



PRODUCT STANDARD

HYDERABAD

Prod. Std. No. GT54237

REV. No. 22

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GAS TURBINE INLET DUCTING

1. Description:

This specification is designed to serve as a general design guide for gas turbine inlet ductwork systems. It also addresses proper packaging, shipping, storage and site repair techniques to insure the integrity, preservation and aesthetics of the system for its design life.

2. Applicable Documents:

The following documents of the issue in effect on the date of invitation for bids or requests for proposal form a part of this specification to the extent specified herein.

2.1 Specifications:

BHEL Gas Turbine Engineering Department :

- | | | |
|----|----------|---------------------------|
| 1. | A12C19 | Expanded Neoprene Rubber |
| 2. | 114A9838 | Fiberglass Cloth |
| 3. | 279A1177 | Insulation (Mineral Wool) |
| 4. | 242B9954 | Humidity Sensor Port |
| 5. | GT54031 | Welding Specification. |
| 6. | GT10112 | Painting Specification. |

2.2 BHEL Reference Drawings:

BHEL, Inlet Ducting GA drg - Drawing number identified in the variant table of this specification.

2.3 Codes and Standards:

The latest issue in effect at the time of the Purchase Order of the following codes and standards are part of this specification to the extent specified herein:

- a. American Institute of Steel Construction (AISC) or equivalent.
- b. American Welding Society (AWS) or equivalent.
- c. American Society of Mechanical Engineers (ASME) or equivalent.

Revisions :

Refer to record of revisions

Prepared :

G. R. C. RAJU

Approved :

B. I. BABU

Date :

15/05/1999



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- d. American Society of Testing and Materials (ASTM) or equivalent
- e. Structural Steel Painting Council (SSPC) or equivalent
- f. American Society for Non-destructive Testing (ASNT) or equivalent
- g. Occupational Safety and Health Administration Standards (OSHA)

2.4

Submittals

2.4.1

Documentation Required After Placement of Purchase Order / LOI

The vendor shall submit the following information after two weeks of receipt of P/LOI.

2.4.1.1

GENERAL ARRANGEMENT DRAWINGS:

General Arrangement Drawing, with BOM shall clearly indicate compliance with the dimensional requirements of this specification. It shall include:

1. Overall and gas path dimensions of each component.
2. Supports structure dimensions, including locations of anchor points.
3. Overall system dimensions.
4. General dimensions of any ladders or stairways or Platforms that may be integrated into the support steel.

2.4.1.2

Foundation Interface Drawing to include:

1. Foundation loading data in table form. This shall include all loads at each support column footpad broken down into X, Y, and Z components..



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2. Support member locations and sizes, including base plate detail.

3. Anchor bolt locations and sizes.

2.4.1.3

Weight and CG Drawing to include:

1. Outline of each major piece of equipment with overall dimensions and lifting lug locations.
2. Weight of each major piece of equipment.
3. Center of gravity of each major piece of equipment located from a single reference point.
4. Recommended lifting method (e.g. spreader bar, straight lift)
5. An indication to whether silencer panels are being dispatched loose and are to be installed separately.

2.4.1.4

Installation Instructions

Copies shall be included with each dispatch of inlet system hardware and contain the following :

- a. Suggested assembly sequence.
- b. List of loose parts as identified on packing list and on each part.
- c. Handling instructions = use of lifting eyes, anchor shackles and proper lift sling orientation.
- d. Any precautions that should be taken in lifting and handling the equipment (e.g. removal of shipping braces, lifting C-sections)
- e. Identified protection added for dispatch and when to be removed in the assembly sequence.
- f. A procedure for repair and/or restoration of damaged painted surfaces. For the standard paint system refer respective drawing referred in the variant table.



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g. Outside on-site storage instructions are as follows:

1. All duct sections must be stored in manner such that the plywood covers are protected from direct rain impingement (plywood faces must be vertical or down). Special precautions (e.g. secure tarps or indoor storage) must be taken to protect sections which are unsuitable for such orientation.
2. All protective packaging must remain intact until assembly.
3. All ductwork stored on site must be elevated at least 6 inches from direct contact with the ground.

2.4.1.5

Design Report

The Design Report shall include the following calculations:

- a. Structural Design calculations with all loads and load combinations identified along with the design criteria and allowable stress levels.
- b. Pressure drop calculations at guarantee flow conditions (inlet filter house outlet flange to transition duct outlet).

2.4.1.6

Exceptions / Clarifications

A complete list of any exceptions taken or clarifications made to this specification by the supplier should be listed in technical offer.

2.5

Equipment to be supplied by Vendor

- a. All equipment shown on the BHEL GA drawing
- b. All assembly hardware (including nuts, bolts and gaskets) required to connect both ends of the inlet system with the adjacent inlet components. (including that of interface flanges).
- c. Foundation bolts, nuts, washers and shim packs.

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2.6

Services to be offered by Vendor

Technical data and information as required to support BHEL at customer meetings.

2.7

Equipment and Services to be Supplied by Others

- a. Unloading and storage of equipment at job site.
- b. Installation, startup, testing and operation to include labor, utilities and consumables.

3.

Requirements

The Requirements listed in this document apply to all designs. All other conflicts between this referenced drawings, or referenced specifications and standards shall be considered as in error. The Supplier shall advise Gas Turbine Purchasing immediately upon the recognition of such conflicts so that corrective action may be taken.

3.1

Design

3.1.1

Design Loads

The ducting and support structure shall be designed per the 1991 edition of UBC or equivalent to withstand the following loads without adverse effects on operation nor shall the system sustain any damage from such loadings.

3.1.1.1

Dead Loads

3.1.1.2

Live Loads

3.1.1.3

Wind Loads

Basic wind speed = 250 Kmph, IS - 875.



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3.1.1.4 Differential Pressure Loads

Internal pressure vacuum on each ductwork component as follows:

Upstream of trash screen – 10 inches of water

Downstream of trash screen – 15 inches of water

3.1.1.5 Earthquake Loads

Seismic Zone – V, IS - 1893

3.1.1.6 Transportation Loads

All ductwork pieces shall be designed to withstand all loads that they may be subjected to during loading, despatching, unloading and proper assembly at the site. Equipment must arrive at the site with its structural integrity intact and ready for assembly.

3.1.1.7 Load Combinations

Each ductwork component and the system as a whole shall be capable of withstanding the most critical effect of the load combinations described in UBC-1991 Section 2303 or equivalent.

