50 % the thickness of the desired galvanization. In case of application of a low melting point zinc alloy repair rod, the rods shall be in accordance with applicable codes, the thickness of the alloy shall be at least as of the desired galvanization.

The restored area is not to exceed 1 % of the galvanized surface.

Surface restoration of parts in contact with drinking water is not allowed and the quality of the galvanization is to be in accordance with relevant standards.

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After fixing, bolt heads, washers and nuts shall receive two coats of zinc-rich paint. Connections between galvanized surfaces and copper, copper alloy or aluminum surfaces shall be protected by suitable preferably hydrophobe tape wrappings to the owner's approval.

7.6.23 Sprayed Metal Coatings

Corrosion protection may be also achieved by spraying of suitable metals as zinc and/or aluminium on the surfaces of structures. For special cases tin, copper, lead can be used as well. Methods of surface preparation have to conform to relevant applicable standards. A proper treatment of the surface followed by an immediate spraying is to apply to ensure adhesion of the sprayed metal. The surface has to be clean, free of impurities, rust, millscale and rough enough to have binding properties to ensure good enticulation with the sprayed layer. Suitable roughness can be achieved by blast cleaning acc. to BS 4232. Welds are to be cleaned and prepared with special care. All surfaces to be treated have to be dry and accessible.

Application of coatings, requirements for thickness, adhesion, composition of coating metals, and subsequent treatment have to conform to relevant standards.

Testing of the spray coated layer are to be carried out in accordance with relevant standards.

The contractor has to specify the type, composition and thickness of the sprayed metal and of the sealing coating acc. to relevant applicable standards including the corresponding warranties and tests if sprayed metal coating will be applied.

7.6.24 Safety of Work

All precautions connected with this type of application of corrosion protection have to be in accordance with relevant standards.

Sprayed, unfused coating of metals and metallic compounds applied by combustion gas flame, plasma arc, detonation and similar processes, and the preparation of components, spraying techniques, sealing, finishing and inspection shall be according to relevant standards.

The hot galvanized surface has to be cleaned before the application of the coats to remove corrosion products, dirt, dust, grease.

The cleaning can be achieved by

- brush off
- washing with 1 - 1.5 % ammonia water with up to 0.1 % detergent added and followed by wet grinding using e.g. scotch britt to turn the foam to grey color,
- steam blasting,

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ANNEX - 1

PAINT SYSTEM - COASTAL AND MARINE ENVIRONMENT

SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM		GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS			IN SHOP	ON SITE
1	Structural steel work, piping (oil + water), tanks outside surface, transmiss, towers, cranes, steel floors, galleries, stairways, outdoor.	upto 130°C	Sa 2½	Prime	2	P6	35	x	
				Intermediate	1	P7	35	x	x
				Finish	1	F2	50		x
						Total min. dft	220		
2	Structural steel work, piping, indoor and outdoor	130 to 200°C	Sa 2½	Prime	1	F9	75	x	
				Intermediate	1	F9	20		x
				Finish	2	F11	20		x
						Total min. dft	135		x
3	Structural steelwork, piping, uninsulated carbon steel, indoor and outdoor	200 to 400°C	Sa 3	Prime	1	F9	75	x	

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM			GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION					
				COAT	NO. OF COATS				IN SHOP	ON SITE				
4	Structural steel work, piping (oil + water), tanks, indoor	upto 130°C	Sa 2½	Intermediate	1		F12	20		x				
				Finish	1		F12	20 115		x				
				Prime	2		P6	35	x					
								35	x					
				Finish	1		F6	100		x				
							Total min. dft	170						
5 (a)	Structural steel work in the battery rooms,	Ambient	Sa 3	Prime	2		P8	30 30	x x					
				Finish	2		F6	100 100		x x				
											Total min. dft	260		
				(b)	Uninsulated - equipment, tanks and piping etc.	upto 80°C	Sa 3	Prime	2		P3	35 35	x x	
								Finish	2		F6	100 100		x x
							Total min. dft	270						

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM		GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS			IN SHOP	ON SITE
6	Steel tanks inside surface (total) for oil storage	normal	Sa 2½	Prime	2	P3	35 35	x x	
				Finish	2	F6	100 100		x x
						Total min. dft	270		
7	Steel tanks inside surface (total) for water storage (potable and distilled water)	normal	Sa 2½	Prime	2	P2	50 50	x x	
				Finish	2	F3	30 30		x x
						Total min. dft	160		
8	Cast iron water pipe lines-outside surface, buried in the soil	upto 60°C	Sa 3	Prime	2	P8	30 30	x x	
				Finish	3	F7	125 125 125		x x x
						Total min. dft	435		
9	Steel pipes inside surface such as cooling water lines	upto 60°C	Sa 2½	Finish	4	F7	125 125 125 125		x x x x
						Total min. dft	500		

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SL. NO.	SURFACE/LOCATION	TEMP. °C	SURFACE PREPARATION	PAINT SYSTEM		GENERIC TYPE	PER COAT MICRONS Dft	APPLICATION	
				COAT	NO. OF COATS			IN SHOP	ON SITE
10	Water pipelines - outside surface, indoor	upto 60°C	Sa 3	Prime	2	P2	50	x	
							50	x	
				Finish	3	F3	30		x
							30		x
							30		x
						Total min. dft	190		
11	Oil pipelines - outside surface, above ground	upto 90°C	Sa 3	Prime	2	P3	50	x	
							50	x	
				Finish	2	F6	100		x
							100		x
						Total min. dft	300		
* For Details of Primer and Finish coats, refer Annex to paint systems.									


VOLUME IIB

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

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



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NEW DELHI, INDIA**

	TITLE TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING FOR EXPORT JOBS	SPECIFICATION NO. PE-TS-888-100-A001	
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1.0 Purpose

The purpose of this specification is to describe minimum packing requirements for the different items/equipment for all export Project and also to define marking and shipping requirements during transportation by ship, road and air for all export jobs.

2.0 SCOPE

For export jobs, sea worthy packing capable of performing all necessary functions like prevention of damage to the contents, sufficient to support frequent handling and lengthy period of outdoor storage in adverse weather conditions are required. Workmanship and materials used shall be of high standard meeting the technical requirements and in accordance with best commercial export packing practices. Vendor shall be responsible for sea worthy export packing, however it shall meet the minimum requirements specified herein. Equivalent or better packing methods may be deployed subject to approval of the BHEL/Purchaser. Vendor shall submit the packing procedure for its equivalent for purchaser's approval during detailed engineering.

The scope this specification is to define VENDOR's responsibilities in terms of:

- Preservation of the GOODS/items/equipments before packing.
- Packing of the GOODS for road, rail, sea and/or air transportation to desired destination i.e. project site
- Making cases/crates
- Chemical Treatment/Fumigation before packing to prevent fungus, damage due to termite, borer, rats, etc.
- Marking of cases/crates.
- Other Services required.


3.0 Application

This specification is applicable to all the goods to be transported to project site and requires to be in transit for longer duration. *However, for "Misc cable erection items", "Fire sealing system" & "Exothermic welding material", the packing requirements shall be as per the procurement specification.*

4.0 Definitions

- "BHEL" : Main EPC vendor
- "OWNER" : Customer for a particular export project.
- "VENDOR" : Company(ies)/VENDOR(s) to whom the BHEL has placed Purchase Order for GOODS/ items/system/package.
- "GOODS": means all or part of the articles, material, equipment supplies including technical documentation, as described in the Purchase Order, to be supplied by VENDOR.
- "PACKER": Packaging Company to whom VENDOR intends to sub-contract the packing in case they do not have own packing capability/facilities .
- "FREIGHT FORWARDER" : Means the Company responsible for performing freight forwarding activities.

5. General Information

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The following requirements are intended as minimum requirements, and compliance to these requirements in no way absolves or relieves **VENDOR** of any responsibility or obligation outlined in the Purchase Order. In all circumstances, the packing will be designed and constructed in order to support **GOODS** during transportation as well as to prevent the Goods from damage due to impact, extreme climatic conditions, sun and rain. It must be ensured that the delivery of the **GOODS** to the jobsite by sea, road or air, in good condition.

GOODS shall be export packed in compliance with the best-established practices for international projects, in accordance with the following instructions. In the event of any conflict between these specified requirement and the established practices, specification requirement shall govern.

Due to climatic conditions and the complex transport operation(s), it is essential that protection and packing is of the highest standard. Packing means to efficiently protect the **GOODS** during the total transport operation; from the moment they leave the factory until they are delivered to the jobsite, including handling operations (loading/unloading) and storage.

When **VENDOR** do not have packing capabilities/facilities of their own and therefore intends to sub-contract, **VENDOR** have to inform **BHEL/Purchaser** of the name and address of proposed **PACKER(s)** for approval.

6.0 Criteria for Selection of Packaging

Packages are to be made according to categories, described in articles 8.1 to 8.5, depending on the type of materials, their fragility and size.

These categories have been established for the protection of equipment and material during multi-mode transports, i.e.: combination of overland and sea transport; containerization, air transportation.

In a general manner, the **GOODS** have to be packed in such a way that crates, bundles, pallets can be stored into General Purpose containers, wherever possible.

If **VENDOR** has any doubt about the correct method of protection or packing, he should contact **BHEL/Purchaser** in order to mutually agree on the adequate type of packing to be used.

Materials can be classified in following categories

- Hazardous Material
- Non-Hazardous Material
-


Further to above categorisation, non-hazardous materials can be sub- categorised for selection of packing.

6.1 Hazardous Materials

Though handling of hazardous material may is not applicable in the scope of this specification. All hazardous material must be packed in adherence to the detailed requirement relating to packing, marking and labelling set out in the most recent report of the Board's Standard Advisory Committee on the Carriage of Dangerous Goods in Ships for sea freight, and the Restricted Articles Regulations, laid down by the International Air Transport Association for airfreight.

6.2 Non-Hazardous GOODS

The scope of this specification is to provide necessary guidelines for packing for power plant equipment, components, Pipings & Valves, Fittings, other structural items, electrical items, spare parts and erection materials. The procedure is defined in subsequent paragraphs in details in clause no. 8.0.

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7.0 Marking Instructions & Despatch details, Storage Code

7.1 Marking Instructions & despatch details

Packages and crates will be marked with indelible black paint, resistant to seawater. Marking must be perfectly legible.

The shipping marks, which will be as per fig-13, shall be stencilled on two sides and one end in clear characters at least 5 centimetres high (where crate size permits, otherwise use optimum size for each package dimension).

When the GOODS are to be shipped in containers then marking may be stencilled on one end only. However, packages must be stowed in a manner that shows these marks.

Crates containing fragile articles must be packed with special precaution against risk of breakage and must be stencilled on all sides "FRAGILE - HANDLE WITH CARE". Where crates are not to be overturned, VENDOR must show on the crates, clear and readily visible identification as per fig-12, to ensure they are kept in the correct position.

Packages/equipment of 2,000 kg or more must be marked with slinging points on all sides, in addition to the centre of gravity marks.

Number packages consecutively i.e. 1 of 10, 2 of 10, etc. Do not duplicate package numbers. VENDOR is responsible for any loss or damage caused by incorrect marking.

All cases/crates shall also be marked with the appropriate international standard graphic symbols for handling as shown in Fig 12.

As a minimum, all cases/crates are to be marked clearly on all four sides with:

- "HANDLE WITH CARE"
- "RIGHT SIDE UP"
- "KEEP DRY"

In the case of packages with a single gross weight totalling 2,000 kg and/or a height of more than 1m, the centre of gravity shall be clearly marked with the symbol on two adjoining sides. For all items of equipment with an eccentric centre of gravity this symbol shall be marked at the bottom, side and top of the package.


The slinging and lashing points shall be marked with a chain symbol.

When packing in cases/crates, these packages shall also have metal corners at the slinging points. (Fig-11)

External front and rear sides of the boxes to be planed for writing instructions.

Dispatch details such as consigner/consignee address, contract and case details, country of origin, port of delivery, stacking instructions shall be written on one side of the boxes. An anodized aluminum plate as per details and specifications given in fig-13 shall be provided on one side of the boxes.

One copy of packing slip wrapped in polyethylene bag covered with aluminum packing slip holder to be nailed on the external surface of the box. One more copy of the packing slip wrapped in polyethylene bag is to be kept inside the box at the pertinent place.

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7.2 Storage Code

The type of storage required is required to be specified, it will be shown on each packaging in **RED colour**.

- X Crates or packages to be stored outdoor without covers
- XX Crates or packages to be stored under tarpaulin
- XXX Crates or packages to be stored in covered or enclosed premises
- XXXX Crates or packages which must be stored in air-conditioned premises

8.0 GUIDELINES FOR PACKING GOODS

8.1 In the subsequent paragraphs details of different types of packings for different types of GOODS are defined. Vendor shall make packing details/procedure based on the guidelines and submit for approval.

8.1.1 Packing for Pipe, Fittings, Flanges and Valves, Structural Steel

Particular attention should be brought to pipe, fittings, flanges, valves and structural steel. Packing categories for piping and fittings will differ according to the diameter and wall thickness of these products. VENDOR shall comply with the following established practice.

IMPORTANT NOTE:

Depending on the project schedule and availability of ocean vessels, the piping and structural steel may be shipped in containers. In this event, VENDOR has to arrange the packages in such a way it allows the stuffing into Open Top in gauge containers.

8.1.2 Pipe

Where practicable, pipe lengths shall be limited to 11.8 meters.

All pipes 2" included and below shall be packed in crates. All pipes to be capped and ends sealed with waterproof tape.

Pipes over 2" up to 6", shall be bundled and banded in bundles of uniform length. Bundling is carried out with U-IRON or traversal planks, joined with threaded connecting rods with locknuts. Quantities and strapping positions depend on the lengths, with a 120 cm spacing to prevent distortion. Bundle weight shall not exceed 2,000 kg. All pipes are to be capped and ends sealed with waterproof tape (tape is not necessary if end caps are of the pre-shrunk or self-sealing type).

Pipes larger than 6" shall be shipped as single lengths with the ends capped. End caps are to be of the recessed type to enable the use of soft faced hooks, but still completely sealing the end and also protecting the weld.

All stainless steel piping must be packed separately in wooden crates. Any banding of bundles is to be with the same material.

8.1.3 Pipe Fittings, Flanges and Valves

All pipe fittings, flanges and valves up to 6", are to be packed in cases/crates. For items over 6", these may be fixed securely to a pallet base and enclosed in a crate, for protection. Where valves have actuators attached, rigidity must be ensured for the valve and actuator. The vulnerable parts of the actuator are to be completely protected within a wooden crate.

All stainless steel fittings, flanges and valves of all sizes, must be packed separately in wooden crates. Any strapping is to be with the same material.

8.1.4 Structural Steel

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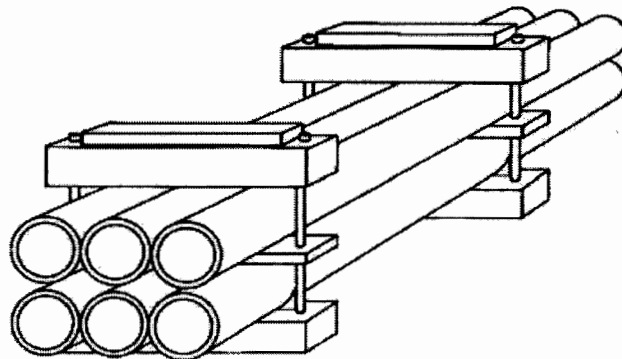
Structural Steel, reinforcing rods, bars, etc., should be packed in bundles of uniform length. Refer to articles 8.1.2, for strapping requirements. Bundle weight not normally to exceed 2,000 kg. Fabricated structures and structural steelwork, etc, should be bundled and packed using wooden beams and long bolting to secure the load.

8.2 Bundling – Packing Category I

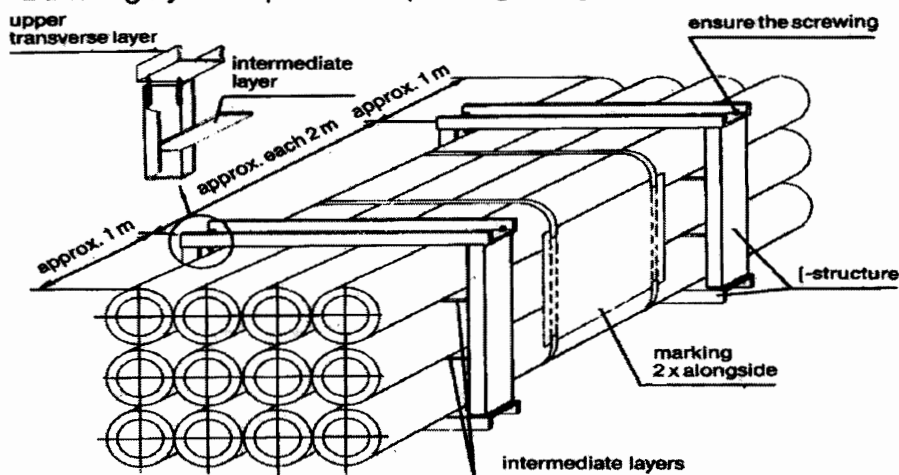
8.2.1 Type of Equipment

Equipment which is not subject to damage by corrosion or mechanical effect, i.e. pipes, piping, structural steel.


Packing category I



Bundling by U-shaped iron – packing category I A



8.2.2 Type of Construction

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- Bundling has to be effected
- By squared timber and threaded rods.
- With an intermediate layer (threaded on tightening bolts) according to the weight of the package.
- Wedge-shaped timbers must be added at the outer points of lower layer.
- Between the bolts a spacer must be nailed.
- The bolts must be secured (e.g. by locking nut).
- If single parts could protrude, an appropriate protection must be installed (flat iron or plates).
- Bundling with steel straps or PVC straps is not accepted.