3.1.2 System Design

3.1.2.1 Standardization

The manufacturer shall to the maximum extent practicable, standardize the design of various assemblies and hardware.

3.1.2.2 Air Handling Capacity

The inlet ducting system shall be capable of directing the required inlet air flow for the turbine from the clean air plenum of the filter house to the inlet plenum of the gas turbine with a minimum amount of air flow disruption and pressure drop. The volume flow rate through the ducting system and the maximum allowable pressure drop shall be as specified in the variant table.



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3.1.2.3 Environmental Design Criteria

The inlet ducting system shall be designed with consideration to the following environmental conditions:

- a. Temperature range: -40°F to + 150°F
- b. Relative humidity range: 0% to 100%
- c. Direct sunlight
- d. Rain water up to 100 inches per year.

3.1.3 General Ductwork Design

3.1.3.01 Air-tightness Requirement

The duct shall be constructed such that there are no passages for unfiltered air to enter. All outer duct walls shall be seam welded.

3.1.3.02 External Stiffener Design

Method of Attachment – To prevent bleed – through rusting it is important that water does not penetrate to base metal in the area between the external stiffener and the wall. Therefore the stiffeners shall be attached by the following method:

- a. Seam welding.

Drainage Requirements - Stiffeners must not form collection areas for rain water. Where no other design permits external covers must be considered.

3.1.3.03 Internal Bolting Requirements

Hardware used in the inlet ducting sections and located on the clean air side of the duct walls shall be kept to an absolute minimum. Any such hardware shall be stainless steel and shall be welded in place so as to prevent any possibility of being ingested by the gas turbine. Where possible, these items shall be welded prior to painting and despatch. If welding is to be completed at the site, all weld locations and procedures are to be clearly identified on the installation and assembly drawings. Hardware items specifically not permitted for use on the inlet ducting sections are self-tapping screws and rivets.

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8.1.3.04

Acoustically Lined Ductwork Design

All duct sections downstream of and including the silencer shall be completely acoustically lined. Duct sections upstream of the silencer shall be acoustically treated only if required to meet guaranteed noise levels. The Acoustic insulation system shall consist of insulation packets fit into support framework and retained by steel sheet (usually perforated).

Insulation Packets – Insulation packets shall consist of a layer of mineral wool per GE Specification # 279A1177, a layer of IPSF lead septum sheet and another layer of mineral wool wrapped in fiberglass cloth material per GE Spec # 114A9838. Thickness of the mineral wool layers will vary and are subject to the approval of GT Design. The fiberglass cloth shall be wrapped and secured with duct tape in a way such that all tape is confined to the side of the packet closest to the lead septum. Packets are to be produced and stored in a clean area before assembly. Any deviation from this construction must be approved by GT Design.

Support Lattice – The lattice framework shall be sized to avoid insulation deformation and sagging. The lattice shall be designed to minimize places for water, rust and dirt collection. Designs that will not permit acceptable blast clean and painting must be avoided. The framework material shall be the same as specified for the perforated sheet.

Insulation Retaining Sheet – Solid or perforated sheet shall be of a configuration and material as defined in the ordering document. If the internal skin is of solid sheet, drain holes of ¼ inch minimum diameter shall be provided for any enclosed cavity to vent to the clean air side.

Assembly – Insulation packets are to be installed only after all blasting, chipping, cleaning, and painting is done. They shall pack snugly into the support framework in a manner to prevent them from deforming and leaving areas uninsulated. The packets shall be assembled such that the securing duct tape is against the external wall.

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Final welding – Insulation retaining sheet shall be securely welded in place. The selected weld configuration and procedure shall insure clean welds as well as structural integrity. Temporary protective covers shall be used to keep weld splatter and shop debris from entering the perforations. Welding shall be in line with BHEL Spec GT54031.

3.1.3.05

Hatches and Doors

Hatch cover plates shall open outward and be provided with lifting handles. They shall bolt into position and utilize leak tight Neoprene rubber gaskets (per GE Spec #A12C19A3) to provide sealing to the duct outside wall. The opening shall be a minimum of 18 inches wide and 24 inches high. The bottom of the opening shall not be located more than 24 inches above floor level inside the ducting. Cover plates must be restrained from falling by use of a chain or cable. Such restraint must not cause the door or hatch to block the opening when it is supporting the door or hatch. If a hinged door is used instead of a cover plate, it must have a latch to restrain it in the open position and to prevent it from being blown shut.

3.1.3.06

Lifting Provisions

All major components which require lifting for field assembly shall be supplied with lifting lugs or eye bolts. All component lifting geometry shall be clearly shown on the manufacturer's weight and CG Drawing.

3.1.3.07

Internal Supports

To insure adequate support of wide duct sections or plenums, the use of internal supports is allowed but with the following restrictions:

- a. The supports shall be of appropriate aerodynamic shape (i.e. round cross sections) and minimum size.
- b. There shall be a minimum of 15 diameters between supports in the air flow direction. Unless otherwise approved by BHEL, no support shall be allowed within 15 diameters of the inlet plenum flange.



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- c. All supports in the air stream must be analyzed for load carrying capability. A vibrational analysis of all such supports must be done to assure that they will not be stimulated by the air flow during both loaded and unloaded conditions.
- d. Any supports must be a permanently welded part of the structure.

3.1.3.08

Welding

Carbon steel and low-alloy steel welding shall be in accordance with AWS D1.1 and B2.1 or ASME. Stainless steel welding shall be in accordance with ASME Boiler and Pressure Vessel Code Section IX. All manufacturing and inspection processes shall be in accordance with AWS, ASME, ASTM and ASNT.

Welds of inner lagging to the supporting lattice steel shall be designed as fillet welds around the full circumference of a minimum ½ inch diameter hole to facilitate inspection for cracks and penetration. Blind plug welds shall not be used.

Continuous Seal Welding – Seal Welding on the individual ducting sections shall be provided at all joints which separate outside air from the clean air path. Gasket sealed connections separating the clean air path from the outside environment shall be permitted at access hatches, doors or covers. Where individual duct or ducts are required to be fabricated in pieces due to dispatching or installation limitations, flanged connections with gaskets shall be permitted.

Welding shall be in line with BHEL Spec GT54031.

3.1.3.09

Materials

Ducting – Generally the materials used in the fabrication of the inlet ducting sections shall be as follows.

(A) External Materials - All Ducting Sections

<u>Materials Group</u>	<u>Material</u>	<u>Duct wall sheet Thickness in (mm)</u>
For any Frame 1,3,5 or 6	Carbon steel IS 2062	5
For any Frame 6FA, 9EC	Carbon steel IS 2062	6

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(B) Internal Materials - Acoustically lined Ducts

<u>Materials Group</u>	<u>Perforated sheet Material</u>	<u>Framing Material</u>
For all Frames	1.6 mm thick ANSI 316 L stainless steel. Also see (D)	3.15 mm thick ANSI 304 L stainless steel.

(C) Internal Material - Silencer Baffles

<u>Material Group</u>	<u>Perforated sheet Material</u>	<u>Framing Material</u>
For all Frames	1.6 mm thick ANSI 316 L stainless steel. Also see (D)	3.15 mm thick ANSI 304 L stainless steel.

(D) Perforated sheet

<u>SLNo.</u>	<u>Hole (Dia)</u>	<u>Hole formation</u>	<u>Hole centres</u>	<u>Open Area</u>	<u>Gauge No.</u>	<u>Thickness of perforated sheet & material</u>
1.	4 mm	staggered	6 mm	40 %	16	1.6 mm thk, SS 316 L

Duct Assembly Hardware – Nuts, Bolts, Washers and any other hardware used for bolting duct sections together shall adhere to AISC Guidelines. All fasteners shall be zinc plated for corrosion protection.

Support Structure & Structural Bolting – The inlet ducting support structure shall be fabricated from ASTM structural carbon steel and hot-dip galvanized (per ASTM A123) or spray galvanized upto 80 micros. All bolting on structural joints of the support steel shall use high strength ASTM A325 grade bolts, zinc plated for corrosion protection.

Gaskets – Gasket material between ducting sections, or where used to seal access doors or panels shall conform to GE Spec #A12C19A3 for expanded neoprene rubber.

3.1.3.10

Surface Preparation and Painting

Refer to Painting scheme in inquiry drawing mentioned in variant table.



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3.1.4

Component Design

The design of all inlet system components and the design and orientation of all component features is subject to the approval of BHEL GT Engineering Department.

3.1.4.1

Silencer

The inlet air ducting system includes silencer duct sections containing acoustical silencing baffles. The length of silencing required shall be as specified in the referenced drawing in variant **Geometry** – Silencers shall have fully acoustically treated walls with vertical parallel baffles. Baffles shall be 6 inches thick and spaced on 12 inch centers.

Baffle Construction – The silencer baffles shall be constructed around a steel frame work with adequate stiffness to prevent fluttering or dynamic instability when under the influence of the inlet air flow. The interior of the baffles shall contain mineral wool insulation packets. The insulation material shall conform to GE Spec #279A1177 and shall be completely wrapped with fiberglass cloth (per GE Spec #114A9838) and secured with duct tape. The insulation packets shall be supported within the baffle by a structural framework configured to prevent slumping of the insulation material under it's own weight. Insulation packets shall be retained by perforated sheet steel which shall be securely welded to the structural framework. The leading edge of each baffle shall be fitted with an aerodynamic nose piece. Materials of baffle construction shall be as specified in the variant table.

3.1.4.2

Expansion Joints

The inlet ducting system contain expansion joints as shown on the outline drawing.

Design – The expansion joint shall be designed to accommodate duct axial movement and/or misalignment of plus or minus 1 inch from the neutral position. Design consideration shall be given with respect to all anticipated shipping, handling, field assembly and operational effects on seal integrity.

Construction – The expansion joint shall be constructed of a 6 mm thick EPDM with two plies of fiber glass material. If asked for in the variant table or referenced drawing GI weather protection cover should be provided over expansion joint. Corner seams of the boot shall be securely mated and sealed to prevent dirt or water from entering the ducting system. complete expansion joint as an assembly shall be procured from M/S Keld Ellentoft, chennai or shall be fabricated at vendor works under the supervision of M/S Keld Ellentoft, Chennai.



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3.1.4.3

Trash Screen

A trash screen shall be provided in all duct systems and shall be located downstream of the silencing section, usually in the elbow. Duct systems which contain turning vanes shall have the screen located downstream of the vanes.

Design – The standard trash screen shall be a two-piece design. The screen assembly shall be constructed of 100% 304 stainless steel and shall be of 0.062 diameter wire (.437 inch openings, 76.4% open area).

Access – An access panel shall be located in close proximity to the trash screen to permit inspection of the screen without having to enter the duct. Suitable platform with handrails and anti-skid grating with caged ladder suitably supported shall be provided.

3.1.4.4

Elbow

Elbow ducts have standard configurations for up-and-over systems for all Frame sizes. Any modifications to those designs must be approved by PP/MSDE.

Turning Vanes – When the elbow directly above the inlet plenum causes the inlet flow to be turned about an axis which is parallel to the turbine compressor axis (side elbow), it must be equipped with turning vanes. Turning vanes shall be designed to prevent excessive turbulence of the air entering the inlet plenum. The design shall be subject to the approval of PP/MSDE.

3.1.4.5

Transition Duct

The transition duct between the top inlet plenum flange and the elbow shall be subject to the following design constraints:

- a. Transition sections shall in general blend smoothly and shall not contain abrupt changes, steps or obstacles in the flow path which may cause boundary layer separation.
- b. The ducting cross sectional area shall not increase as the duct approaches the inlet plenum.



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- c. A decreasing cross section is desirable to reduce flow separation at the duct wall. Unless otherwise approved by BHEL, the total contraction angle for opposite walls shall not exceed 30 degrees.
- d. Transition sections which utilize a pair of convergent walls in conjunction with a pair of divergent walls shall have a net reduction in cross section area of not less than 5 percent. Unless otherwise approved by BHEL, the total angle of divergence for opposite walls shall not exceed 30 degrees.

Pressure Tap Ports – The transition duct shall contain 8 ports to accommodate pressure tap instrumentation. Each port shall consist of a 7.0 inch long 0.50 PS pipe nipple with a cap on the end outside the flow path. The nipple shall be seam welded to both the flow path perforated sheet and the outer wall such that the end extends approximately 0.50 inch into the flow path.