8.3 Skids, Square Timber Constructions, Casings – Packing (Category II)

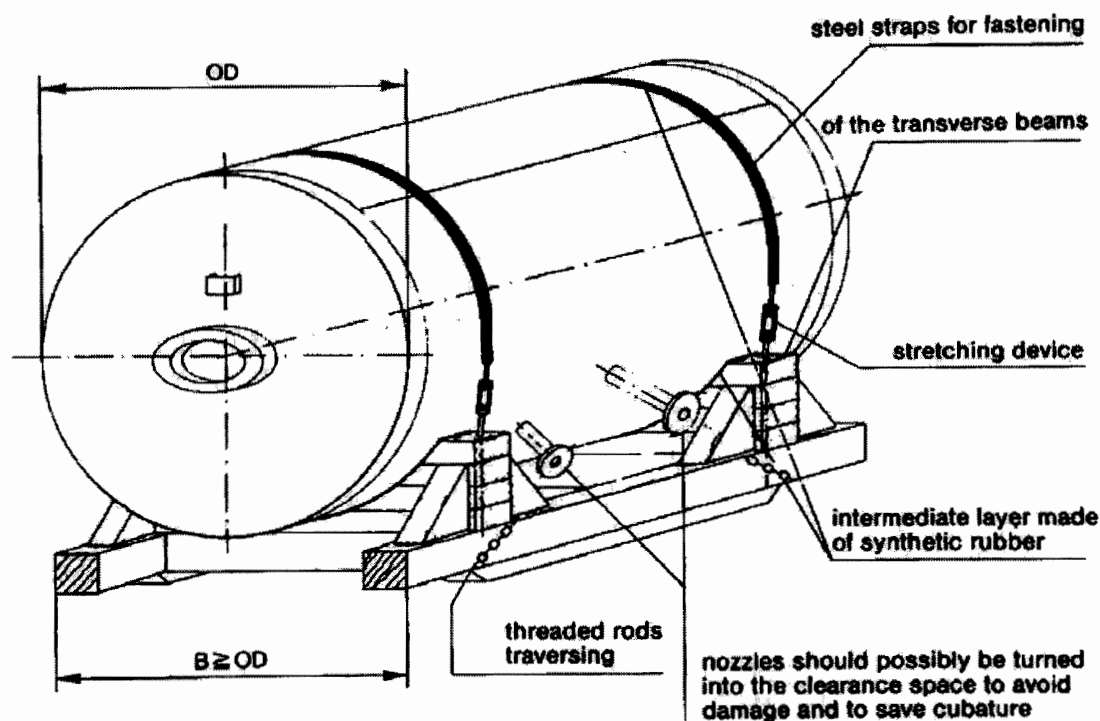
8.3.1 Type of Equipment


Voluminous apparatus, tanks and/or heavy pieces those are not vulnerable to mechanical or corrosive effects.

8.3.2 Type of Construction

- The construction skid can be made of wood or of metal.
- The fastening of the packages on the skid will be made by steel straps (flat iron) which have to be elastically lined, non-slip and securely bolted onto the skids.
- Flange openings have to be closed with gaskets and blind flanges or, if necessary, provided with cover.
- Skid constructions may not be less than the dimensions of the package in length or in width.
- Tanks and apparatus with their own support cradles must be supplied with an anti-slip lining.

PACKING CATEGORY-II



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8.4 Packing of GOODS in Wooden Crates/Cases/Boxes

The construction of wooden crate/cases/boxes shall be as per the details indicated in clause 9.0 & Fig 1 to 11. Details indicated in the sketches for different categories Packing crates/boxes are only for a typical equipment considered for illustration.

8.4.1 Packing Category III

8.4.1.1 Type of Equipment

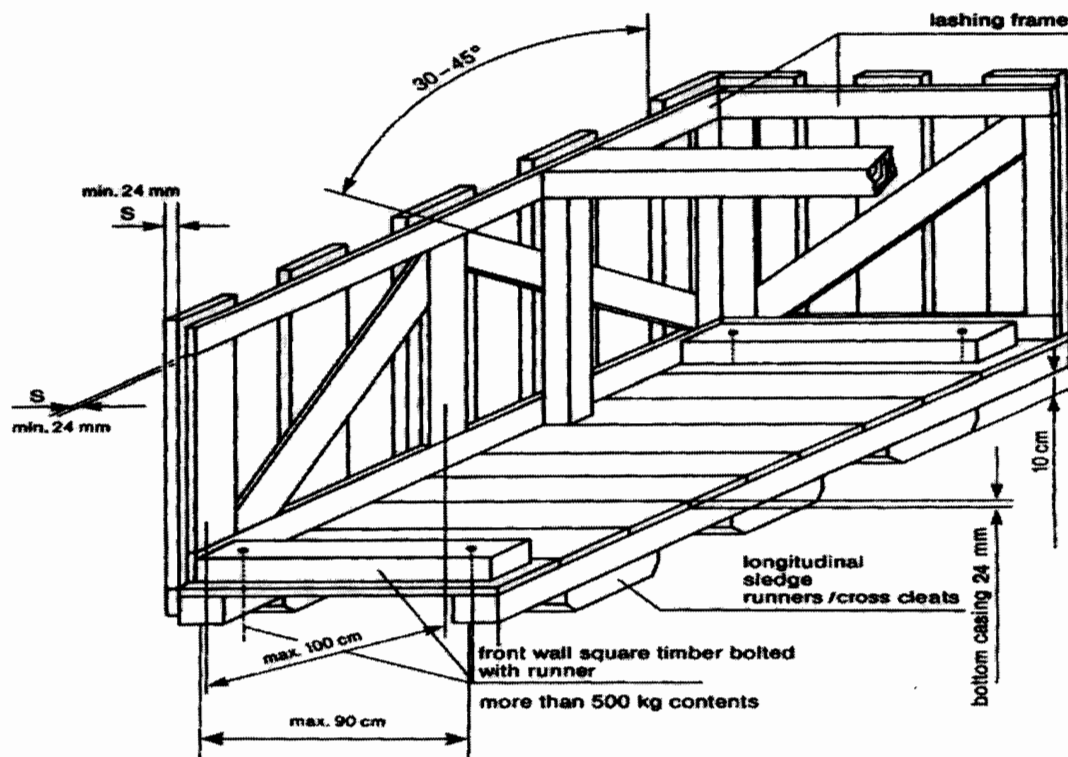
Fabricated equipment, which cannot be transported on cradles; frame-works, prefabricated piping and fittings, mechanical and electrical assemblies. *This type of packing is recommended where many parts of the equipment/component/assembly are not protruding out.*


8.4.1.2 Type of Construction

The equipment must be safely fastened to the bottom with bolts, possibly by the runners or to be spread in such a manner that no protruding parts are possible. For parts, sensitive to rainwater and/or debris, a protection has to be made by a foil cap.

If it is possible that single part could protrude through the front/back side wall, they shall be closed completely. The marking of the package shall be done on plywood plates at the prescribed sides.

Packing Category III



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8.4.2 Cases with Lining – Packing Category IV

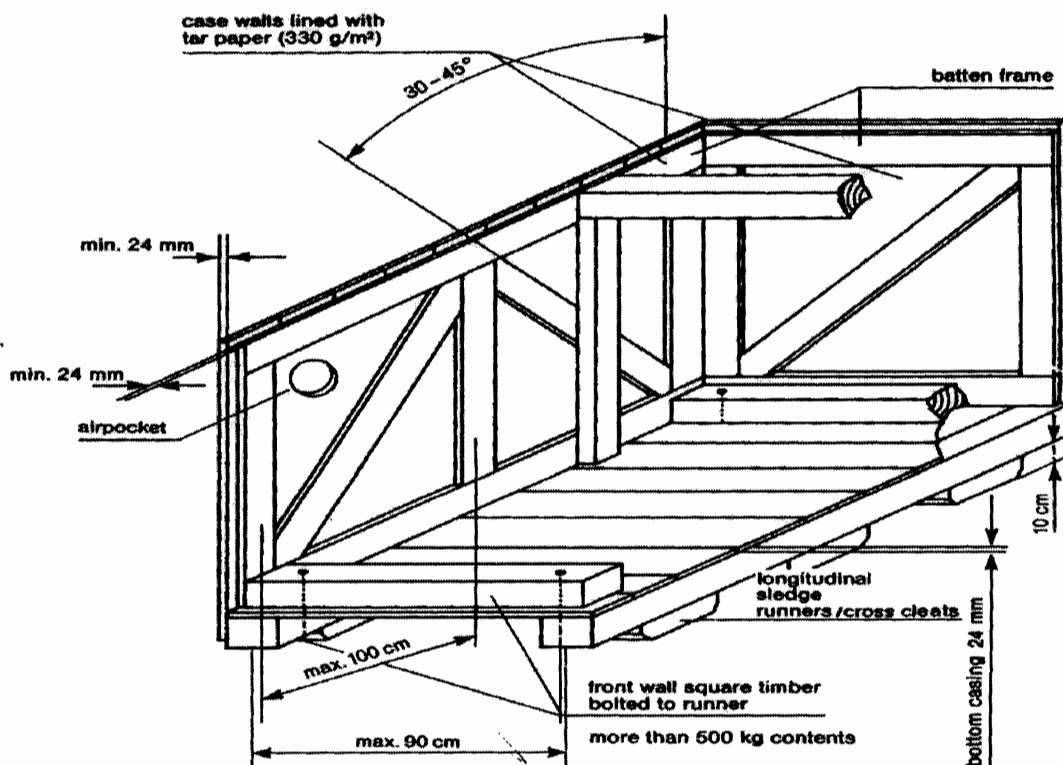
8.4.2.1 Type of Equipment

Recommended for equipment and mechanical parts Equipment sensitive to mechanical damage or parts and components that are particularly at risk of theft or loss; pumps, elbows, flanges, fittings, tools, erection materials, etc.

8.4.2.2 Type of Construction

The same type of construction as article 8.4.1.2, but with all sides completely boarded without space between the boards. Sides to be provided with waterproof lining; fabric-reinforced waterproof tar paper or polyethylene-foils resistant to ultraviolet rays can be used. Polyethylene-foil shall be fixed under the lid cover to avoid penetration of water. At weights of more than 500 kg the longitudinal runner must be bolted to the front all square timber. For ventilation inside the case, an opening in the waterproof lining must be placed between the diagonal battens and diagonal joists.

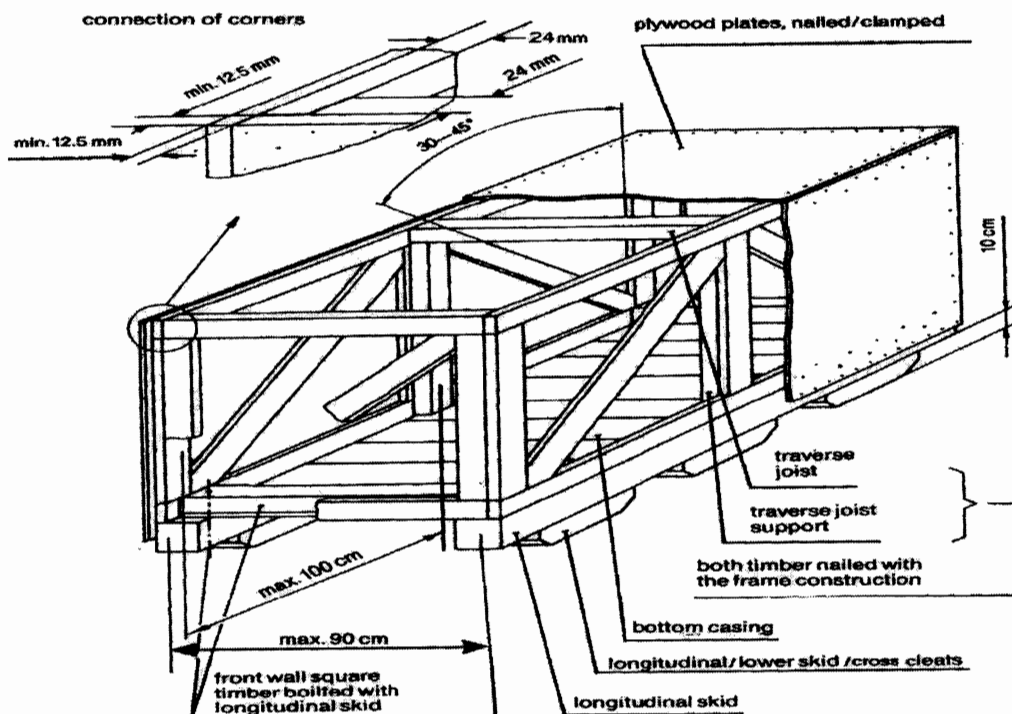
Packing Category IV



8.4.3 Cases with Alternative Surface Materials

8.4.3.1 Plywood Box – Packing Category IV A

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Case constructed of 5 layers of watertight, glued plywood with a total thickness of 12.5 mm. The frame must be constructed from minimum 24 mm timber or as per guide lines given above against clause 8.0, Fig 1 to 11 and must be suitable for the weight and nature of the parts to be packed. Planed square timber must be bolted with longitudinal skid and covered with diagonal joists. If applicable, construction of the cover and sides is to include diagonal bracing. Covers consisting of several layers of plywood are to be sealed with durable elastic putty or additional water-resistant sheets to be fixed.

8.4.4 Case with Barrier Material – Polyethylene Foil – Packing Category V

8.4.4.1 Type of Equipment

Sensitive equipment, simple electrical equipment, insulation materials, fire-resistant materials, with non-corrosion- guarantee for a period up to twelve (12) months.

8.4.4.2 Type of Construction


Preservation by welding in polyethylene-foil with addition of desiccants and if necessary, application of non-corrosive contact agents, otherwise, type of construction as indicated in article 8.4.2.2.

Additional marking:

- Case with desiccants.

8.4.5 Case with Barrier Material – Aluminium Compound Foil – Packing Category VI

8.4.5.1 Type of Equipment

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Electrical equipment such as, switchboards, electric motors, sensitive equipment, with non-corrosion guarantee, for a period up to twelve (12) months.

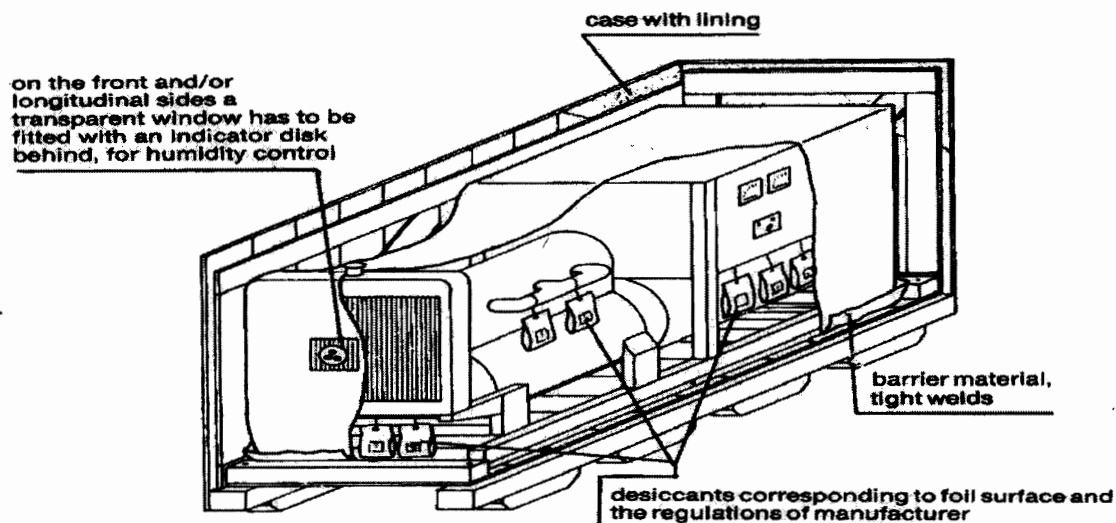
8.4.5.2 Type of Construction

Type of construction as indicated in article 8.4.2.2. Preservation by sealing an aluminium compound foil, with the addition of desiccants. Humidity indicators, if required and installed in the barrier wrapping, shall allow easy control from the outside.

Additional marking:

- Case with desiccants.

Packing Category V/VI




8.4.6 Double Case – Packing Category VII

8.4.6.1 Type of Equipment

GOODS which are of high sensitivity to shock, impact and vibration, for instance, special electrical equipment like computers, switchboards, laboratory instruments

8.4.6.2 Type of Construction

Case construction as indicated in article 8.4.2.2, with additional floating inner packing (case-in-case principle), padding corresponding to weight and sensitiveness. Preservation by sealing in aluminium compound foil with the addition of desiccants. The inner case has to be made of plywood or equivalent material with a thickness of 8-12 mm, depending on the weight of the GOODS to be packed. The inner buckles and/or frame borders have to be dimensioned so that the full stability of the inside case will be reached and no twisting is possible. The inner sides of the inside case will be lined with bituminous kraft paper on all sides (except bottom).

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8.4.7 Cable Drum – Packing Category VIII

8.4.7.1 Type of Equipment

All type of cables, wires, ropes, hoses.

8.4.7.2 Type of Construction

For all type of cables refer clause no. 11.1. For other items (wires, ropes, hoses) new or practically new drums are to be used. Planking of the e drums by use of boards, thickness minimum 20 mm, with additional double steel strapping, nailed, and carefully preserved/protected cable ends prior to packing.

8.4.8 Hazardous Materials – Packing Category IX

8.4.8.1 Type of Equipment

Hazardous materials according to the law are explosives, compressed gases, liquefied gases dissolved under pressure or deeply refrigerated, flammable liquids, flammable solids: substances liable to spontaneous combustion; substances which, on contact with water, emit flammable gases, oxidizing substances, organic peroxides, poisonous (toxic) and infectious substances; radioactive materials, corrosives, miscellaneous dangerous goods.

8.4.8.2 Type of Construction

Hazardous materials shall always be packed and documented separately from any other material. Selection of packaging materials, execution of packing and marking as well as documentation shall always be in compliance with the applicable laws and regulations. Any certificates required for transportation or for authorities to be supplied before shipment of the GOODS.

8.4.9 Wooden Floor as a Transport Support – Packing Category X

8.4.9.1 Type of Equipment

Any materials to be stuffed in containers or on flat racks and that are not stowed on standard pallets or otherwise suitably packed

8.4.9.2 Type of Construction


- Longitudinal internal square timbers bolted to the front wall runners, longitudinal skid.
- Maximum distance between longitudinal runners 90 cm (middle to middle of the runner).
- Full boarding of the floor.
- Attaching of lifting lugs and/or iron ropes for lifting/pulling the units off the transport equipment.
- If applicable, preservation of the equipment by sealing in polyethylene-foil or aluminium compound foil and the addition of desiccants.