Four ports on the forward face shall be located directly across from and in line with four ports on the aft face of the duct. The orientation shall accommodate a tubular rake of pressure sensors to be suspended between each of the four pairs of ports which will allow for complete transverse pressure monitoring across the flow path. The exact lateral locations of the ports shall be approved by BHEL. The vertical location shall be 18 inches above the bottom flange of the duct unless otherwise approved.

Abrasive Cleaning Injection Ports – Two abrasive cleaning compound injection ports shall be required if shown on the BHEL Inlet System G.A. Drawing. The ports shall be located on the AFT face (closest to the GT) of the transition duct. Each port shall consist of a 13.50 inch long 2.00 IPS pipe nipple with a cap outside the flow path. The nipple shall be angled down into the both the flow path at 45 degrees from the vertical and welded to both the flow path perforated sheet and the outer wall such that the end extends approximately 0.50 inch into the flow path.

The exact latest locations of the ports shall be approved by BHEL. The vertical location shall be 15 inches above the bottom flange of the duct unless otherwise approved.

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3.1.4.6

Plenum Extensions

Plenum extension (or wing) designs shall be subject to the approval of BHEL. They should provide the inlet plenum with air-tight sides and a flat upper flange to interface with the transition duct.

View Ports – A view port with an accompanying light port may be required if requested by the customer. This requirement will be specified on the ordering document. A standard design and orientation for this option for each gas turbine model shall be approved by BHEL and shown on the G.A. Drawing.

Access Door – One of each pair of plenum extensions shall contain a hatch for plenum access. This will be identified on the G.A. Drawing.

3.1.4.7

Support Structure

The support structure for the inlet ducting system shall utilize bolted construction to the maximum extent possible. Field welding shall be reserved only for necessary adjustments. Any required structural bracing shall be symmetrical if possible.

3.1.5

General Assembly Requirements

In general, ducting sections shall be designed for bolted field assembly. The use of field welding shall be kept to an absolute minimum and shall be clearly indicated on the manufacturer's assembly drawing. Such field welding shall be limited to assemblies external to the clean air path or surfaces of the ducting sections unless specifically authorized by BHEL.

All duct sections shall be self-supporting when assembled. Whenever possible sections placed under others shall be designed to carry the combined load without separate supports. Temporary braces required for installation shall be supplied.



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3.1.5.1

Flanged Joint Design

Slot or hole spacing shall be as defined on the BHEL G.A. Drawing.

Expansion joint / Filter House Interface – The slots in the filter house exit flange shall always be 1.125 X .625 inches and in a vertical orientation. The mating flange of solid steel expansion joints shall have slots of the same dimensions but shall be horizontal to allow for maximum ease of assembly. Expansions joints without a solid framework shall not have slots but shall have .625 inch diameter round holes.

Plenum Extension / Plenum Interface – These flanges on the plenum extensions shall have vertical slots that accommodate the bolt hole sizes in the mating plenum flanges. The slots will allow vertical adjustment of the extensions to insure a smooth plenum & extension / transition interface.

All Other Duct Interfaces – The direction of slots shall alternate one flange to the next as possible to allow for maximum ease of assembly.

Gaskets – Gaskets shall be supplied for all flange interfaces in the ducting system and adhere to material requirements of GE Spec #A12C19A3. Gaskets shall be designed for no leakage at a compressed thickness of 0.12 inch and shall not protrude from the flange perimeter or interfere with inlet air flow in the compressed state.

3.2

Quality

3.2.1

Design Life

The inlet ducting system shall have a useful life of 20 years. No repair or replacement shall be necessary during the life of the system with the exception of paint repair.

3.2.2

Safety Considerations

The supplier shall assess the safety of his product and shall advise BHEL in writing of all warnings and instructions which, in the opinion of the supplier, are necessary to preclude occurrence of



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hazardous conditions or to define and minimize the risk of potentially hazardous conditions. A hazardous condition is defined as one which may cause personnel injury or death due to the installation, operation, failure, servicing or disposal of the product.

3.2.3 Final Cleaning and Inspection

3.2.3.1 Final Cleaning

All parts components and assemblies shall be thoroughly cleaned prior to and after assembly including removal of all loose, spattered, excess brazing or welding materials, rosin, weld flash, metal chips or any other foreign matter, burrs and sharp edges. Final cleaning shall take place after blast cleaning or other procedures that are required by the specified paint system and prior to paint application.

Vacuuming Requirement – All blasted surfaces are to be vacuum cleaned. An industrial grade vacuum of 500 to 700 CFM capacity shall be used with wands capable of reaching and removing all loose particles. Vacuum should continue until no particles larger than 355 microns (14 mils) are collected on an ASTM mesh 45 sampling screen.

3.2.3.2 Final Inspection

Final inspection before installation of acoustic material shall be visual by use of sufficient light and reflective devices to inspect all parts of the fabrication. Any scale, slag, or other surface debris that can be removed or loosened by normal application of standard cleaning tools such as scrapers, brushes, or needle guns shall be removed prior to paint.

3.2.4 Quality Assurance Provisions

Unless otherwise specified on the ordering document or purchase order, the manufacturer is responsible for the performance of all test and inspection requirements. Except as otherwise specified, the manufacturer may utilize his own facilities or any commercial laboratory acceptable to BHEL. BHEL in addition, reserves the right to perform any of the required inspections or tests where such inspections and tests are considered to be necessary to assure that the item supplied conforms to the requirements of this specification.



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All tests and inspections shall be conducted in a manner to permit the recording of pertinent data in reliable and accurate values so as to permit proper evaluation of inspection and test results by BHEL.

The manufacturer contract shall specify the frequency and scope of manufacturer test reports to be supplied to BHEL.

3.2.4.1 Design Qualification, Inspection and Test Requirements

Qualification of a supplier to manufacture inlet ducting systems shall consist of preliminary engineering qualification of the design followed by a first piece qualification.

3.2.4.2 Preliminary Design Qualification

Preliminary qualification of an inlet ducting system shall be given when engineering documentation demonstrating conformance to the paragraphs of this specification have been reviewed and approved.

3.2.4.3 First Piece Qualification

First piece qualification shall consist of an inspection or inspections of the first system manufactured. The finished equipment shall be factory test assembled to demonstrate proper fit of field assembled parts.

Suppliers once demonstrating their ability to control manufacturing quality through a first piece qualification shall not be required to qualify additional similar approved designs unless so directed by BHEL.

3.2.4.4 Production Inspection and Test

The supplier is responsible for establishing a production quality program assuring and documenting compliance to the requirements of this specification, ordering document and purchase order.

3.3 Marking, Packaging and Shipping

3.3.1 Markings

All components and containers shall be properly and legibly marked. Each duct section shall be marked with the words "TOP - AIRFLOW" and an arrow in the direction of air flow. Refer to the purchase order or quotation request for any additional marking requirements.



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3.3.2

Packaging

Packing, preservation & shipping should be in line with BHEL specification GT14024. Shipping packaging shall be designed to insure that the hardware arrives on site in a clean and undamaged condition. All packaging shall be in accordance with commercial practices and be designed for an effective life of at least 4 months while stored in an outdoor environment. Any special packaging requirements shall be found on the purchase order or quotation request. The following requirements also apply.

3.3.2.1

Acoustically Lined Ductwork

Acoustically lined ductwork shall be protected from dirt and water contamination by a plastic dust shield and a plywood shipping cover on each open end.

3.3.2.2

Unlined Duct work

Unlined duct sections do not require protective shipping covers.

3.3.2.3

Miscellaneous Parts

Any miscellaneous parts including unassembled silencer panels, inlet-duct fasteners, gaskets, spare parts and special tools required for assembly of the ductwork system shall be packaged using a minimum number of shipping containers that will allow safe transit.

3.3.3

Despatch

Refer to the purchase order or quotation request for specific instructions.

3.3.3.1

Trucking

All duct sections, whenever possible, shall be oriented on the truck such plywood covers are not subjected to direct rain impingement.

3.3.3.2

Overseas Shipping

Unless otherwise allowed by the purchase order, all hardware shall be shipped below deck for protection against saltwater corrosion and oxidation.



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3.3.3.3

Extra Assembly Hardware

The vendor shall supply 10% spare nuts, bolts, washers and gaskets.

3.3.3.4

Special Tools

The vendor shall supply a complete set of special tools that may be required for installation and normal maintenance of the equipment.
This does not include standard lifting beams commonly required for all installations.

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VAR NO.	GT MODEL	PROJECT	PROJECT SPECIFIC INFO.	BHEL OUTLINE DWG.	BHEL MATERIAL CODE	REMARKS
01	FR-6-FA	TNEB, KOVILKALAPAL	- MIN TEMP - 21°C - MAX TEMP - 40°C - RH - 60% - DESIGN WIND - 200 KMPH - SEISMIC ZONE - IV - SILENCER LENGTH - 8 FEET 50% OPEN AREA BAFFLE TYPE. - OUT DOOR INSTALLATION - INLET BLEED HEATING NOT APPLICABLE.	2-36408-T1001	GI 9754 237018	
02	FR-9E	OMAN, RUSAIL, EXTN. UNITED	- MAX. TEMP - 50°C - RH - 60% - DESIGN WIND - 130 KMPH - VAC SEISMIC ZONE - III - SEISMIC FACTOR - 0.3g - SILENCER - 8 ft - INSTALLATION - OUTDOOR	1-364-08-91003 (2 B.L.G.)	GT 9754 237026	FOR DETAILED SCOPE REFER BHEL DRG. 1-364-08-91003 (2 B.L.G.) VEENDORS SCOPE ALSO INCLUDES GALV. SUPPORT STRUCTURE FOR CIRCULAR VENT DUCTING, 2 NO'S TUBE AXIAL FANS ABOVE POSH. W.S. 6, GALV. SUPPORT PLATFORMS WITH GALV. ANTI-RUST GRATING, RAILING, TIE BOARD, 2 NO'S CAGED LADDERS AND FOUNDATION FIXING ARRGT. FOR CAGED LADDERS REFER PAINTING SCHEME GT 54/RUS/001

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VAR NO.	GT MODEL	PROJECT	PROJECT SPECIFIC INFORMATION	BHEL OUTLINE DRAWING	BHEL MATERIAL CODE	REMARKS
03	FR-9E (PG 9171E)	BPD B, BAGHABARI, BANGLADESH	- DESIGN AMB. TEMP. : 35°C - RELATIVE HUMIDITY : 98% - DESIGN WIND - 150 Kmph - SEISMIC ZONE - V - SILENCER - 8ft - INSTALLATION - OUTDOOR	1-364-08-91004 (2 sub)	GT975423703 -	- FOR DETAILED SCOPE REFER BHEL DRAWING 1-364-08-91004 (2 sub) - VENDORS SHOULD QUOTE IN TWO PARTS. PART-A FOR INLET DUCTING. PART-B FOR GALVANIZED SUPPORT STRUCTURE. - SCOPE SHOULD ALSO INCLUDE SUPPORTS FOR VENT FANS/DUCTING MOUNTED ON INLET DUCT, PLATFORMS BELOW VENT FANS WITH GALV. ANTI-SKID GRATING, RAILING, TDE BOARD, 2 NO'S CAGED LADDERS AND FOUNDATION FIXING ARRGT. FOR CAGED LADDERS. DETAILED STRUCTURAL RIGIDITY AND STABILITY CALCULATIONS SHOULD BE SUBMITTED FOR REVIEW ON PLACEMENT OF RO. USING STARD SOFTWARE UNDER PART-A, VENDOR SHOULD ALSO QUOTE PER 100 kg OF INLET DUCTING AND UNDER PART-B, VENDOR SHOULD QUOTE PER 100 kg OF SUPPORT STRUCTURE. - REFER PAINTING SCHEME QTE4/RUS/001.