8.5 Air Transport Packing

8.5.1 General

Certain types of material may have to be shipped by air from their country of origin. This means of transport will be exceptional, and will be used only:

- For GOODS, which are highly sensitive to shock or vibrations, such as computers, electronic instruments, or those of small dimensions and weight.
- For GOODS urgently required at the module yard(s) and/or jobsite.

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8.5.2 Type of Packing

Depending on the goods to be packed, VENDOR may use one of the following types:

- A triple-corrugated cardboard container made with waterproofed glue and a barrier layer of polyethylene on the outsides to keep out humidity.
- Wooden/cardboard packing cases: the wood being used for the framework and base of the cases, waterproofed triple-corrugated cardboard being used for the sides and top. These cases are of the "Bell" type, and used for material of small or medium dimensions.
- For larger dimensions, plywood cases are acceptable. The timber characteristics, cross-sections and thickness will be systematically determined by the nature of the loads to be packed.

8.5.3 Dimensions

In order to optimize the existing transport facilities (passenger or cargo aircraft), the dimensions of:

- Triple-corrugated containers.
 - Wooden/cardboard packing cases.
 - Plywood cases.
- Are to be adapted to pallets used for air transportation.

9.0 Detailed specification for Wooden Crates/Boxes/Cases and other packing materials

9.1 Technical specification for wood

The wood shall be Fir, Chir, Silver Oak (Gravillea Robusta), chemically treated mango and Pinewood with moisture content not exceeding 50%. The wood shall have flexural and compressive strength, stiffness, shock absorption and nail retention properties. The wood shall be free from common defects such as warp, bone, twist, knot, cracks, splits, end splits, bend, visible sign of infection and any kind of decay caused by insects or fungus, etc. Surface cracks with maximum depth of 3mm are permissible. A continuous crack of any depth all along the length is not allowed.

9.2 Chemical Treatment of Wood:


The wood shall be chemically treated to provide protection against deterioration due to fungi and attack by termites, borers, marine organism and any other kind of infection. It shall be treated only after final processing like cutting, planning, joint grooving, etc.

9.3 TYPE, DESIGN & DIMENSION OF WOODEN PACKING CASES:

9.3.1 PACKING OF EQUIPMENTS

Various mechanical, electrical and C&I equipment e.g. Pumps, motors, equipment skids, heat exchangers, control panels, switch gears, transformers, etc. shall be wrapped in weather proof packing and then secured in wooden packing cases. The construction of wooden packing cases/crates shall be as per details given below and also given in figure 1 to 11.

9.3.1.1 Bottom Frame

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The construction of bottom frame shall be as per Fig-2. The No. of slides/runners for bottom frames shall be selected depending upon the weight and overall dimensions of the load to be carried. The equipment shall be secured by fixing their base frame/plate with the help of bolt and nuts etc. to bottom frame of the wooden packing cases/crates. The equipment not provided with base frame/plate like cylindrical vessels, etc to be secured to the bottom frame of the wooden cases with "C" clamps fabricated from steel channels/ angle iron.

9.3.1.2 TOP FRAME

The construction of top frame shall be as per fig-3.

9.3.1.3 END PANELS

The dimension of the end and lateral panels shall be calculated according to overall dimensions of the items to be packed. Diagonal braces shall be used for packing cases having height exceeding 500mm. Details of bracings shall be as per fig 5 to 9.

9.3.1.4 Sling Plate


To facilitate lifting of cases, longitudinal under slide boards shall be fixed. To avoid damage to the box while lifting sling plates shall be provided. Refer fig-11.

9.3.1.5 Angle Iron Cleats

Angle iron cleats shall be used for strengthening the joints as indicated in fig-10

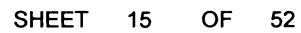
9.3.1.6 Other Requirements

- The thickness of planks for top, bottom, side and end panels shall be at least 25mm. Planks used for this purpose shall be joined with each other by tongue and groove joint. The groove dimension shall be such that tongue fits tightly into groove to make the joint.
- Runners/slides, traverse bars, etc shall be of single length i.e. without any joint. Planks for sheathing, diagonal bracing etc shall also be of single length up to 2400mm, proper jointing is permitted for planks for sheathing and diagonal bracings.
- Each equipment to be individually covered with double polyethylene petticoat. Sheet thickness of polythene sheet shall not be less than 0.175 mm (175 microns). The sealing shall be such so as not to allow moisture inside.
- The inner surface of 4 sides of shooks shall be nailed with bituminized water proof craft paper. Wherever 2 pieces of kraft paper are used, joint shall have an overlap of minimum 20 mm.
- All the inner sides of the box shall be nailed with bitumen coated HESSIAN POLYTHYLENE KRAFT PAPER. For top frame it shall project on all sides by 100mm and shall be nailed on sides. Wherever 2 pieces of kraft paper are used, joint shall have an overlap of minimum 20 mm.
- For delicate equipment like control panels and switchgears, lighting panels and lighting transformers, suitable cushioning material like rubberised coir (min. 50 mm thick and 100 mm wide) shall be provided on their bottom support and the gap between the panel and casing

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shall be filled with rubberized coir with distance between consecutive supports less than 500 mm (ref fig15). For other equipment suitable support from sides of the casing shall be provided.

- Switchgear cubicles, control panels and control desks shall be packed and shipped in separate convenient sections. The components e.g. circuit breakers relays and instruments etc. which are removed from panels for shipping purpose and shall be separately packed and shipped as per packing instructions in clause 10.4.
- Packing case for control panels and switchgear panels shall be finally covered with GI sheet of minimum thickness of 0.4mm.
- Packing cases shall be bound at edges by nailing MS clamps/brackets at sufficient intervals. Further heavier boxes shall be strapped with C clamps (ref fig-4) fabricated from steel channels/angles and lighter boxes shall be strapped with hoop iron strips.
- Silica gel is used for this purpose to protect contents over sufficiently long time from corrosion. Silica gel shall be indicating type confirming to IS-304 (1979) packed in cotton bags placed at different positions inside the packing for absorbing moisture and shall not come into directly contact with equipment/material inside the package. The quantity of silica gel shall be adequate for storage period of one year, however it shall not be less than 4 gm. per ltr. Volume of case subject to minimum 400 gm. Per case.





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BOTTOM FRAME ARRANGEMENTS

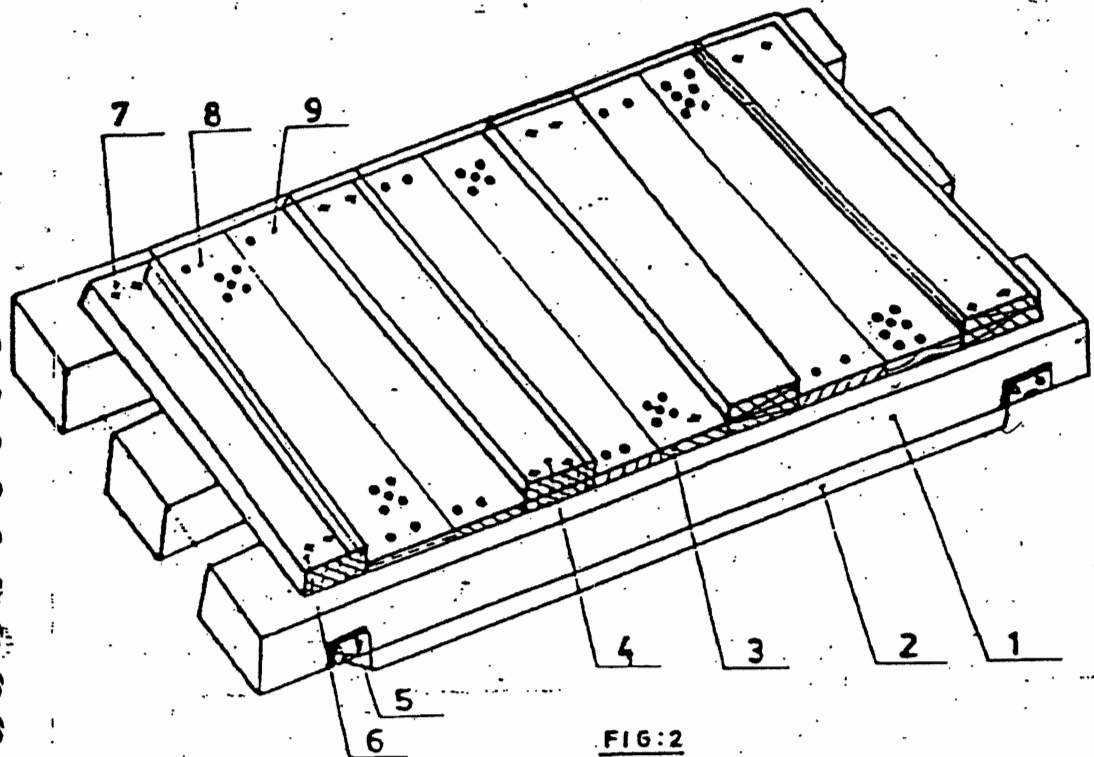


FIG:2

Nos. of slides: Minimum 2 Nos.
For length more than 1800 mm or
load more than 1000kg, Nos. of
slides shall be minimum 3 Nos.
For dimensions of slides, refer Table 1
Cross section of end traverse bar; 100 x 100 mm.
(minimum)

1. SLIDE
2. UNDER SLIDE BOARD
3. BOTTOM BOARD
4. CARRIER TRAVERSE BAR
5. SLING PLATE
6. TRAVERSE BAR
7. BOLT, NUT & WASHER
8. DRAINAGE HOLES
9. NAILS

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TOP FRAME ARRANGEMENT

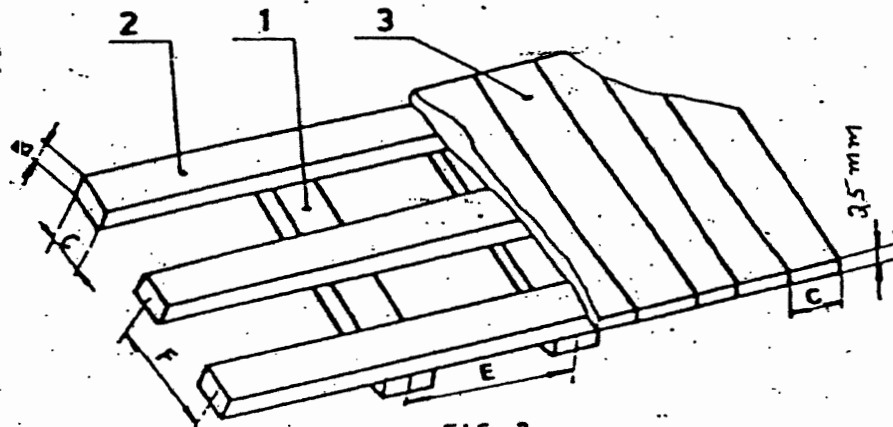
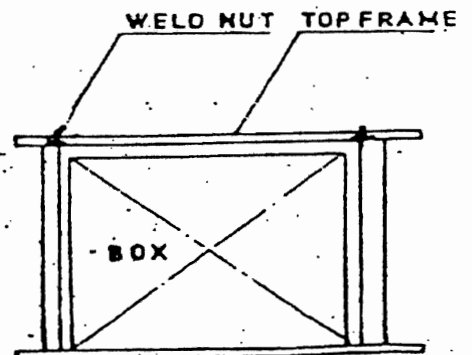
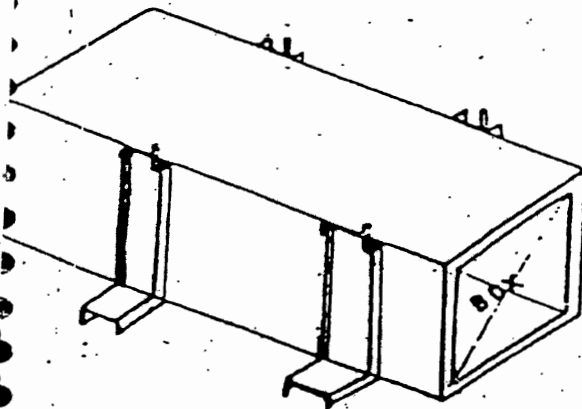


FIG-3

F : 700 to 1000 mm
E : 500 to 900 mm
30 x 100 mm.

- 1 - Traverse Bars
- 2 - Horizontal Soans
- 3 - Top Board

ARRANGEMENT OF C-CLAMPS AROUND CASES



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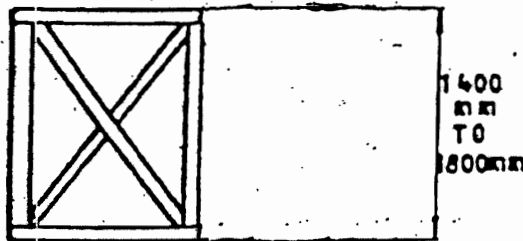
**ARRANGEMENT OF DIAGONAL BRACING AND
HORIZONTAL SUPPORT**

FIG: 6

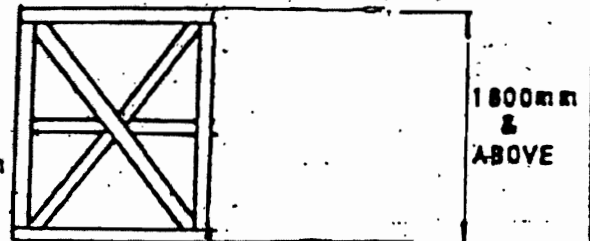


FIG: 8

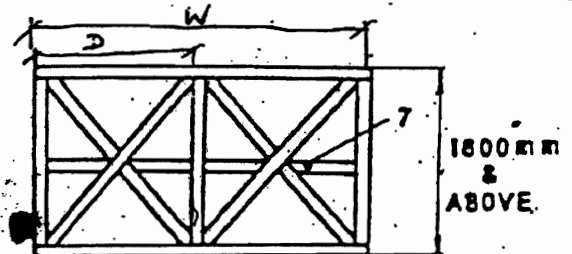


FIG: 7

7- Middle Horizontal Support

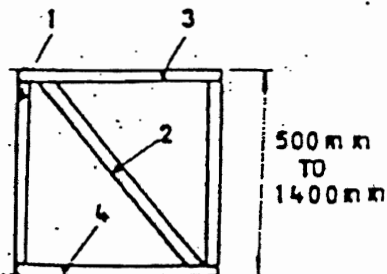


FIG: 5

1- Vertical Support

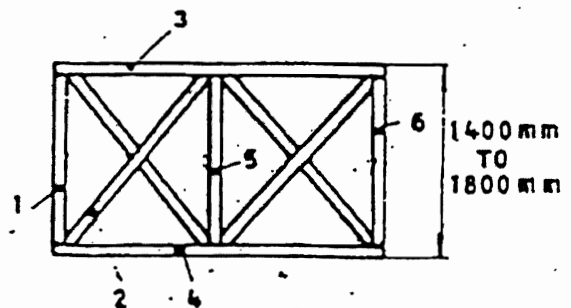


FIG: 7

1, 5, 6 - Vertical Support

**TITLE**

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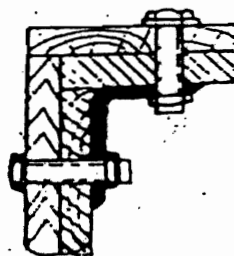
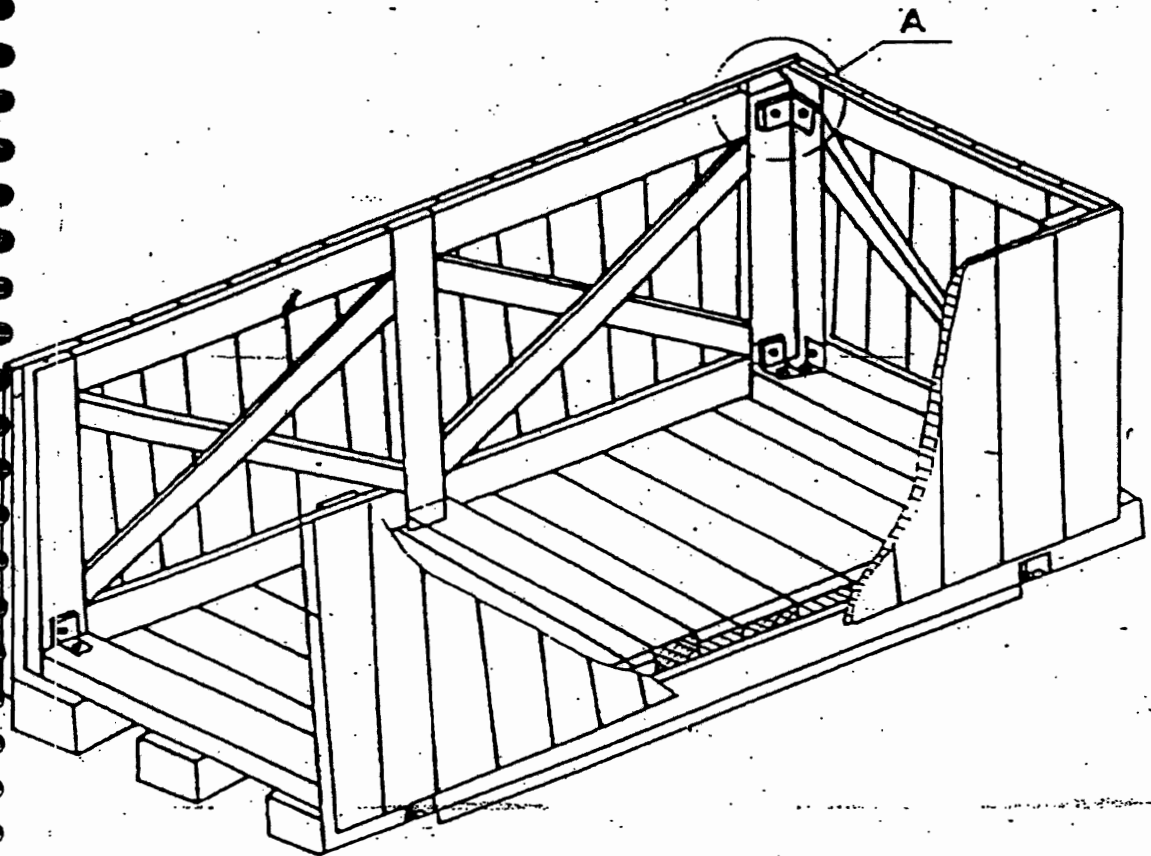
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ARRANGEMENT OF PACKING CASE