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VAR No.	GT MODEL	PROJECT	PROJECT SPECIFIC INFORMATION	BHEL OUTLINE DRAWING	BHEL MATERIAL CODE	REMARKS
04	FR-9E	KELANITISSA (68.1 MW CPP) SRI LANKA	DESIGN AMB. TEMP: 27°C RELATIVE HUMIDITY: 90% DESIGN WIND: 38 m/s. SEISMIC ZONE: SILENCER - 8 ft. INSTALLATION - INDOOR	1-364-08-91005 (3-266)	GT9754237042	FOR DETAILED SCOPE REFER BHEL DRAWING 1-364-08-91005 (3-266) * REFER PAINTING SCHEME GT9754237001.
05	FR-6FA	CC106FA TNEB, PERUNGALAM	DESIGN AMB. TEMP: 28.2°C RELATIVE HUMIDITY: 60% DESIGN WIND: 140.4 kmph (PER IS: 875) SEISMIC ZONE: PER IS: 1893 SILENCER - 8 ft. INSTALLATION - INDOOR	1-364-08-71001	GT9754237050	FOR DETAILED SCOPE REFER BHEL DRAWING 1-364-08-71001 * FOR SURFACE CLEANING & PAINTING REFER PAINTING SCHEME.
06	FR-5	100L, DIGBOL	DESIGN AMB. TEMP: 35°C RELATIVE HUMIDITY: 85% DESIGN WIND: (PER IS: 875) AVERAGE: 5 kmph MAXIMUM: 90 kmph SEISMIC ZONE: ZONE - I PER IS: 1893 SILENCER - 8 ft INSTALLATION - INDOOR	1-364-08-51011	GT9754237069	FOR DETAILED SCOPE REFER BHEL DRAWING 1-364-08-51011 * FOR SURFACE CLEANING & PAINTING REFER PAINTING SCHEME.
07	FR-5	100L, HALDIA	DESIGN AMB. TEMP: 40°C RELATIVE HUMIDITY: 92% DESIGN WIND: (PER IS: 875) MAXIMUM: 200 kmph. SEISMIC ZONE: ZONE - II PER IS: 1893 SILENCER - 8 ft. INSTALLATION - INDOOR	1-364-08-51010	GT9754237077	FOR DETAILED SCOPE REFER BHEL DRAWING 1-364-08-51010 * FOR SURFACE CLEANING & PAINTING REFER PAINTING SCHEME.

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VAR NO	GT MODEL	PROJECT	PROJECT SPECIFIC INFORMATION	BHEL OUTLINE DRAWING	BHEL MATERIAL CODE	REMARKS		
08	FR-6FA	GSECL DHUVARAN FR-6FA	DESIGN AMB. TEMP: 32.6°C RELATIVE HUMIDITY: 64% DESIGN WIND PRESSURE: 158.4 KMPH SEISMIC ZONE: PER IS 1893 INSTALLATION: INDOOR SILENCER: 8 ft INLET: UP, OVER & SIDE ARRANGEMENT.	Engineering sketch HY/GTEG/GEB, DHUVARAN EUP/001, Rev-00	GT9754237085	Vendor to quote per meter length for plain un-insulated ducts (additional scope) and per 100 kg for additional support structure.	TD-106-2 Rev. 5 Form No.	PROD. STD. No. GT54237
09	FR-9E	IRAP, RUMAILA	MAX. TEMP: 55°C MIN. TEMP: -5°C SEISMIC ZONE: PER UBC WIND VELOCITY: 160 KMPH SILENCER: 8 ft SH. SILTING INLET ARRGT: UP & OVER Common support structure for Inlet duct & Air Filter in inlet duct vendor scope & supply.	Engineering drawing Ref. I-366-09-99010	GT9754237093	- do - Expn. Bellows should be suitably protected against for high amb. temp. - Surface preparation & painting should be suitable for these high amb. temp. - No. evap. cooling.	HYDERABAD	REV. No. 22
10	FR-6B (6561)	AZAKSHITAN	MAX. TEMP: 44°C MIN. TEMP: -40°C DESIGN WIND VELOCITY: 40 m/sec SEISMIC ZONE: EARTHQUAKE INTENSITY IS ZERO SILENCER: 8 ft SH. SILTING INLET ARRGT: UP & OVER LOCATION: INDOOR	Engineering drawing Ref. I-366-09-69045	GT9754237107	- Vendor to quote for per meter length for plain un-insulated ducts (addl. scope) and per 100 kg for addl. support structure. - No. evap. cooling. - Vendor should use resilient steel materials - ASME: SA 516, Grade 70 for ducts, structures, silencers etc., suitable for 40°C and structural analysis for low amb. of -40°C to be furnished. - Surface preparation & painting should be suitable for 40°C ambient. - Expn. joint should be suitably designed & selected for 40°C to 44°C ambient.	Page 24 OF 31	
							REMARKS (Contd.):	
							- In addition to old, tests, Supplementary test requirements should be performed per ASME/SA 516 and AS 20/AS 20M. - ASME standards. - Isolated foundation already cast. Vendor offered inlet duct should be suitable for already cast foundation.	

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VAR NO	GT MODEL	PROJECT	PROJECT SPECIFIC INFORMATION	BHEL OUTLINE DRAWING	BHEL MATERIAL CODE	REMARKS		
11	FR-6FA	TNEB, KUTTALAM	- MAX. TEMP. 39.5°C - MIN. TEMP. 20.1°C - WIND PR. 5m/sec IS:875 - SEISMIC PER IS 1893 - INSTALLATION: OUT DOOR - SILENCER: 8ft SH - INLET ARREST: UP & OVER - INLET BLEED HEATING TO BE PROVIDED BETWEEN SILENCER & ELECTRODUCT - INLET BLEED HEATING PIPING & MINUTEDUCT VENDORS SCOPE OF SUPPLY.	- Enquiry drawing no. 1-366-09-79010 - For inlet bleed heating ref. dng. no. 114E4420P003	GT9754237115	- Vendors to quote for per meter length for plain un-insulated ducts (Addnl. scope) and for 100kg for addnl. support structure. - With vap. cooling & bleed heating.	TD-106-2	Rev. 5 Form No.
12	SOLAR TITANIBOS	GAIL, VITAIKUR DVPL PROJECT	- MAX. TEMP. 46°C - MIN. TEMP. -2°C - DESIGN AMB.: 46°C - R.H. 37% @ -2°C to 84% @ 46°C - Design wind pressure: (Max) 160kmph - Seismic data: Non Seismic Zone (IS 1893) - GT location: INDOOR - Inlet Arrest: UP & OVER	Enquiry drawing no. 1-364-08-31001	GT9754237123	- Total ducting shall be of Stainless Steel Construction. - Vendors to quote for per meter length of plain un-insulated SS ducts (Addnl. scope) and per 100 Kg for additional support structure.	Prod. Std. No. GT54237	REV. No. 22
13	FR-6FA	GSECL Dhuvaran - II	- DESIGN AMB. TEMP. 32.6°C - RELATIVE HUMIDITY: 64% - DESIGN WIND PRE: 158.4 kmph - SEISMIC ZONE: Per IS 1893 ZONE-III - INSTALLATION: OUT DOOR - SILENCER: 8 ft - INLET: UP & OVER ARRANGEMENT.	Enquiry drawing no. 1-36408-71003	GT9754237131	Vendor to quote per meter length for plain un-insulated ducts (additional scope) and per 100kg for additional support structure.	Page 25 OF 31	