DETAIL-A

HOLE DIAMETER
MUST CONFORM
TO BOLT DIA

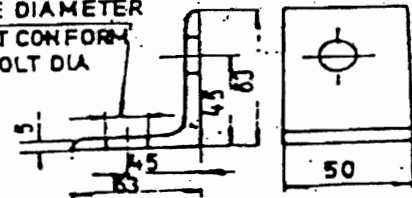


FIG:10

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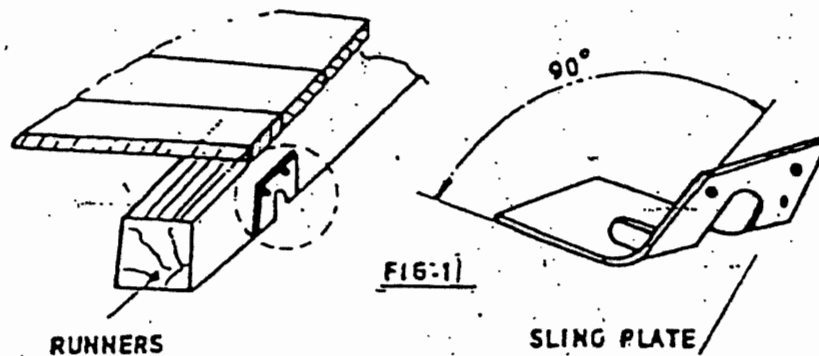
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**ARRANGEMENT OF SLING & PLATE ON
CASES**


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TABLE-1

LOADS	LENGTHS OF SLIDES						
	600	800	1000	1200	1300	1500	2000
	Cross section b x c				<div style="border: 1px solid black; display: inline-block; width: 80px; height: 20px; vertical-align: middle;"></div> c b		
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





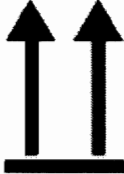




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Table-2

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	30	30	30	30	30	30
		X	X	X	X	X	X	X
	1201 to 1600	100	100	100	130	130	130	130
		X	X	X	X	X	X	X
	1601 to 2000	130	130	130	130	130	130	130
		X	X	X	X	X	X	X
	2001 to 3000	130	130	130	130	130	130	130
		X	X	X	X	X	X	X
	3001 to 4000	130	130	130	130	130	130	150
		X	X	X	X	X	X	X
		150	150	150	150	150	150	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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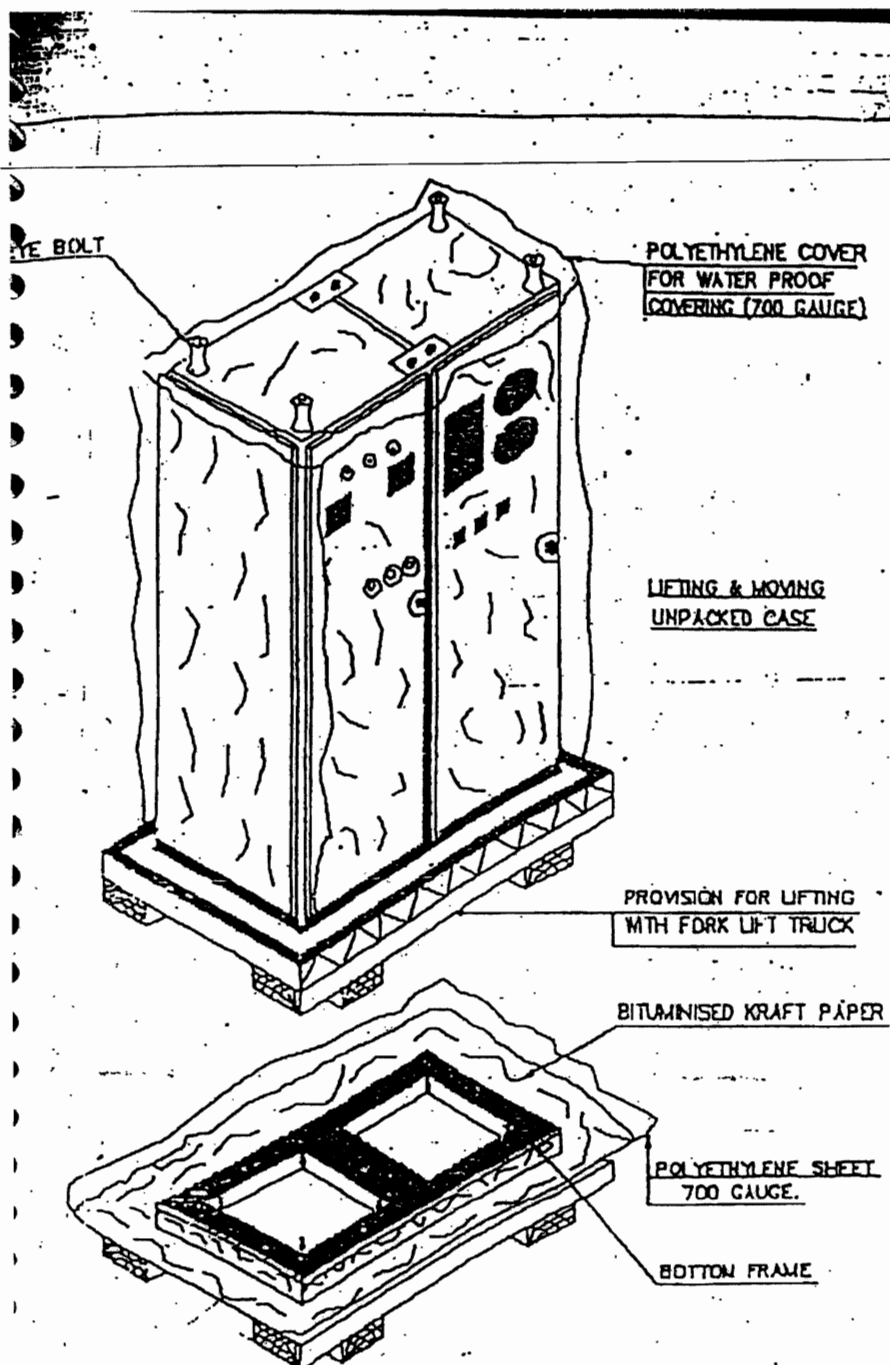


FIGURE-14



TITLE

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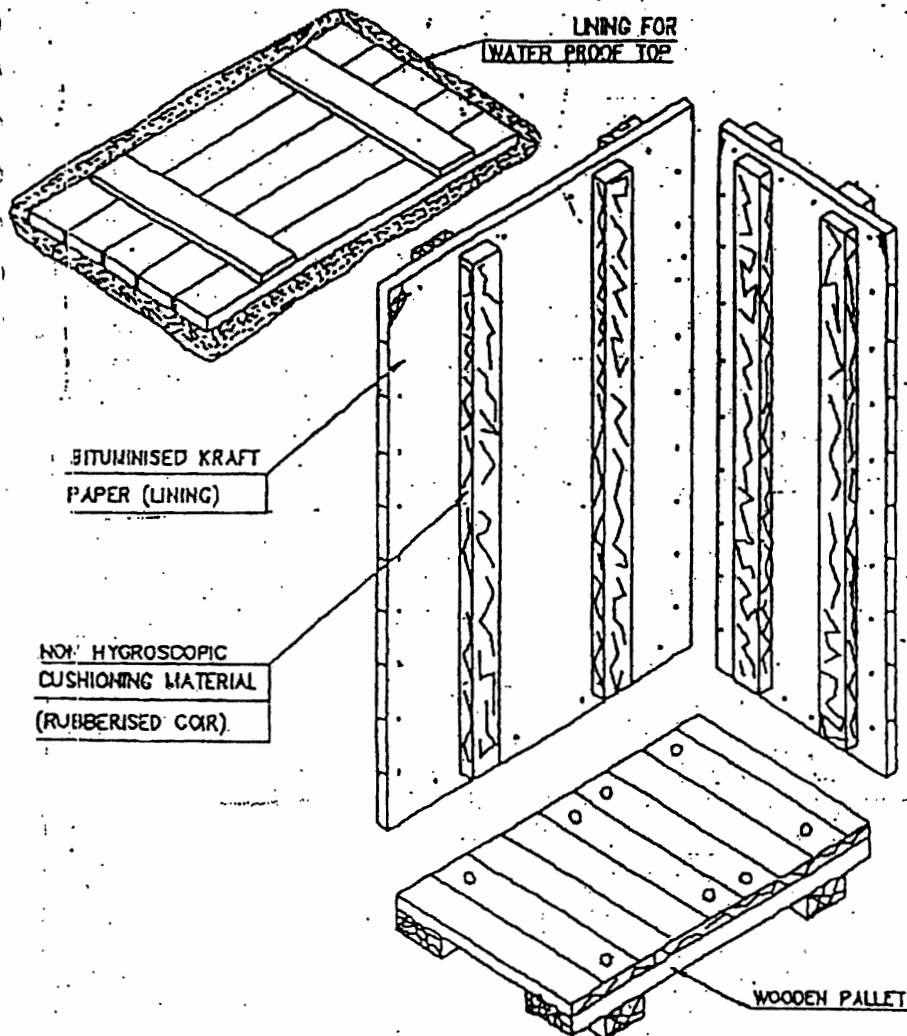

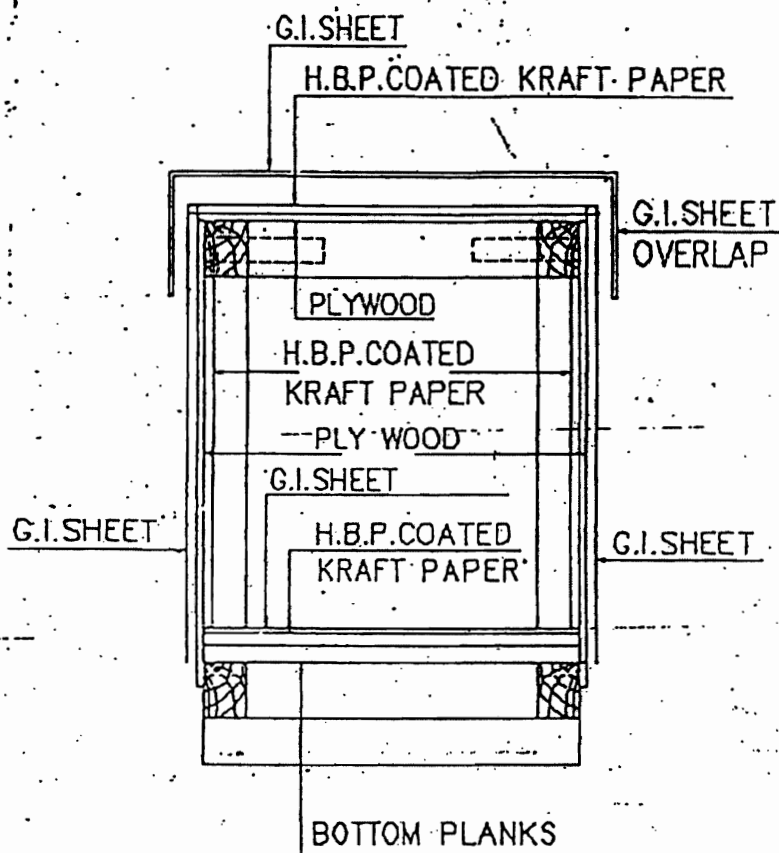



FIGURE-15

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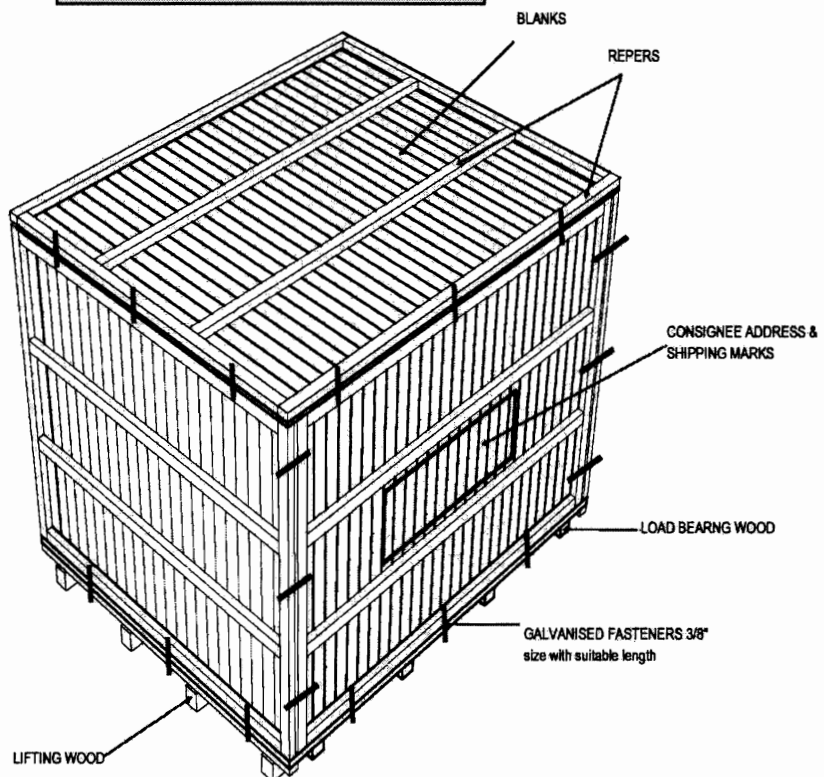
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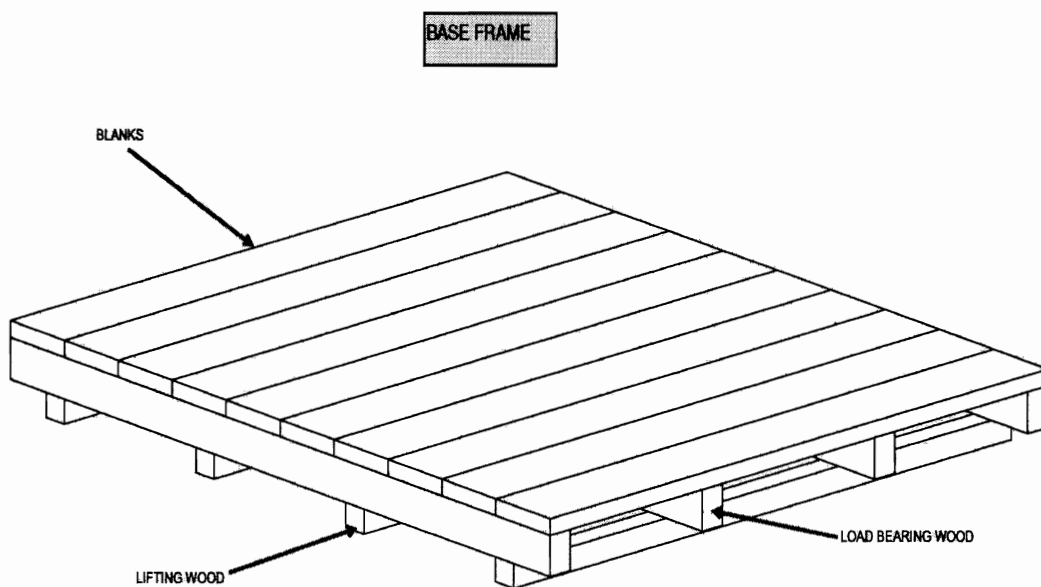
MODEL: FASTNERS TYPE (BASE, SIDE & TOP
ATTACHED WITH BOLT, NUT & WASHER)

This Type of case to be used for
following items:

1. BALL SEPERATOR
2. BALL COLECTOR SKID



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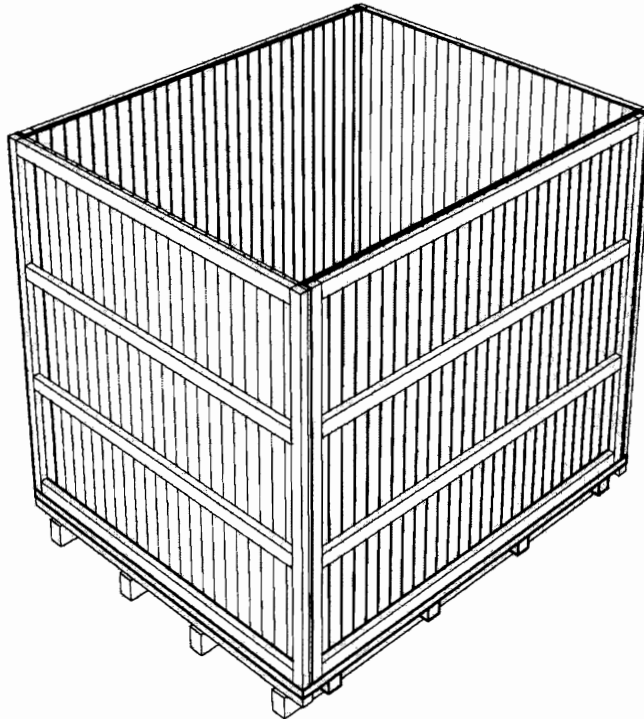
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MODEL: FASTNERS TYPE - WITHOUT TOP