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VAR NO	GT MODEL	PROJECT	PROJECT SPECIFIC INFORMATION	BHEL OUTLINE DRAWING	BHEL MATERIAL CODE	REMARKS	 PRODUCT STANDARD HYDERABAD Prod. Std. No. GT54237 Rev. No. 22 Page 26 OF 31
14	Fr-9	RVUNL Dholpur	DESIGN AMB. TEMP : 34°C RELATIVE HUMIDITY : 60% DESIGN WIND SPEED : 200 KMPH SEISMIC ZONE : Per IS 1893 ZONE-III INSTALLATION : OUT DOOR SILENCER : 8 ft INLET : UP & OVER ARRANGEMENT.	Enquiry drawing no. : 1-36408-91006	GT9754237140	Vendor to quote per meter length for plain un-insulated ducts (additional scope) and per 100kg for additional support structure.	
15	Fr-9	SIDHIRGANJ Bangladesh	DESIGN AMB. TEMP : 35°C RELATIVE HUMIDITY : 98% DESIGN WIND SPEED : 250 KMPH SEISMIC ZONE : Per IS 1893 ZONE- V INSTALLATION : OUT DOOR SILENCER : 8 ft INLET : UP & OVER ARRANGEMENT.	Enquiry drawing no. : 1-36408-91007 INLET BLEED HEAT DRG NO. 0-36408-91003 VARIANT-07	GT9754237158	Vendor to quote per meter length for plain un-insulated ducts (additional scope) and per 100kg for additional support structure.	
16	Fr-9FA	ONGC TRIPURA	DESIGN AMB. TEMP : 27°C RELATIVE HUMIDITY : 77% DESIGN WIND SPEED : 250 KMPH SEISMIC ZONE : Per IS 1893 ZONE- V INSTALLATION : INDOOR SILENCER : 8 ft INLET : UP & OVER ARRANGEMENT.	Enquiry drawing no. : 1-36408-81001 INLET BLEED HEAT DRG NO. 0-36408-81002	GT9754237166	Vendor to quote per meter length for plain un-insulated ducts (additional scope) and per 100kg for additional support structure.	
17	FR-6FA	APGCL NAMRUP	DESIGN AMB. TEMP : 35°C RELATIVE HUMIDITY : 60% DESIGN WIND SPEED : 250 KMPH SEISMIC ZONE : Per IS 1893 ZONE- V INSTALLATION : INDOOR SILENCER : 8 ft INLET : UP, OVER & SIDE ARRANGEMENT.	Enquiry drawing no. 1-36408-71004 INLET BLEED HEAT DRG NO. 0-36408-91003 VARIANT- 03	GT9754237174	Vendor to quote per meter length for plain un-insulated ducts (additional scope) and per 100kg for additional support structure.	

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VAR No	GT MODEL	PROJECT	PROJECT SPECIFIC INFORMATION	BHEL OUTLINE DRAWING	BHEL MATERIAL CODE	REMARKS
18	Fr-9	IOCL, PARADEEP	DESIGN AMB.TEMP: 39°C RELATIVE HUMIDITY: 85% DESIGN WIND PRE: 250 KMPH SEISMIC ZONE: Per IS 1893 ZONE-V INSTALLATION: IN DOOR SILENCER: 8 ft INLET: UP & OVER ARRANGEMENT	Enquiry drawing no. : 1-36408-91011	GT9754237182	Vendor to quote per meter length for plain un-insulated ducts (additional scope) and per 100kg for additional support structure.
19	Fr-9	BELARUS	DESIGN AMB.TEMP: -8.1°C RELATIVE HUMIDITY: 60 % DESIGN WIND PRE: 250 KMPH SEISMIC ZONE: Per IS 1893 ZONE-V INSTALLATION: IN DOOR SILENCER: 8 ft INLET: UP & OVER ARRANGEMENT	Enquiry drawing no. : 1-36408-91012 INLET BLEED HEAT DRG NO. 0-36408-91003 VARIANT-07	GT9754237190	Vendor to quote per meter length for plain un-insulated ducts (additional scope) and per 100kg for additional support structure.
20	Fr-6FA	NEEPCO MONARCHAK	DESIGN AMB.TEMP: 47°C RELATIVE HUMIDITY: 98% DESIGN WIND PRE: 250 KMPH SEISMIC ZONE: Per IS 1893 ZONE-V INSTALLATION: IN DOOR SILENCER: 8 ft INLET: UP, OVER & SIDE ARRANGEMENT	Enquiry drawing no. : 1-36408-71005 INLET BLEED HEAT DRG NO. 0-36408-91003 VARIANT-03	GT9754237204	Vendor to quote per meter length for plain un-insulated ducts (additional scope) and per 100kg for additional support structure.



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VAR No	GT MODEL	PROJECT	PROJECT SPECIFIC INFORMATION	BHEL OUTLINE DRAWING	BHEL MATERIAL CODE	REMARKS	 PRODUCT STANDARD HYDERABAD
21	FR-6FA	KRIBHCO SS INLET DUCT	Design Amb Temp:35 C RH:65% Design wind pr:250KMPH Seismic Zone: Per IS1893 Zone -V Installation :INDOOR Silencer:8FT INLET:UP,OVER&SIDE Arrangement	Enquiry Drawing No. 1-36408-71007 Inlet Bleed Heat Drg No. 03640891003-03	GT9754237212	Vendor To Quote Optional price Per Meter Length For Plain SS Insulated Duct(Position No 7 in theEnquiry drw.) And Per 100KG For Support Structure.	
22	FR-9E	RVUNL - UNIT 1V	Design Amb Temp: 27C RH: 60% Design wind pr: 250 KMPH Seismic Zone: IS1893 Zone - 1V Installation :OUTDOOR Silencer:8FT INLET: UP & OVER Arrangement	Enquiry Drawing No. 1-36408- 91013	GT9754237220	Vendor To Quote Optional price Per Meter Length For Plain Insulated Duct(Additional scope) And Per 100KG For Support Structure.	
23	FR6B	ONGC HAZIRA	Design Ambient Temp.: 35 Deg C Relative humidity: 70 % Design Wind Pr.: 250 KMPH (MAX) Seismic Zone: IS1893 Zone - III Installation of GT: INDOOR Silencer Duct length=3658 mm (12 ft.) Silencer Panel length = 2438 mm (8ft.) INLET: UP & OVER ARRANGEMENT.	Enquiry Drg. No. 1-36408-61032 Inlet Bleed Heat Drg. No. 0-36408-61001	GT9754237239	VENDOR TO QUOTE PER METER LENGTH FOR PLAIN SS UN-INSULATED DUCT(FOR ADDITIONAL SCOPE)&PER 100 KG FOR ADDITIONAL SUPPORT STRUCTURE. VENDOR TO QUOTE PER METER LENGTH FOR BLEED HEAT PIPING OF DIFFERENT SIZES.	GT54237 Rev No. 22 PAGE 28 of 31

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VAR No	GT MODEL	PROJECT	PROJECT SPECIFIC INFORMATION	BHEL OUTLINE DRAWING	BHEL MATERIAL CODE	REMARKS
24	FR 6B	RIL VADODARA	Design Ambient Temp: 35 Deg C RH(MIN/DESIGN/MAX): 60/95/95 % Relative humidity: 90% Design wind pr: 250 KMPH Seismic Zone: IS1893 Zone - III Installation: INDOOR Silencer: 8FT INLET: UP & OVER Arrangement	Enquiry Drg. No. 1-36408-61033	GT9754237247	
25	FR-6FA	HPCL VIZAG	Design Amb Temp: 42 C RH(MIN/DESIGN/MAX): 60/95/95 % Design wind pr: 250 KMPH Seismic Zone: IS1893 Zone - III Installation: INDOOR Silencer: 8FT INLET: UP & OVER Arrangement	Enquiry Drg. No. 1-36408-71008 Inlet Bleed Heat Drg. No. 0-36408-71001 Packing Shall be done as per GT14024.	GT9754237255	VENDOR TO QUOTE PER METER LENGTH FOR PLAIN SS UN-INSULATED DUCT(FOR ADDITIONAL SCOPE)&PER 100 KG FOR ADDITIONAL SUPPORT STRUCTURE. VENDOR TO QUOTE PER METER LENGTH FOR BLEED HEAT PIPING OF DIFFERENT SIZES.
26	FR-5	ONGC URAN	Design Ambient Temp.: 38 Deg C Relative humidity: 98 % Design Wind Pr.: 250 KMPH (MAX) Seismic Zone: IS1893 Zone -IV Installation of GT: INDOOR Silencer Duct length= 3658 mm (12 ft.) Silencer Panel length = 2438 mm (8ft.) INLET: UP & OVER	Enquiry Drg. No. 1-36408-51033 Inlet Bleed Heat Drg. No. 0-36408-51001 Packing Shall be done as per GT14024.	GT9754237263 SS INLET DUCTING	VENDOR TO QUOTE PER METER LENGTH FOR PLAIN SS UN-INSULATED DUCT(FOR ADDITIONAL SCOPE)&PER 100 KG FOR ADDITIONAL SUPPORT STRUCTURE. VENDOR TO QUOTE PER METER LENGTH FOR BLEED HEAT PIPING OF DIFFERENT SIZES.



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27	FR-6FA	HPCL,VIZAG 6FA	Design Amb Temp:42 C RH(MIN/DESIGN/MAX) :60/95/95 % Design wind pr:250KMPH Seismic Zone: Per IS1893 Zone - III	1-36407-7-1001 GT INLET AIR FILTER SUPPORT STRUCTURE	GT9754237271	SCOPE OF SUPPLY INCLUDES AIR FILTER SUPPORT STRUCTURE,PLATFORM AND STAIRCASE WITH ANTISKID GRATING & RAILING AS INDICATED IN 13640771001 FOUNDATION HARDWARE IS IN VENDOR SUPPLY. ALL THE STRUCTURAL STEEL USED SHALL BE GRADE E350 QUALITY BR/B0 CONFIRMING TO IS:2062. Support structure, Platforms, Railing, Staircase shall be Individually wrapped with minimum 3 – Layer Wrapping as per the Point 7 of the Clause 2.0 in GT14024 Fasteners, Foundation plates & bolts etc. shall be packed in Closed Packing Case as per pont 32 of Clause 2.0 in GT14024.



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RECORD OF REVISIONS

Rev. No.	Date	Revision Details	Revised	Approved
00	15-5-91	FIRST MADE	—	—
01	15/7/1999	VAR-02 added	Q215 (GRC RAJU)	(B.I.BABU)
02	13/3/2000	VAR-03 ADDED	Q215 (GRC RAJU)	(B.I.BABU)
03	18/10/2000	VAR-04, 05, 06 & 07 ADDED	Q215 (GRC RAJU)	(B.I.BABU)
04	7/8/2001	VAR-08 ADDED	Q215 (G.J.C)	(GRC RAJU)
05	27/2/2002	VAR-09 to 11 added	Q215	(B.I.BABU)
06	25/09/2002	VAR-12 added	Q215 (G.J.C)	(GRC RAJU)
07	20.04.04	Var No. 13 added.	(VSH)	(B.I.BABU)
08	29.06.04	Var No. 14 added.	(VSH)	(B.I.BABU)
09	19.02.07	Var No. 15 added.	(VSH)	(BSN)
10	02.12.09	Var No. 16 & 17 Added.	(VSH)	(BSN)
11	16.07.10	Var No.18 ADDED	P. Chinnar (AV)	(BSN)
12	13.09.10	VAR No.19 ADDED	P. Chinnar (AV)	(BSN)
13	11.07.11	VAR No 20 ADDED	DEEPTH	(VSH)
14	02.04.12	VAR No 21 ADDED	CHKK	JAMESH
15	16.04.12	VAR NO 21 MODIFIED	CHKK	JAMESH
16	11.03.13	VAR NO 22 ADDED	CHKK	(VSH)
17	27.09.14	Clauses 2.1, 3.1.3.04, 3.1.3.08 & 3.1.3.10 revised to include painting & welding BHEL spec details.		
18	29.09.14	Clause 3.3.2 updated to include BHEL Spec. GT14024.		
19	23.07.15	VARIANT 23 ADDED.		
20	07.05.18	VARIANT 24,25 & 26 added	CHKK	(VSH)
21	27.10.18	VAR-25 Updated	CHKK	(VSH)
22	30.03.19	VAR-26 Added.	CHKK	VSH

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