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MODEL: NAILING TYPE
(FRAME & INSIDE REEFER 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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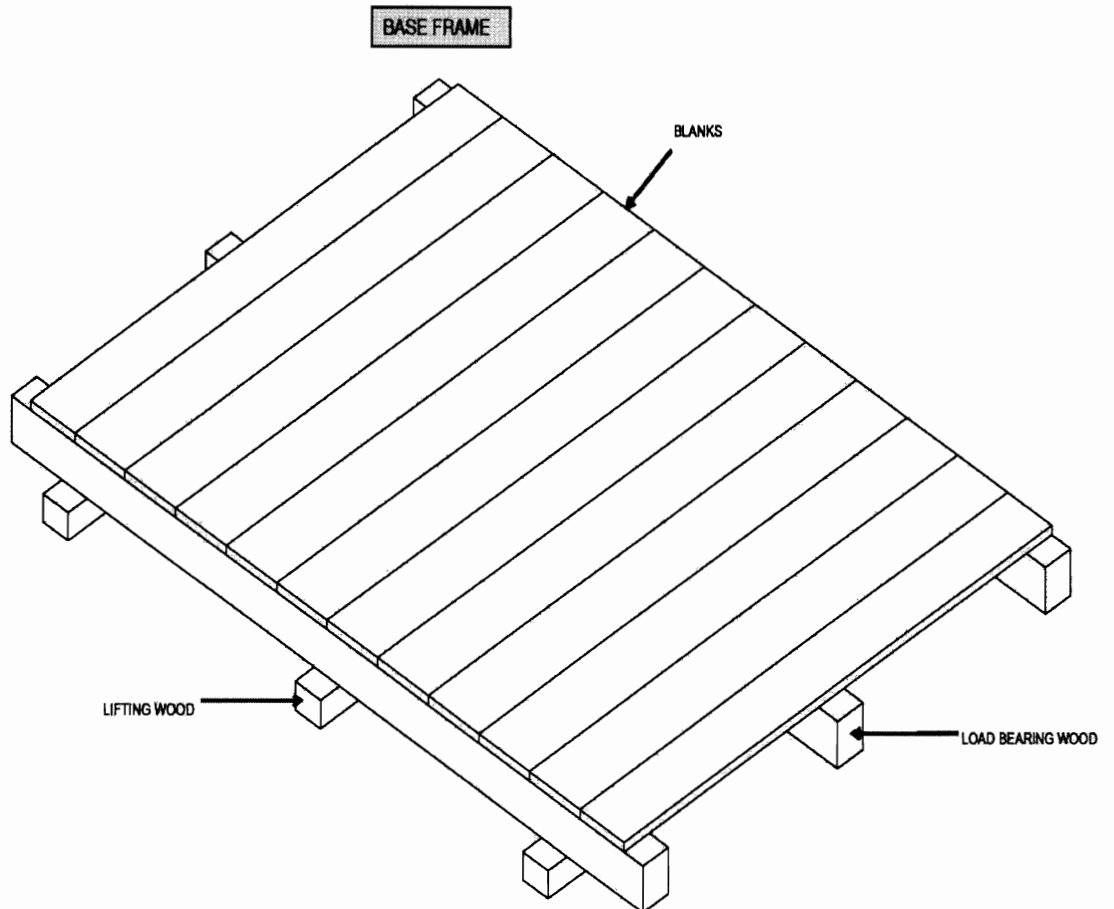
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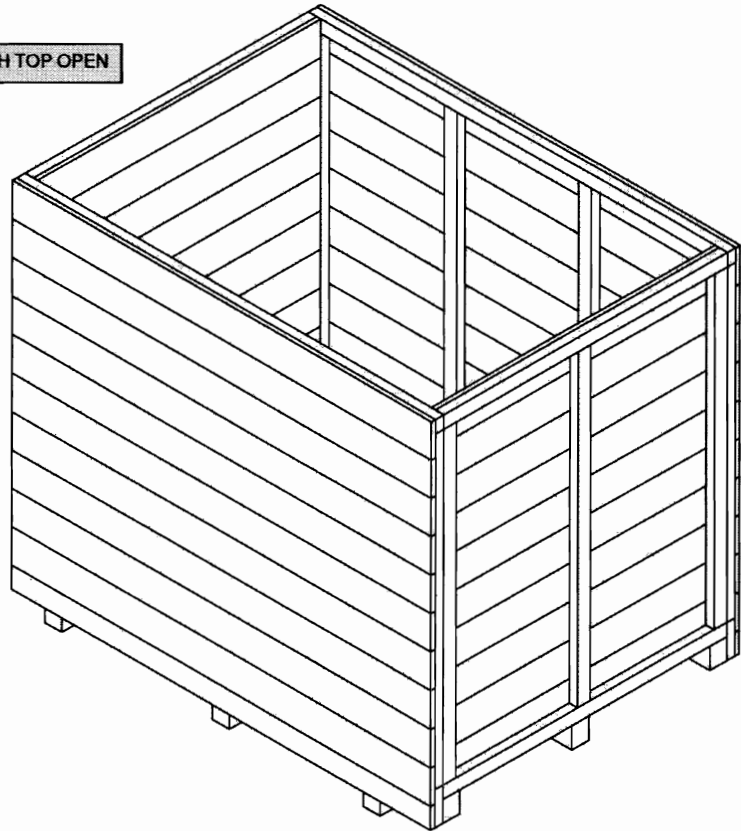
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NAILING TYPE MODEL WITH TOP OPEN



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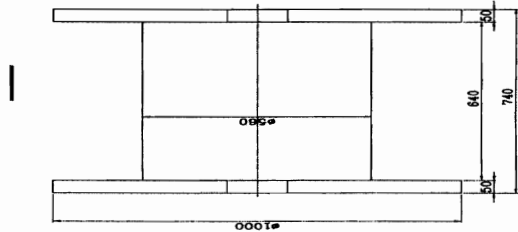
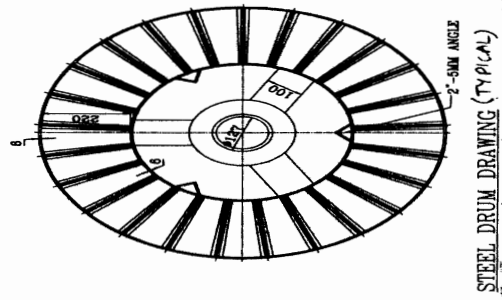
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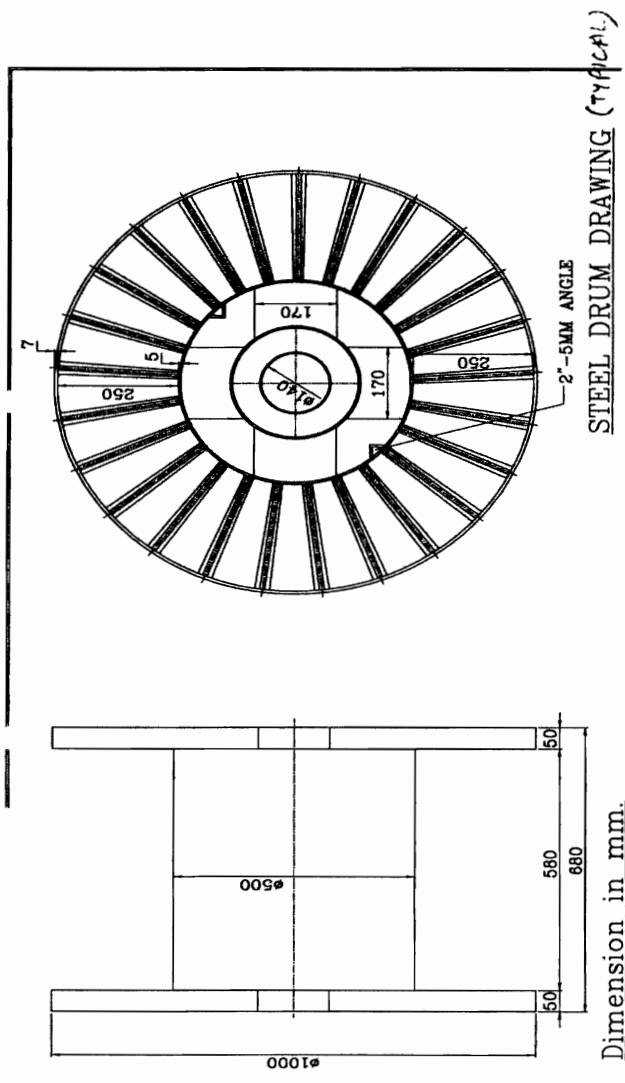
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11.2 PACKING OF CABLE TRAYS & ACCESSORIES AND CABLE TRAY SUPPORT MATERIAL

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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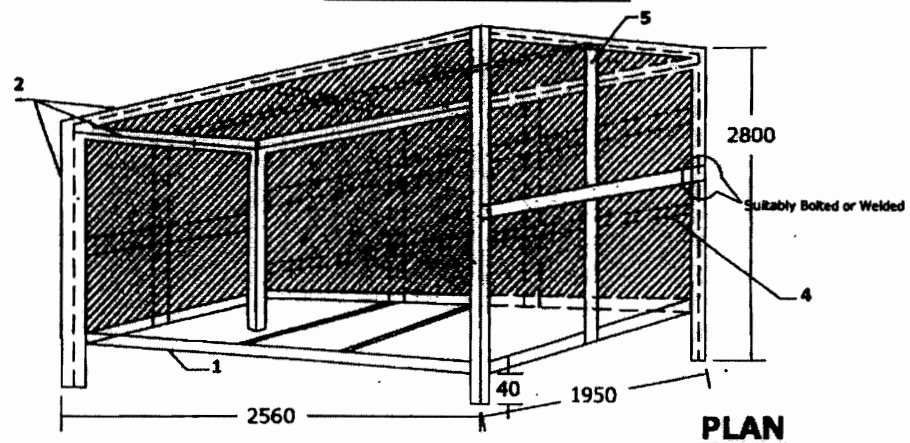
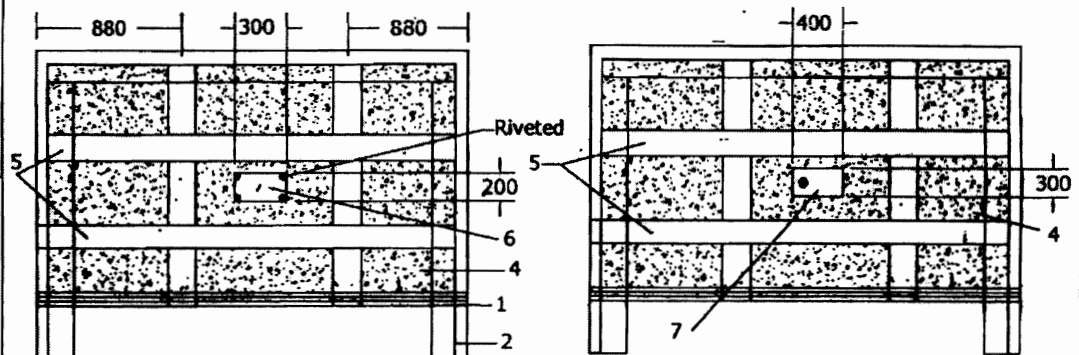
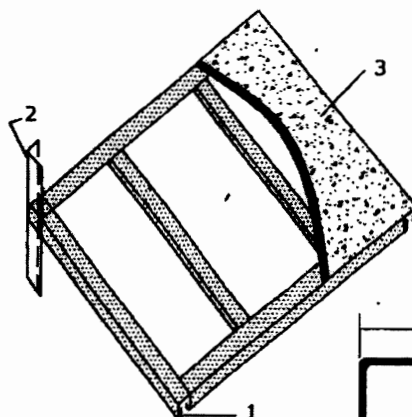
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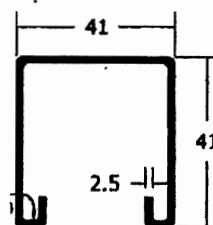
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STEEL PACKING (TYPICAL DETAILS)**PLAN****FRONT SIDE OF BOX****BACK SIDE OF BOX****BOTTOM FRAME ARRANGEMENT****Note:**

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

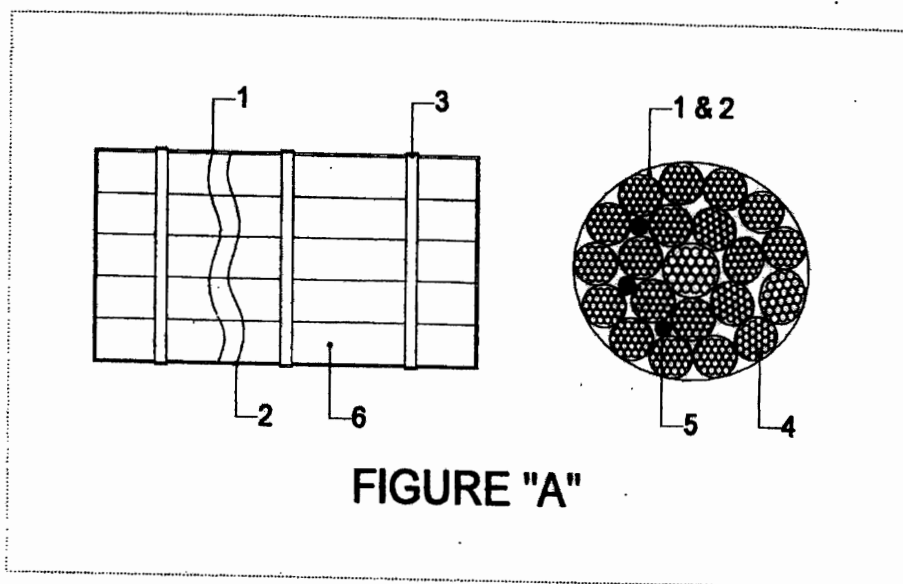
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Structural steel will be different sizes and shapes. Hence it will be packed as per Figure No. B and described as following :

- 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.

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PACKING PROCEDURE FOR CONDUIT PIPE



- 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.

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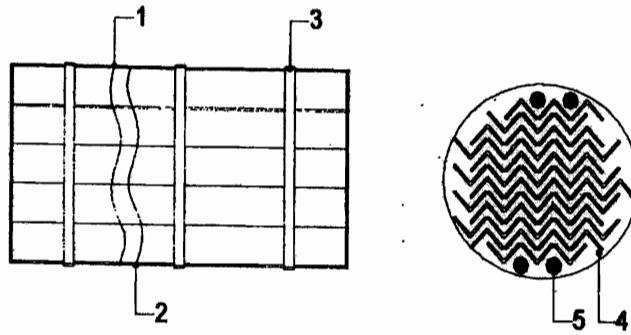
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PACKING PROCEDURE FOR STRUCTURAL STEEL**FIGURE "B"**

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



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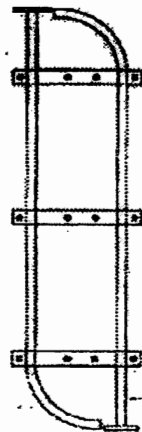
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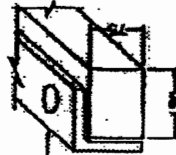
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packing procedure for poles



POLES WRAPPED WITH POLYTHENE SHEET &
EXTRUDING COATED HESSIAN CLOTH



TOP WOODEN BATTEN TO BE
FIXED WITH 150x80x6 MM ON TOP
OF IT FOR TIEING THE ROD
25 MM DIA



BOTTOM WOODEN BATTEN TO BE
FIXED ON 150x80x6 MM ANGLE

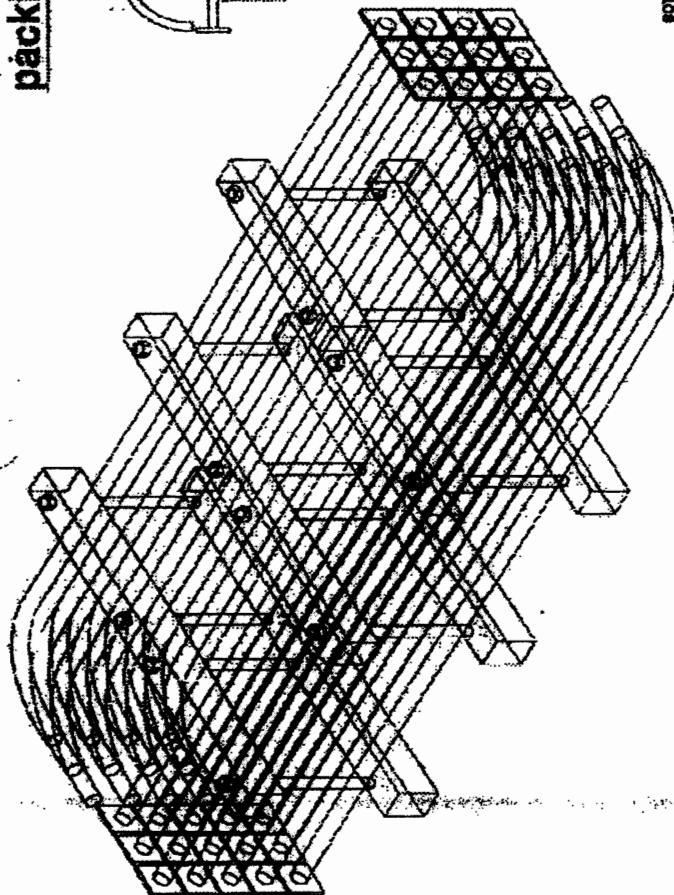



FIGURE "C"

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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.
- d 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

	TITLE TECHNICAL SPECIFICATION FOR SEAWORTHY PACKING FOR EXPORT JOBS	SPECIFICATION NO. PE-TS-888-100-A001	
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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.

<p style="text-align: center;">Bharat Heavy Electricals Limited International Operations - Projects Division Integrated Office Complex, Lodhi Road New Delhi -110003</p>			
400 MW MARIB GAS TURBUINE POWER STATION PHASE-II			
Following dispatch instructions for effecting supplies under the above contract are being issued for compliance by all the units involved in this project.			
Sr. No.	Item No.	Details	Action By
01	01	<u>Purchaser's Name and Address:</u> Public Electricity Corporation Airport St P.O. Box 178 Sana'a Republic of Yemen Attention: Eng. Abdul Mumen M. Mutaher Managing Director Tel : (967 1) 328 141-142 Fax : (967 1) 328 150 E-mail : YPECNT@Y.net.ye	For information
02	01	<u>Delivery Terms:</u> DAP (Marib Site YEMEN) Public Electricity Corporation Airport St P.O. Box 178 Sana'a Republic of Yemen	Units to ensure proper marking on the boxes so as to Identify the final destination clearly.
03	01	<u>Seller's Name and Address:</u> Bharat Heavy Electricals Limited International Operations Division Lodhi Road Integrated Office Complex New Delhi –110003, INDIA	For information
04	01	<u>Payment Terms for Equipment Supply:</u> <u>Contract Terms:</u> Advance - 10% of the Contract price. Supply– 80% on submission of shipping documents 5% on the receipt of Taking over and Acceptance Certificate and 5% on the receipt of Final Acceptance Certificate	All Units
05	01	<u>Shipping Marks :</u> As Per LC (Copy Enclosed)	All Units
06	01	<u>Consignee:</u> As per LC (Copy Enclosed)	All Units
07	01	<u>Notifying Party :</u> As Per LC (Copy Enclosed)	All Units

08	Packing Instructions & Inspection Prior to Dispatch by Supplying Units/Sub-Vendors:		All Units & Suppliers
	01	Packing (tare) shall be part of the Equipment cost and shall not be subject to return. The packing should ensure integrity and cohesiveness of each delivery batch of Equipment during transportation. In case of Equipment assemblies and unit's delivery in the packing of glass, plastics or paper the specification of packing with the material and weight characteristics are to be indicated.	All Units/Suppliers
	02	<u>Special instructions from PEC Yemen :</u>	
	02.1	All equipment and instruments should be fully packed and protected from damage during transportation and field storage. All machine surfaces should be protected with planks or similar materials and reinforced with metal strips or plates from the outside.	All Units/Suppliers
	02.2	All electrical / electronics equipment such as motor, switch, control device, instrument and component should be sealed with polyethylene insulation and a corresponding drying agent should be provided.	All Units/Suppliers
	02.3	For all piping ends as well as pipes and tanks, the openings should be protected from damage and sealed to avoid getting affected by particulates, moisture and air. These Protection measures should be kept intact before the start of installation or moving for periodic inspection. The cost spent for the moving, modification and replacement of the packing and protection device would be paid by the BHEL.	All Units/Suppliers
	02.4	A waterproofed packing list should be provided in each planks or packing case. The name of articles in the packing case should be marked clearly on the packing list so as to be identified easily.	All Units/Suppliers
	02.5	The articles in the case should be supported by wooden bars in order to be fixed safely and it should not be wedged individually with wooden pad. The marks outside the case should be printed with climate proof materials or paints so as to be protected from being removed during transportation.	All Units/Suppliers
	02.6	All materials and equipment should be packaged according to the typical environmental conditions during storage. In case of severe conditions, these materials and equipment should be packaged carefully by taking a full and appropriate preventive measure to protect from any damage or wear. The marks should be painted or printed clearly and durably with characters of 40 mm height at minimum on both ends of the packing case. The labels should be well protected to prevent loss / tempering.	All Units/Suppliers
	02.7	A mark indicating the correct lifting position should be shown by an arrow on the packing case.	All Units/Suppliers
	02.8	<u>Preparation for Shipment of Operational Spare Parts</u>	
	02.8.1	Shipping preparations shall be of export quality and crating shall adequately protect the items against injurious corrosion, dampness, breakage, or vibration that might be encountered in their transportation and handling. BHEL to submit a detailed packing and crating procedure to PEC on a parent equipment basis at least sixty calendar days prior to shipment.	All Units
	02.8.2	Operational spare parts shall be crated on a parent equipment on exclusive basis and there shall be no common crating of unrelated spare parts. For items too small to be individually crated, they have to be crated on the same kind of equipment basis under condition that they are classified and packed in a vinyl bag or small box on a parent equipment basis.	All Units
	02.8.3	To the extent that BHEL intends to utilize containers in the shipment of operational parts, BHEL shall utilize good quality shipper owned or nonreturnable containers which should be conveyed to Owner before its receipt at the Site.	All Units/ROD

02.8.4	All shipments of operational spare parts shall be consolidated prior to shipment and shall be transported to the Site in accordance with the contractual shipping schedule. BHEL shall not make partial or multiple shipments of operational spare parts for the same parent equipment item without prior approval of Owner.	All Units
02.8.5	BHEL shall submit schedules identifying completion of fabrication, ship date and site delivery dates for the operational spare parts on a parent equipment basis.	All Units
02.8.6	To the greatest extent practicable , BHEL shall individually tag each Operational Spare Part. The tagging data shall include the Contract number, Item number and the part identification number. Where such individual tagging is impracticable due to the size or quantity of certain operational spare parts the tagging data shall be fixed to the permanent packing of these operational spare parts.	All Units/Suppliers
02.8.7	BHEL shall prepare packing lists in strict accordance with the tagging requirements and shall reference the Exhibit C, Section 3. Item numbers of the individual operational spare parts including required quantities. Contractor shall include on the packing list the net weight of operational spare parts exceeding 300 Kg. Packing lists shall also provide a certification verifying that the packing list quantities constitute "Partial" or "Complete" shipment of all required quantities of operational spare parts.	All Units/Suppliers
02.8.8	All packages to be wrapped in <u>Sealed transparent polythene</u> inside the crates for effective weather proofing	All Units/Suppliers
03	Each package should have the following inscriptions and signs stenciled with an indelible ink legibly and clearly: Destination Package number: BHEL/YMN/XXX/YYY/ZZZZ where XXX stands for Unit abbreviation e.g. HWR , HYD ,EDN, PEM, RPT etc YYY stands for Vendor abbreviation Following series of ZZZZ should be used by Different Units HWR (10000) ,HYD (20000),PSNR (30000),PEM (40000),BPL(50000),RUD(60000), TBG(70000),TRY(80000),EDN(90000) i.e. first package dispatched from HWR should be numbered : BHEL/YMN/HWR//10001 . Gross and Net weight Dimensions Lifting places Handling marks and the following delivery marking: CONTRACT Nr. 12/2008 PURCHASER: PEC YEMEN	All Units/Suppliers
04	<u>Completeness of Contents of each packing case:</u>	
04.1	Concerned CQA/Unit QC/Third Party Inspection Agency shall verify the completeness of contents of each package w.r.t packing list both in terms of quality and quantity before authorising dispatch of the consignment.	All Units/Suppliers
04.2	Packing commensurate with international standards and accepted norms will be ensured by CQA/ Unit QC/Third Party Inspection Agency. Packing has to be sea-worthy and secure. As far as possible, the packing has to be rectangular in shape for optimum space utilization in the ship and economize on shipping costs. Projections on packages are prohibited.	CQA/All Units
04.3	The packing list has to be checked and certified by the Inspection agency (ies) with due signatures. All packages shall be enclosed in suitable GI sheets on all sides.	CQA/All Units
04.4	No loose items / Gunny bag packing are allowed for shipment. Proper pallets and crates are to be used for packing of Oil drums and Structures.	CQA/All Units

	05	<u>Routing of Packing Lists:</u> Packing list is an extremely important document, which forms a part of export documentation in connection with the processing of customs formalities. Packing List has to be generated by units/Unit vendors and sent to IO and ROD, Mumbai (both at the same time), two weeks in advance, for processing and obtaining shipping bills' clearances and avoiding octroi payment through 'N' form at Mumbai.	All Units/ suppliers
	06.1	<u>Advance intimation to ROD, Mumbai & IO</u> All supplying units/vendors will give at least 15 days advance intimation to ROD, Mumbai & IO along with package details before actual dispatches to arrange for storage/shipping arrangements by ROD Mumbai and customs invoicing by IO. <u>Information must be sent to consolidate the details and arrange for shipments in time.</u>	All Units
	06.2	<u>Telephonic Intimation to ROD Mumbai of Movement of Vehicles:</u> Vehicle drivers to be instructed by the units to contact ROD regarding movement of vehicles on daily basis for heavy lifts, especially 2 days before arrival at Mumbai so that suitable directives can be given to the driver of the vehicle for further transportation of the goods either to docks or godown.	All Units
	07	To avoid opening of big cases for examination by customs at port of shipment, the supplying unit may arrange to get the packing cases sealed by local excise authorities/ self certification and to get the relevant invoices and packing lists endorsed from Superintendent, Central Excise. For this purpose, Units should send the packing lists to IO at least 2 weeks in advance to enable prepare Shipping Invoices for furnishing to the units for requisite attestation and sending the same to ROD Mumbai through fastest means for a smoother and faster customs clearance. Also Units to provide "specification of packing with the indication of the number of cargo packages, type of packing and weight of packing in English" along with the packing list.	All Units/ suppliers
	08	<u>Provision of inspection windows on Packages:</u> Unit/Vendors should provide inspection window of size 6" x 4" (glass perplex) for customs examination for all packages (above 1.5 x 1.5 x 1.5 cu m) involving panels of any kind. Care would be taken to ensure that all packages are properly sealed to avoid ingress of moisture, rodents etc. Packing slip folders shall be attached in each box.	All Units/ Suppliers
	09	<u>Transportation Drawings for Heavy Weight/ODC consignment:</u> For any package/item weighing above 20000 kgs and/or size greater than 2.5 X 2.5 X 4 m : Detailed engineering documents (at least 4 sets) for all items of the above category shall be furnished by respective units to issue shipment enquiries in a proper manner. This would include Gas Turbine ,Transformers, Lube Oil tanks,Storage Tanks (Oil and Water) and Generator . The drawing has to include center of gravity of the item clearly (Units to identify such items and notify IO as soon as the engineering documents are released).	All units
	10	<u>Lifting Beams:</u> All heavy lifts for which safe handling is essential at the port of dispatch shall be accompanied by lifting beam on non-returnable basis	All Units
09	01	<u>Marking for Safe Handling:</u> To ensure safe handling, packing case shall be marked to show the following: <ul style="list-style-type: none"> • Upright position. • Sling position and Centre of Gravity position. • Storage category. • Fragile components (to be marked properly with a clear warning for safe handling). 	All Unit

10	01	<u>Marine Insurance Policy:</u> Insurance Policy for 110 percent value of the contract covering all risks including war and SRCC from Port of shipment in India/Third country direct dispatches, to site shall be taken by IO Insurance Policy and it shall indicate PEC as co-insured.	IO Projects
11	Shipping Documentation including those covered by customs requirements:		
	01	Customs Invoices: Values to be allocated by IO (Alternatively, Excise attested invoices where the package is sealed and dispatched by the units)	ROD/ IO Projects/ All Unit
	02	Packing List	All Units /Sub-vendors of units
	03	ARE1 forms/Excise Invoice corresponding to Unit invoice values and Delivery challans.	All Units /Sub-vendors of units
	04	Chartered Engineer's Certificate, applicable to be arranged by Units. Care should be taken to ensure that usage of the materials shown in C.E. certificate out of DEPB goods is not disproportionate.	All Unit/ROD
	05	Catalogues/literature/write-up in case of customs endorsement for discharging exports obligation in case of DEEC imports to be made available to ROD before arrival of goods in the city of port of dispatch.	All Unit
	06	Unit's sub-vendors, whose responsibility of supply is upto FOB, can make their own arrangements of Customs House Agents as well as Octroi clearance, apart from physical examination of the cargo at the port of dispatch and make arrangements of loading on BHEL's nominated vessel. BHEL, in such a case, through ROD would arrange to furnish a copy of the shipping invoice to CHA of sub-vendors. All units to keep ROD Mumbai informed in this regard about the arrangements made with sub-vendors.	All Units/ Suppliers/ROD
	07	To avoid any problem with Octroi post at Mumbai & Customs, the values appearing in Unit invoice sent with the cargo shall be preferably within $\pm 10\%$ of IO-Projects shipping invoice value.	All Units/Rod
	08	Octroi Clearance: Drivers/Escorts carrying the export cargo for this project on behalf of the units to be advised to contact the agents at Octroi Naka:(To be intimated by RODMumbai) Copies of the dispatch documents must be sent to ROD Mumbai by i) Fax ii) e-mail through scanning of the documents with copy to IO	All Units/Rod
12		<u>Full Set of Clean Multimodal Transport Document:</u> Complete set of shipping B/L showing freight prepaid as per the rates of regular shipping lines. In case of Air Freight consignment, one original of AWB is required together with three copies of the same.	ROD/ IO Projects
13		<u>Certified Inspection Certificate Approved by Customer:</u> The certificate signed by PEC inspector (if equipment tested in presence of PEC representative) is to be provided to IO . In case the Certificate is signed by BHEL/Third Party Inspection Agency, it is to be provided by Units/ suppliers to IO and IO will get it approved from PEC.	All Units/ Suppliers

14	Shipping Carrier Specification and related Requirements:		
	01	Certificate of Freight having been pre-paid as per the regular shipping lines is required on MTDs.	ROD/ IO Projects
	02	Subject cargo would be generally shipped under the deck. Specific confirmation/clearance of IO is needed for shipment on deck.	ROD/ IO Projects
	03	Vessel age to be restricted as per insurance policy in force Buyer's Reference (Contract No.) is required on B/Ls.	ROD/ IO Projects
	04	For Third Country Supplies , concerned units will ensure all the above certificates in addition to Certificate of Origin.	All Units/ Suppliers
15	Guidelines for Dispatches from Units/Indian Vendors:		
	01	Vehicle drivers shall carry ARE1 in photocopy (3 originals to be sent to ROD). Each consignment carried by the vehicle shall have a separate ARE1 and it must be ensured that materials under one ARE1 get transported in the same truck/trailer. In order to avoid any problems at port of dispatch from the point of view of i) shipping bill preparation and passing thereof ii) 'N' form at Octroi check post and iii) control and movement of cargo within Mumbai and iv) physical examination of cargo by customs, the materials under the same category e.g. a) DEEC cargo b) Free shipping bill cargo c) DEPB (duty entitlement pass book scheme) and d) duty drawback must be sent in the same truck/trailer. Units to ensure that ROD is communicated very clearly the type of shipping bills to be prepared, well before the materials are dispatched from the works.	All Units
	02	<u>All materials to be dispatched under intimation to:</u> Senior Manager(Exports) Bharat Heavy Electricals Limited Regional Operations Division 14th Floor, World Centre 1, Cuffe Parade Mumbai-400005 Attention: Mr.Sanjeev Shikhare Telephone No.: 22171302 (Mumbai)	All Units/Rod
	03	<u>Clearing Agents:</u> All materials to be dispatched to Mumbai on door delivery basis, freight prepaid to the address of the clearing agents(to be specified by ROD, from time to time)	All Units/Rod
16	01	<u>Customs formalities Period:</u> Packages arriving at the port shall have a minimum time of 3 working days for customs examination and other related formalities in respect of the cargo under shipment. The goods received after arrival of the ship may not be loaded if either sufficient time does not exist or space available in the ship is booked by the carrier for other exporters due to lack of availability of the goods at the port in time for shipment from BHEL. In cases, where the committed cargo to the carrier based upon information received from all the units does not reach in time of scheduled shipment at the port of dispatch, IO-Projects would be within its right to decide the priority of loading as per the project schedule requirements given the condition that adequate space in the ship is not available to accommodate the cargo.	For information
17	01	<u>Triplicate ARE1 forms for Cancellation of Bonds:</u> It is necessary that the units ensure that ARE1 forms are sent in Triplicate to ROD Mumbai. After ROD Mumbai effects the shipment, endorsement of customs on triplicate copy of ARE1 form would be obtained by ROD Mumbai and sent to the concerned unit within 6 to 8 weeks for cancellation of the excise bond.	Units/ ROD Mumbai

18	01	<u>Formalities in Connection with 'N' form:</u> After the shipment is effected, requisite formalities indicating physical export of the goods earlier exempted from payment of Octroi at Mumbai will have to be ensured. Units to ensure this from their sub-vendors because In past , Octroi notices from Mumbai municipal corporation were received and 'N' form facilities were withdrawn at times.	Units
19	01	<u>Shipping Procedures and ROD Responsibilities:</u> Consolidation of Packages and Storage in Warehouse: ROD Mumbai either themselves or through their CHA would ensure following: <ul style="list-style-type: none"> • Proper storage of goods at an elevated level if store is in open to avoid damages to the consignment during rainy season (All the packages to be covered with a proper tarpaulin in open storage). • All Electrical and C&I items to be stored indoors. • Consolidation of the goods as per summary packing lists. • Check marks and numbers on packages. Carry out the corrections, if necessary. • Label the packages linking to the proposed shipping carrier to ensure that package does not get left out. 	ROD



**TECHNICAL SPECIFICATION
AIR CONDITIONING SYSTEM
400 MW MARIB GTPS PH II
LIST OF MAKES**

SPECIFICATION NO. PE-TS-372-553-A001

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REV.

DATE: 31.07.2012

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**ANNEXURE-I
LIST OF MAKES**



**TECHNICAL SPECIFICATION
AIR CONDITIONING SYSTEM
400 MW MARIB GTPS PH II
LIST OF MAKES**

SPECIFICATION NO. PE-TS-372-553-A001

VOLUME II B

SECTION C

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S.No.	Description	Makes
1.	DX Condensing unit	York / Trane / Carrier / Kirloskar / Mcquay / Voltas/ Dunham Bush / Blue Star.
2.	Package AC	Voltas / Blue Star / Carrier
3.	Split Air Conditioner	Voltas / Blue Star / Carrier / Hitachi
4.	Air Handling Units	Voltas / Blue Star / Carrier-Aircon / Zeco / Carryaire(Flakt) / Ethos / Saiver Suvridha / Edge Tech
5.	AHU Fan (Centrifugal Fan)	CB Doctor / Flakt / Nicotra / Comefri / Krugger /Patel Air flow/ Sarla
6.	Induction Motors (LT)	Siemens / ABB / Kirloskar / Bharat Bijlee/CGL/KEC/Marathon
7.	Air Filters	Purolator / Ucomech / John Fowler / FMI / Anfilco / Tenacity / SMI / Puromatic /Spectrum
8.	Axial Fans/F.A. Fans	Marathon / Flakt / CB Doctor / Draftair / Advance Ventilation / Patel Air Flow / SK System/Sital
9.	Insulation Material	FGP / Lloyds / Basf / Mettur-Beardshell / UP Twiga / Owens Corning / Armacell / Arma Flex
10.	GI Sheets for Ducting	SAIL / Jindal/Bhushan / TATA.
11.	Thermostats	Honeywell / RANCO / Penn / Danfoss / Indfoss
12.	Humidistat	Honeywell / Penn.
13.	Antifreeze thermostat	RANCO / Honeywell / Penn / Danfoss / Indfoss
14.	Strip Heaters	Escorts / RACOLD / Daspass/ALCO/HEATCO/Hotset
15.	DP Switches	KAUSTUBA UDYOG /SWITZER/SOR INC/VASU TECH
16.	Temperature Switch	INDFOSS/DRESSER/SWITZER/SOR INC/TOSHNIWAL BRO/VASU TECH
17.	Temperature Element	GENERAL INST CONSORTIUM/DETRIVE INST & ELECTRONICS /PYRO ELECTRIC /TOSHNIWAL BROS/WAAREE INST
18.	Transmitters	BRISTOL BABCOCK/BIRLA KENT-TAYLOR /BLISS ANAND/FISHER-ROSEMOUNT/SIEMENS/SBEM /SMART INST/TATA HONEYWELL/V.AUTOMAT & INSTS/
19.	Pan Humidifier	Rapid Cool / Hotset/ALCO
20.	Fire Damper	TSC /Carryaire/ Ravistar.
21.	Control Panel	Industrial Control & Appliance / Control & Switchgear / Siemens / L&T / Pyrotech / GE-Power / Positronics
22.	Annunciator for Panels	Procon / IIC / Pecon
23.	Temp/RH Sensor	Siemens Building Technology/Johnson/ Honeywell

Note: Above makes are subject to Customer / BHEL approval during detailed engineering stage.

SECTION D
STANDARD TECHNICAL SPECIFICATIONS



TECHNICAL SPECIFICATION

AIR HANDLING UNITS

SPECIFICATION NO.PES-553-05

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SECTION-D

AIR HANDLING UNITS

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1.

GENERAL

1.1.1

This specification covers the design, manufacture, construction features, installation, commissioning, inspection and performance testing at site of AHUs.

2.

CODES AND STANDARDS

The design manufacture and performance of AHU shall comply with all currently applicable statutes, regulations and safety codes in the locality where the AHU is to be installed. The equipments shall also conform to the requirements of the latest editions of applicable Indian/British/US standards. Nothing in this spec. shall be construed to relieve vendor of this responsibility. In particular the equipment shall conform to the latest editions of the following standards:

2.1.1

IS-659:

Safety code for air conditioning

2.1.2

IS-660:

Safety code for mechanical refrigeration

2.1.3

ASHRAE:

Method of testing forced circulation air-cooling and air heating coils. standard 33

2.1.4

ARI 410:

Standard for forced circulation air cooling and air heating coils.

2.1.5

ARI 430/435:

Air-cooling and air heating coils Central Station AHU / Application on of Central Station AHU.

2.1.6

AMCA: 211 and 311

In case of any conflict in the standards and this specification the decision of PEM,BHEL shall be final and binding.

3.

CONSTRUCTION FEATURES

3.1.1

The casing of AHU shall be made of insulated double wall construction of min. 24 gauge galvanized sheet steel - IS 277 Gr. 120 (parent sheet: D/DD-IS-513) ribbed and reinforced for structural strength and rigidity with 25 mm thick polyurethane insulation of minimum 40 kg/cu.m density in between. The external wall will be pre-plasticised over GI coating on the outside. Angle irons or channel sections made of 16 gauge galvanized sheet steel shall be used for reinforcing. The casing shall be of sectionalized construction with proper sealing at the joints to make them air tight.

Fan section and panels with bearing support shall be reinforced with heavy gauge channels (min. 5 mm thick). Suitable number of forged hot dip galvanized (610 gm/sq.m) U brackets shall be provided for AHU suspended from ceiling/roof.


3.1.2


For AHU supported on floor, leg package/base frame shall be provided to raise the level by at least 350mm. All edges shall be formed interlocking to stiffen and support the weight and shall be secured with HD galvanized nuts and bolts class 4.6.

Necessary arrangement shall be provided on the casing for measuring temperature and pressure in cooling/heating coil. Class of instruments shall be min. 2.

3.1.3

Fan impeller shall be backwardly inclined curved blade centrifugal type. Impeller shall be double width double inlet type. Fans shall be preferably low rpm (≤ 1500) to minimize vibration and noise. Noise shall be within 85 dB(A) at 1 metre distance from AHU casing. Max. Vibration level shall be and acceptance norms to be specified. Two to three wheels (impellers) shall be provided for each AHU. Impeller blades shall be fabricated from (min. 1.0 mm) galvanized/ epoxy powder coated sheet steel. Fan shall be of epoxy powder coated / galvanized sheet steel (min. 1.6 mm) scroll with die formed inlets for uniform air flow. Fan shafts shall be solid cold rolled carbon steel (EN8 normalised), ground and polished. Fan shaft bearings shall be of heavy duty type selected for average operating life of 100,00 hours. Bearings shall be self

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		<p>aligning, permanently lubricated type. Make of Brgs(SKF/FAG/NORMA/TATA) to be specified. Bearing Housing shall be of casting of min. IS Gr. 210, split type and suitably supported. The V-belt drive with belt guard shall be provided. The motor shall conform to motor spec. no. PES-506-02 enclosed. Motors shall have minimum 15% margin over maximum BHP in working range. DX or chilled water cooling coils and steam/hot water coils shall be internally corrugated copper/ cupronickel tubes (as per manufacturer's standard) with smooth non corrugated external fins of aluminium (thickness 0.14 mm and grade 1100 as per spec) unless specified otherwise in data sheet A. At least 5 fins /per cm. shall be provided. The chilled water/hot water coils shall have suitable (standardize class, size, threading) drain and vent connections.</p> <p>3.1.4 The filters in the filter section shall be provided as detailed in data sheet A and specification no. PES-554-03 enclosed.</p> <p>3.1.5 Pan type Humidifier consisting of SS304/316 tank, heater, geyserstat with piping connection to supply air duct shall be provided unless specified otherwise in data sheet A.</p> <p>3.1.6 Heaters and branch line shall be of galvanized steel (min. galvanising grade: ?) and nozzles shall be of brass (matl. grade) /SS 304.</p> <p>3.1.7 Condenser water from coil or surplus water from spray humidifier shall be collected in 16 gauge SS-304 pan. Minimum 50mm dia GI pipe nipple shall be provided on each end for drain connection. The drains for these points shall be extended to the main drain in AHU room. The AHU casing and condensate drain pan shall be insulated with 25 mm thick polystyrene. Condensate drain pipe (GI) of required length with sealing loop shall be provided and insulated with 25 mm thick expanded polystyrene and finished with 24G Aluminum Sheet cladding. Minimum requirement For GI Pipes and fittings shall be ERW/Seamless of medium thickness as per IS-1239/3589 and Hot dip galvanized</p> <p>3.1.8 Suitable number of Spring type vibration isolators or 25mm thick ribbed neoprene rubber pads shall be provided for vibration isolation</p>	
		<p>TESTING AND INSPECTION at Manufacturers works:</p> <p>List of TCs arranged as per Approved Quality Plan shall be furnished along with copy of TCs at the time of inspection by BHEL.</p> <ul style="list-style-type: none"> ➤ Visual inspection of GI sheets and angles, channels etc. – dents, black spots, chipping of zinc coating, white dust on galvanised sheets shall be avoided. Pitting , lamination in angles and channels shall be avoided.- visual inspection by manufacturer. ➤ Galvanised sheets - Test certificate shall be furnished for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating –review of TC by BHEL/Customer. For pipes and fittings compliance report shall be furnished by Manufacturer through Main contractor for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating. ➤ Shaft: Mechanical and chemical— review by BHEL ➤ Motors (of approved make): Routine TC. ➤ Workmanship and dimensional check as per manufacturing drg. and approved Drgs.- by main contractor of BHEL. ➤ Balancing of impellers- Dynamic balancing certificates shall be furnished –grade 6.3 or better to ISO-1940. Balancing weights shall be positively locked to avoid loosening. Balancing weights and fasteners used shall be galvanised.- witness by manufacturer- TC to be furnished for review. ➤ Performance test of one Centrifugal fan/per type/per size as per AMCA standard (for indigenous make) – by BHEL 	


	TECHNICAL SPECIFICATION AIR HANDLING UNITS	SPECIFICATION NO.PES-553-05	
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<div><div>➤ Centrifugal fans for AHUs will be 100% run tested by main contractor of BHEL. One centrifugal fan/per type/persize will be run tested by BHEL- Vibration shall be within good zone of VDI 2056 / ISO 10816-1(group- K) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient</div><div>➤ Complete assembly of one AHU/per type/ per size (excluding cooling coil and filter) shall be witnessed by BHEL. Balance assembly to be witnessed by main contractor of BHEL.</div><div>➤ Run test of one complete assembly/per type/per size (excluding cooling coil and filter) by BHEL. Balance to be witnessed by main contractor of BHEL. Vibration shall be within satisfactory zone of VDI 2056 / ISO 10816-1(group- K) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient</div></div>			



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Description**Data**

- | | |
|--|--|
| 1. Designation | Refer Section-C. |
| 2. Nos. required/working | Refer Section-C. |
| 3. Location: | As per tender drawing. |
| 4. Service/type | Air Conditioning (Double skin) |
| 5. Fan | Centrifugal (backward curve Blade) limit load type. |
| a) Capacity | To Suit as per calculation. |
| b) Static pressure | To suit but not less than 60 mm wc with Micro-V filters for control room areas. |
| | High efficiency filters (average arrestance efficiency of 80-90 %
(in the common discharge of AHUs shall be provided to cater the air conditioning requirement of all control room and allied areas. |
| c) Discharge direction | Vertically upward/to suit. |
| d) Motor | By Bidder, |
| e) Local push button station (Start/Stop) | By Others |
| f) Motor location | As per Manufacturer's standard./Outside AHU Casing. |
| g) Drive | Belt, pulley, etc. |
| 6. Face and Bypass Damper | Required (Opposed blade type) as per system requirement. |
| 7. Cooling coil | |
| a) Duty sensible heat | To suit as per calculations |
| b) Duty latent heat | -do- |
| c) Type of coil | As per spec. |
| d) No. of rows | As per spec |
| e) Material of tube /Thickness | Seamless Copper to ASTM E-75/Equivalent. |
| f) Material of fins | Aluminium to SAE-1100-/1145-0 |
| g) Number of fins | Not greater than 5 per cm (13 per inch). |
| h) Max. face velocity | 2.5 m/sec. |
| i) Air flow quantity | To suit as per tender drawings/documents. |
| 7. 3 - way motorised mixing valve with thermostat. | As per spec. |

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AIR HANDLING UNIT			
DATA SHEET - A			
8.	Damper at discharge	Manually operated at discharge of each AHU outlet.	
	a) Material of construction	Mild Steel, galvanised.	
9.0	Filters (Pre-filters)		
	a) Type & thickness	Dry panel type/ 50 mm	
	b) Filter area.	To suit as per velocity requirements. "V" - Bank.	
	c) Filter efficiency	Average arrestance efficiency of 65-80 %	
	d) Press drop (Clean)	Not to exceed 2.5 mmwc when clean & 6.5 mmwc while dirty.	
10.	Humidification section	As per spec.	
	a) Type		
	b) Operation		
11.	Fresh air arrangement	Required.	
	a) Fresh air fan	Tube axial flow fans with motor.	
	b) Accessories	i) Inlet cone with Bird screen. ii) Dry panel pre-filters, iii) High efficiency filters for control room areas. iv) Volume Control Dampers, v) Supports etc.	
12.	Vibration isolator required.	Yes	
13.	Type of vibration isolator.	Neoprene ribbed Rubber.	
14.	Any other requirement	i) Cooling coil & fan section including pan shall be thermally insulated as per specification. ii) In addition to dry panel filters on AHU, High efficiency filters(average arrestance efficiency of 80-90 %) shall be provided in supply air duct side of AHU for all control room and allied areas. iii) Bidder to also provide suitable electrical strip heaters for winter heating & monsoon reheating with Contactor box etc. Heaters to be interlocked with airstat.	
15.	Instrument & controls	Lot.(including Control box for strip heaters, pan humidifiers etc. in each AHU room.)	
16.	Insulation of drain piping	Lot	
17.	Casing thickness	24G GI or better.	



TITLE

STANDARD TECHNICAL SPECIFICATION**AIR HANDLING UNIT**

SECTION D

SPECIFICATION NO. PES-553-05

VOLUME II-B

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SHEET 1 OF 1

DATA SHEET - C**DRAWINGS/DOCUMENT/DATA REQUIRED AFTER AWARD OF CONTRACT**

- 1.0 GA drawing of AHU & data- sheet to be submitted along with technical schedules enclosed in Volume III.
- 2.0 Drawings including equipment layout, foundation & loading details etc. for civil works. These drawings must cover sufficient details so that design of civil works can be completed.
- 3.0 Inspection, operation & Maintenance Manuals.
- 4.0 Equipment description giving complete design calculations, basis of design, selection criteria etc.
- 5.0 Test Certificates.
- 6.0 Final as built documentation i.e. final-version of all drawings, data & information as per the requirement specified elsewhere.
- 7.0 Performance Test Certificates.



TECHNICAL SPECIFICATION
LOW PRESSURE AIR DISTRIBUTION
SYSTEM

SPECIFICATION NO.PES-553-07

VOLUME II B

SECTION D

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SECTION-D
LOW PRESSURE AIR DISTRIBUTION SYSTEM



TECHNICAL SPECIFICATION
LOW PRESSURE AIR DISTRIBUTION
SYSTEM

SPECIFICATION NO.PES-553-07

VOLUME II B

SECTION D

REV. 02

DATE: 11.04.2007

SHEET 2 OF 6

1. GENERAL

This specification covers the design, manufacture, construction features, installation, inspection testing and air balancing of air distribution system upto a total pressure of 95mm w.g. The specification is intended to cover the air distribution for airconditioning system and ventilation system not involving localised exhaust.

2. CODES AND STANDARDS

2.1.1 The design, construction and performance of complete system shall conform to all currently applicable statutes, regulations, safety codes in the locality where the equipment are to installed.

2.1.2 Unless specified otherwise the equipments shall generally conform to latest applicable Indian Standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. In particular the equipment shall generally conform to latest editions by the following standards:-

- a) IS: 655 - Specifications for metal air ducts
- b) IS:277 - Specifications for galvanised steel sheets
- c) IS:737 - Specification for wrought aluminium and aluminium alloy sheet and strip.

3. MATERIAL

3.1.1 Metal air ducts shall be either of galvanised steel sheets or aluminium sheets, as indicated in data sheet-A.

3.1.2 The rolled steel sheets before galvanising shall be properly annealed or normalised so as to allow fabrication of ducts without developing cracks. Zinc coating on the steel shall be as per IS 277 Gr. 275 / as specified in Data Sheet A.

3.1.3 The aluminium sheets shall be of grade S1C or NS3 and shall be suitable for duct fabrication work as per IS-737 latest.

4. CONSTRUCTION/FABRICATION

The thickness of sheets, the type of bracing and other fabrication details shall generally conform to requirements given hereunder unless specified otherwise in data sheet A and/or indicated on drawings.

4.1 RECTANGULAR DUCTS

4.1.1

S.No.	Max Side	Sheet Thickness		Type of transverse Joint connections	Bracings
		(mm) GI	(mm) Al		
a)	Up to 600	0.63 (24G)	0.80	S-drive, pocket or bar slips or flanged joints on 2.5m centres	None
b)	601 to 750	0.63 (24G)	0.80	S-drive, 25mm pocket or 25mm bar slips or flanged joints on 2.5m centres	25x25x3 mm MS angles, 1.2m from joints
c)	751 to 1000	0.80 (22G)	1.00	S-drive, 25mm pocket or 25mm bar slips or flanged joints on 2.5m centres	25x25x3 mm MS angles, 1.2m from joints



TECHNICAL SPECIFICATION
LOW PRESSURE AIR DISTRIBUTION
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d)	1001 to1500	0.80 (22G)	1.00	40x40x3mm MS angle, flanged connections or 40mm pocket or40mm bar slips with 35x3mm bar reinforcing on 2.5m centres	40x40x3 mm MS angles, 1.2m from joints
e)	1501 to2250	1.00 (20G)	1.50	40x40x3mm MS angle, flanged connections or 40mm pocket or40mm bar slips, 1M maximum centres, with 35x3mm bar reinforcing	40x40x3 mm diagonal angles or 40x40x3mm angles, 600mm from joints
f)	2251 & above	1.25 (18G)	1.80	50x50x3mm MS angles,connections or 40mm pocket or 40 mm bar slips, 1M maximum centres with 35x3mm bar reinforcing.	50x50x3mm diagonal angles or 50x50x3mm angles 600 mm from joints.
g)	No bracing is required if transverse joints are less than 600mm apart				
h)	For ducts larger than 2250mm, special handling and supporting methods shall be provided as per the approval of Purchaser				

- 4.1.2 All rectangular ducts having either dimension larger than 450mm shall be cross broken except these ducts which are insulated with sand cement plaster. Air outlet connections on ducts need not be cross broken.
- 4.1.3 The seams on duct cones shall be of Pittsburgh type. Longitudinal seams shall be smooth inside the ducts.
- 4.1.4 The flanges used for transverse joints shall be joined together with GI bolts (grade 4.6) and nuts spaced at 125mm centres as per following:
- Upto 1000mm - 6 mm dia GI bolts
 - 1001 to 1500 - 8 mm dia GI bolts
 - 1501 and above - 10mm dia GI bolts
- 4.1.5 The MS angle flanges shall be connected to ducts with rivets at approx. 100mm centres. The flanged joints shall have 6mm thick felt packing stuck to flanges with shellac varnish. The holes in the felt packing shall be burnt through. The ducts are to be tapped 6mm across the MS flanges.
- 4.1.6 MS angles used for bracings shall be tack welded to the ducts or rivetted at 125mm centres, as applicable.

4.2 ROUND DUCTS

4.2.1

S.No.	Duct dia-mm	Sheet Thickness		Reinforcing
		(mm) GI	(mm) AI	
a)	Up to 150	0.63 (24G)	0.80	None
b)	151 to 600	0.80 (22G)	1.00	None
c)	601 to 1000	1.00 (20G)	1.50	40x40x3mm girth MS
d)	1001 to1250	1.00	1.50	40x40x3mm girth MS angles at 2.0 meter centres



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LOW PRESSURE AIR DISTRIBUTION
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		(20G)		
e)	1251 & above	1.25 (18G)	1.80	40x40x3mm girth MS angles at 1.2m centres

4.2.2 The seams on round ducts may be continuously welded or grooved longitudinal seam. In case of welding of GI sheet, zinc rich paint shall be applied on the welded zone.

4.2.3 Round ducts shall either be joined by welding or the ducts shall be swedged 40mm from the ends such that larger end will butt against the swedge and is held in place with sheet metal screws.

4.3 DUCT SUPPORTS

Unless specified otherwise on drawings, rectangular ducts with larger side of 2250mm or above shall be supported by 15mm MS rods and 50x50x3mm and MS angles while those below 2250 mm shall be supported by 10mm MS rods and all angles shall be given a coat of primer paint. The duct supports shall be at a distance not exceeding 1800mm. The MS rods shall be fixed to MS angle cleats, which in turn are fixed to ceiling slab by suitable anchor fasteners. All anchor fasteners, MS angle cleats, coach screws, hooks and other supporting material required shall be provided by vendor.

However, If ducts are thermally insulated, the MS angles and supports shall not be in direct contact with ducts, for which purpose wooden pieces/ Resin bonded fibre glass sheets (50 mm thick) shall be used in between.

4.4 FLEXIBLE CONNECTIONS

Wherever the sheet metal ducts connects to intake or discharge of fan units a flexible connection of at least 150mm width made by closely woven double layer Fire resistant or canvas shall be provided. The same shall be attached to angle iron frames on equipment and to similar frame on duct or casing by means of a steel band 9r (or) collar fitting over the end of the flexible connection and bolted through angle iron frame so as to clamp securely between the band and the angle frame.

4.5 TRANSFORMATIONS AND BREACHES

All curves, bends, offsets and other transformations shall be made for easy and noiseless flow of air. The throat of every branch duct shall be sized to have a velocity not exceeding that in the main duct to which the branch is connected.

4.6 CAULKING

Wherever duct passes through wall, the opening between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to adjoin by space with a rated fire resistant material.


4.7 EASEMENT

Normally pipe hangers, light fitting rods etc. shall not be allowed to pass through the ducts. Wherever, It becomes absolutely essential to pass these hangers/rods etc. Through the ducts, prior approval of purchaser shall be taken and light streamlines easement around the same shall be provided to maintain smooth air flow.

4.8 ACCESS DOORS

Access doors shall be provided in ducts, plenums etc. on both sides to allow access and servicing of equipment viz. pipes, dampers, coils, valves, heaters etc.

All access doors shall be adequately sized and lined suitably with felt to prevent air leakage. The doors shall be of built-up construction, structurally strong and shall have

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at least two hinges each, and shall be with two rust proof window sash locks of approved type. All doors shall be so set as to flush with outer finish of duct insulation etc.

4.9 DAMPERS AND SPLITTERS

4.9.1 Dampers and splitters shall be provided at suitable points for proportional volume control of the system. Splitters and dampers shall be made of minimum 18 gauge GSS of quadrant type with locking device mounted outside the duct at accessible location.

4.9.2 Fire Dampers

Fire dampers/fire doors shall be provided as specified in Data Sheet -A and shall be installed at locations indicated on drawings and/or as required/approved by purchaser, including all openings in passage of duct work through fire walls and floors etc. The fire damper shall be of electrical type with damper motor actuated by thermal sensor or fusible link type.

4.9.3 Gravity operated back draft dampers shall be provided to ensure pressurisation of rooms as specified. These dampers shall be designed such as not to allow infiltration of outside air while forced exit of air shall be achieved through this damper. The louvres shall be freely mounted on spindles to allow the dampers to open with the pressure developed by the fan. The dampers shall be provided with flange at inlet.

4.9.4 Vanes

Unless otherwise shown in the drawings all elbows shall be such that the throat radius is 75% of the duct width. In case throat radius is smaller, suitable single thickness vanes of approved details shall be provided.

4.9.5 Flashing

For the ducts penetrating roofs or outside walls, provision of flashing shall be made by the ducting vendor.

4.10 DIFFUSERS AND GRILLS


The type and quantity of diffusers and grills is indicated on enclosed drawings/data sheet A. The size/quantity of diffusers/ grills indicated in the drawing/data sheet is indicative and is for vendor's reference purpose only. Vendor shall ensure that the diffusers/grills offered are of requisite capacity, throw and terminal velocity. The pressure drop and noise levels shall be as per data sheet. A enclosed. The diffusers/grills shall be approved by purchaser.

Unless specified otherwise the diffusers/grills shall be of mild steel land painted with two coats of primer paint. Supply air grills shall be complete with volume control dampers. Supply air grills shall be double deflection type while Return Air grills can be single deflection type. Ceiling outlets/diffusers shall have volume control dampers, fixed grids and blanking baffles. All volume control dampers shall be operated by a key from the front of grills/diffusers.

Suitable vanes shall be provided in duct collars to have uniform air distribution. Blank-off baffles wherever required, shall also be provided.

4.11 PLENUMS AND RA BOXING

All plenum chambers and/or connections to fans, dampers etc. shall be constructed in 18 gauge GI sheet. supported on 40x40x6mm MS angle frames. All vertical angles shall be riveted at appox. 125mm. centres to the casing. Suitable caulking compound (Pecora or equivalent) shall be inserted between the base of the angle and all masonry construction to which angles are fastened.

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Return air boxing requirements if any are indicated in data sheet-A and the same shall be provided by vendor. The return air box shall be fabricated out of GI sheets shall be insulated with 25mm thick fibre-glass.

4.12

ACCOUSTIC LINING

The ducts shall be lined acoustically from inside as given in data- sheet A and/or section C of the specification.

4.13

PAINTING

Wherever specified the ducts shall be painted or lined with suitable anti-corrosive paint/ lining as per approval of purchaser. In particular the ducts coming in contact with acid fumes shall be epoxy coated, inside and outside.

4.14

THERMAL INSULATION

Thermal insulation shall be as per data sheet - A and the insulation shall conform to enclosed spec. no. PES-553-08.

5.

INSPECTION AND TESTING

5.1

INSPECTION & TESTING DURING FABRICATION-BY MAIN VENDOR

5.1.1

Visual inspection of GI sheets and angles, channels etc. – dents, black spots, chipping of zinc coating, white dust on galvanised sheets shall be avoided. Pitting , lamination in angles and channels shall be avoided.- visual inspection by Main Vendor.

5.1.2

Galvanised sheets - Test certificate shall be furnished for visual check, coating thickness, adhesion test, sheet thickness, uniformity of coating –review of TC by BHEL/Customer

5.1.3

Check for dimensions & mass as per latest IS-277.

5.1.4

Check for defect, twists, ungalvanised spots as per IS-2629.

5.1.5

Bend test & wrapping test as per IS-277.

5.1.6

Zinc coating test on samples as per IS-6745.

5.2

INSPECTION & TESTING AT SITE.

5.2.1

The duct branches, elbows etc. shall be inspected and the joints and connections etc, are to be checked before they are assembled in position.

5.2.2

After completion, all duct systems shall be checked and tested for air leakage, tightness, velocity, pressure drop, vibration and noise etc.

6.

BALANCING

6.1.1

The entire air distribution system shall be balanced by vendor to supply the air quantities as required in various rooms so as to maintain the requisite temperature and air flow in the conditioned spaces. The final balance of air quantities through each grill/diffuser etc. shall be recorded and submitted to purchaser for approval. Proper steps shall be taken to have a uniform temperature in all enclosures, with utmost care for noise level to be within tolerance limit

6.1.2

All instruments required for testing/balancing etc. of the air distribution system shall be provided by vendor.



TITLE

LOW PRESSURE AIR DISTRIBUTION SYSTEM**DATA SHEET - A**

SPECIFICATION NO. PE-TS-372-553-A001

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SECTION D

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SHEET 1 OF 2

Description**Data**

- | | |
|---------------------------------------|---|
| 1) General (List of areas) | As per Specification/Tender drawing. |
| 2) GSS Duct Work | |
| a) Type | GSS as per IS: 277
(Zinc coating as per spec.) |
| b) 20 G ducting | Bidder to estimate as per drawings/sketch
Separately for AC system (Area wise). |
| c) 28 G " | -do- |
| f) Any other size | -do- |
| 3) Acoustic lining | As per spec. |
| 4) RA boxing & fresh air duct system. | Required. |
| 5) Special painting | Galvanised. |
| 6) Thermal Insulation | As per spec. |
| 7) Diffusers (Circular/Square) | |
| 300 mm size | Bidder to estimate as per
drawings./specification.
All grille frame and louvers shall be
manufactured of at least 16 SWG Aluminium |
| 350 mm size | |
| 450 mm size | |
| 550 mm size | |
| 600 mm size | |
| Any other size | |
| 8) SA grilles (for each size) (SQ.M) | To suit air flow as per System
requirements / Tender Drawings. |
| 9) RA grilles (for each size) (SQ.M) | -do- |

NOTE:

- 1) Duct sheet thickness shall be as per IS-655
- 2) Opposed blade type volume control damper shall be provided at each supply air diffusers/grilles.
- 3) Bidder to provide suitable gasketing at each duct flange.
- 4) Bidder to indicate unit rates for variable items like ducting, diffuser/grilles with & without volume control damper, thermal insulation, acoustic insulation etc.
- 5) Fire damper shall be motor operated type.
- 6) Access door in ducting system shall be provided as required.
- 7) MS Angle (painted) shall be used for duct supports etc.



TITLE

LOW PRESSURE AIR DISTRIBUTION SYSTEM**DATA SHEET - A**

SPECIFICATION NO. PE-TS-372-553-A001

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SHEET 2 OF 2

- 8) Velocity thru duct shall normally not exceed 9.0 M/sec for Air conditioning system. Maximum velocity (outlet) for supply air diffuser shall not exceed 2.5 m/sec.
- 9) All Grilles & diffusers shall be supported with frame. Frame etc. shall be supplied by bidder.



TITLE

**STANDARD TECHNICAL SPECIFICATION
LOW PRESSURE AIR DISTRIBUTION SYSTEM**

SPECIFICATION NO. PES-553-04

VOLUME II-B

SECTION D

REV 01

DATE 04-12-1996

SHEET 1 OF 1

DATA SHEET - C

Data to be furnished by vendor after the award of contract.

1. Fabrication drawings of ducts and grilles, louvers, dampers, etc, including typical details of grilles dampers etc.
2. Test certificates in line with scope of inspection.
3. Other dimensional drawings & documents as may be required by purchaser for better understanding of the system & for preparation of operation, maintenance & instruction manual.



TECHNICAL SPECIFICATION

VENTILATION FANS

SPECIFICATION NO.PES-553-11

VOLUME II B

SECTION D


REV. 02

DATE: 19.06.2007

SHEET 1 OF 4

SECTION-D

VENTILATION FANS

	TECHNICAL SPECIFICATION VENTILATION FANS	SPECIFICATION NO.PES-553-11	
		VOLUME II B	
		SECTION D	
		REV. 02	DATE: 19.06.2007
		SHEET 2 OF 4	

1.

GENERAL

This specification covers the design, manufacture, testing of performance at manufacturer's/sub-contractors works, delivery at site, handling at site, erection and commissioning of ventilation fans.

2.

CODE AND STANDARDS

The design, manufacture and performance of equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where it is to be installed. The equipment shall conform to latest edition of applicable Indian Standards or their equivalent standards. Nothing in this specification shall be construed to relieve the vendor of this responsibility. In particular the equipment shall conform to the latest editions of the Following standards.

2.1.1

IS:4894

-Centrifugal fans

2.1.2

IS:3588

-Electric Axial Flow fans

2.1.3

IS:2312

-Propeller type A.C. ventilation fans

2.1.4

IS-3963

-Roof extractor units

2.1.5

BS:848

-Method of performance test for fans.

2.1.6

AMCA publication 99 standards handbook

2.1.7

AMCA standard 210, Test code for air moving devices.

3.

DESIGN AND CONSTRUCTION

3.1

THE ENCLOSED DATA SHEET A GIVES THE NECESSARY DETAILS FOR CENTRIFUGAL/AXIAL/ROOF EXTRACTOR UNITS ETC.

3.2

WELDING PROCESS AND WELDERS EMPLOYED FOR FABRICATION SHALL BE QUALIFIED AS PER ASME SEC. IX

3.3

CASING

3.3.1

The centrifugal fans casing shall be of welded construction fabricated with heavy gauge material (min 3 mm) with flanges (min. 5 mm) on inlet and out let side for direct connection and shall be rigidly reinforced and supported by structural angles. The seams shall be permanently sealed airtight. Horizontal Split casings shall be provided on large size fans. Casing drain (at bottom) with threaded plug/ with valve shall be provided, as required. All mounting/ connecting holes shall be drilled off centre.

3.3.2

The axial flow casing for supply fans/roof extractors shall be of heavy gauge construction (min 3 mm) properly reinforced for rigidity and shall be complete with suitable supports. Access doors with suitable locking arrangement shall be provided in the casing for easy access to the motor and impeller. External junction box/ Terminal box on casing with IP-55 protection shall be provided, if required. Wiring for motor from external junction box/ Terminal box shall be through flexible conduit.

3.3.3


Suitable motor brackets designed for rigid mounting of motors, shall be provided for roof extractors and wall mounted exhaust/ supply fans.


3.4

IMPELLER

3.4.1

Centrifugal fan impeller shall have die formed, aerofoil or laminar blades welded to the rim and back plate and shall have non-overloading, self cleaning characteristics. Rim shall be spun to have smooth contour. If required, intermediate stiffening rings

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		<p>shall be provided. Shaft sleeves shall be furnished, if specified. The impeller, pulley and shaft sleeve shall be secured to the shaft by key and/or nuts (threaded opposite to direction of rotation of impeller). The impeller shall be statically and dynamically balanced.</p>	
3.4.2		<p>The axial fan impeller shall be of high efficiency aerofoil design. The blades shall be mounted on a streamlined hub and the impeller shall be mounted directly on the motor shaft. Impeller shall be in one piece however; fabricated blades will be acceptable up to 450 mm impeller diameter. Final assembled fan motor shall be statically and dynamically balanced.</p>	
3.4.3		<p>Roof ventilator impeller may either be centrifugal or axial type. Backward inclined blades shall be provided for centrifugal impellers. Blades may be die-formed or cast. Axial flow impeller shall be directly mounted to motor shaft whereas centrifugal impeller may either be direct-driven or belt-driven. The shaft of belt-driven centrifugal fan shall be solid cold rolled carbon steel, ground and polished. However, direct mounted impellers are preferred.</p>	
3.5		BEARINGS:	
3.5.1		<p>The centrifugal fan bearing may be ball, roller or sleeve bearings of self-aligning heavy duty type with adequate capacity and life. Make of Bearings to be specified. Bearings shall be oil/grease lubricated and provided with fittings for lubrication from outside and shall be located in easily accessible position to facilitate maintenance.</p>	
3.6		INLET CONES AND GUARDS	
3.6.1		<p>Centrifugal fans inlet shall be spun to have a smooth contour. Inlet screen, if provided, shall be galvanised wire mesh of 25 mm square with wire thickness of min. 1.5 mm.</p>	
3.6.2		<p>Inlet cone, outlet bell and suitably designed guards shall be provided.</p>	
3.7		GUIDE VANES:	
3.7.1		<p>In case of vane axial fans guide vanes shall be provided on discharge side.</p>	
3.8		BASE PLATE AND VIBRATION ISOLATORS	
3.8.1		<p>Base plate and vibration isolators, which may be double deflection rubber in shear or rubber in compression type or spring type shall be provided. With each fan rubber bushes, washers wherever needed for vibration isolator in sufficient nos. shall be included, as required, to ensure isolation of foundation from vibration of equipment. For roof ventilators suitable mounting arrangement shall be provided such that there is no ingress of rain water into the building.</p>	
3.9		HOOD AND COWL	
3.9.1		<p>Roof exhaustors shall be provided with hinge type hood providing easy access to motor and impeller. Weather proof lockable type disconnect switch shall be provided such that hood can open only when the disconnect switch is in 'off' position. On larger size of roof ventilators hoods may be of split construction. 15 mm mesh galvanised bird screen shall be provided.</p>	
3.9.2		<p>Rain protection cowls shall be designed to suit wall exhausters/supply fans for protecting fans from rain. The cowls shall be provided with bird screen of heavy gauge expanded metal netting.</p>	

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3.10

SPEED

3.10.1

The speed of axial flow fans/roof ventilators shall not exceed 960 RPM for impeller dia exceeding 450 mm and shall not be greater than 1440 with impeller dia less than 450 mm.

4.

MOTORS

Drive motors shall be of totally enclosed type, suitable for horizontal/vertical mounting as applicable and shall comply with the requirements of the specifications furnished elsewhere for motors.

5.

ACCESSORIES

Accessories as specified in Data sheet-A and as required for satisfactory trouble free & safe operation of fans shall be provided.

TESTING AND INSPECTION

List of TCs arranged as per Approved Quality Plan shall be furnished along with copy of TCs at the time of inspection by BHEL

➤

Visual inspection of sheets/plates, angles, channels etc. – Pitting, lamination in sheets/ plates, angles and channels shall be avoided.- visual inspection by main contractor of BHEL.

➤

Sheets/ Plates - Test certificate shall be furnished for physical and chemical properties for sheets / plates- for review by BHEL

➤

Shaft: Mechanical and chemical— review by BHEL

➤

Motors (of approved make): Routine TC ,FLP TC if applicable

➤

Workmanship and dimensional check as per manufacturing drg. and approved Drgs.- by main contractor of BHEL.- Shall be checked by BHEL/ Customer during final inspection.

➤

Balancing of impellers- Dynamic balancing certificates shall be furnished –grade 6.3 or better to ISO-1940. Balancing weights shall be positively locked/ welded to avoid loosening. - witness by manufacturer - TC to be furnished for review by BHEL(consisting of weight of impeller, radius of correction and balancing rpm). For spare impellers Dynamic Balancing shall be witnessed by BHEL.

➤

Performance test of one Centrifugal fan or Axial Fan /per type/per size as per applicable standard – by BHEL.

➤

Centrifugal/ Axial fans 100% run tested by main contractor of BHEL. Run test by BHEL/Customer may be at random or 100%- Vibration shall be within satisfactory zone of VDI 2056 (group- G) machines when measured on bearing housing and noise level <85 dbA at 1 metre distance. Max. Temp. on bearing housing- 40 degrees Centigrade + ambient