



**TENDER DOCUMENT FOR THE CAPTIVE POWER PLANT
OF FGGS AT BAGHJAN, UPPER ASSAM**

**POWER PACKAGE ENGINEERING FABRICATION
AND SUPPLY**



Jayathe Petrotech Engineers & Consultants Pvt. Ltd

**VOLUME-II TECHNICAL
FOR BAGHJAN**

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Section-I

Specifications

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD SPECIFICATION FOR NATURAL GAS GENERATOR SETS				
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SPECIFICATION FOR NATURAL GAS GENERATOR SETS

1	Issued for ITB	14-08-19	AS	KPS	CK	
0	Issued for ITB	16-07-19	AS	KPS	CK	
C	Issued for Approval	05-07-19	AS	KPS	CK	
B	Issued for Approval	08-05-19	AS	KPS	CK	
A	Issued for Review/Approval	20-03-19	AS	MKV	CK	
REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

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1.0 INTRODUCTION

M/s OIL India Ltd (OIL) is a Navaratna Company under the Ministry of Petroleum and Natural Gas, Govt of India. As an integrated upstream company with pan India presence and overseas wings spreading over different parts of the globe, OIL is engaged in exploration, production and transportation of crude oil and natural gas and production of LPG with its headquarter at Duliajan, Assam. In line with OIL's strategy for balanced growth, an ambitious plan for development of non-associated gas fields is presently underway in OIL's Upper Assam operational area. As a part of this development scheme, OIL desires to construct a modular Field Gas Gathering Station (FGGS) for augmenting natural gas production facility at Baghjan field in Upper Assam, India.

Jayathe Petrotech Engineers and Consultants (JPEC) have been awarded the contract for Engineering and Project Management Consultancy for developing the engineering and managing project execution.

1.1 PROJECT OBJECTIVE

The Baghjan field is having huge amount of Non-Associated Gas (NAG) potential and the expected gas production from this area in 7.5 MMSCMD. To explore these resources one modular Field Gas Gathering Station (FGGS) having the facilities for production of natural gas is to be created. The proposed FGGS shall have Non-Associated Gas (NAG) processing facility for 5.0 MMSCMD (2 trains x 2.5 MMSCMD) and provision to feed Associated Gas (AG) of 0.5 MMSCMD along with the NAG to a Glycol based Dehydration facility (5.0 MMSCMD) for achieving water dew point less than or equal to (0) Zero Deg C. The facility shall include Production and Test Manifolds, Gas /Condensate/Water Separators, Gas Dehydration, Flare system and Effluent Treatment and disposal system along with all the required utilities and auxiliary systems. Space provision will be made within the plant to augment its capacity by installing one more train of 2.5 MMSCMD in future.

2.0 PURPOSE

This specification covers the requirements for natural gas engine driven generator sets.

3.0 CODES, REGULATIONS, STANDARDS

Vendor shall meet or exceed the requirements of the latest edition of the following codes, regulations and standards or equivalent standards, except as superseded herein. In the event of a conflict between this specification and other specifications or correspondence, the OWNER shall be consulted and a ruling, in writing, shall be obtained before any work is started.

3.1 INTERNATIONAL CODES AND STANDARDS

a. NORTH AMERICAN STANDARDS

- American National Standards Institute (ANSI)
- American Society of Mechanical Engineers (ASME)
 - Boiler and Pressure Vessel Code, Section VIII - Unfired Pressure Vessels
 - Boiler and Pressure Vessel Code, Section IX – Welding, Bracing and Fusing Qualifications

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- International Electrical Codes (IEC)
 - IEC 34 Rotating Electrical Machines
 - IEC 72 Dimensions and Output Ratings for Rotating Electrical Machines
- American Society for Testing and Materials (ASTM)
- Internal Combustion Engine Institute Standards (ICEIS)
- Society of Automotive Engineers (SAE)
 - SAE J1349 (Engine) Performance Standards

b. EUROPEAN STANDARDS

British Standards (BS)

- BS 800 Specification for Radio Interference Limits
- BS 1701 Air Filters for Air Supply to Internal Combustion Engines and Compressors Other Than for Aircraft
- BS 2757 Method for Determining the Thermal Classification (IEC60085) of Electrical Insulation
- BS 4999 General Requirements for Rotating Electrical Machines
- BS 5000 Specification for Rotating Electrical Machines of Particular Types or for Particular Applications
- BS 5304 Code of Practice, Safeguarding of Machinery
- BS 5420 Specification for Degree of Protection of Enclosures of Switchgear and Control Gear for Voltages up to and including 1000V A.C and 1200V D.C
- BS 5514 Reciprocating Internal Combustion Engines - Performance
- BS 6491 Electro-Sensitive Safety Systems for Industrial Machines
- ISO-3046-1 Reciprocating Internal Combustion Engines.
- ISO- 8528-1,5 Reciprocating IC engine driven alternating current generating sets.

3.2 INDIAN STANDARD

IS	-	14122	Built in thermal protection for electric motors rated up to 660 V AC
IS	-	5572	Classification of Hazardous Area (other than mines) having flammable gases and vapours for electrical installation
IS	-	8239	Classification of maximum surface temperatures of electrical equipment for use in explosive atmosphere.
IS	-	3202	Code of practice for climate proofing and electrical equipment
IS	-	2274	Code of practice for electrical wiring installation – system voltages exceeding 650 V.
IS	-	732	Code of practice for electrical wiring installations –system voltages not exceeding 650 V.
IS	-	13408	Code of practices for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining application or explosive processing & manufacture)



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IS	-	3043	Code of practice for Earthing
IS	-	2253	Designation for type of construction and mounting arrangement of rotating electrical machines
IS	-	4691	Degrees of protection provided by enclosure for rotating electrical machinery
IS	-	6362	Designation of methods of cooling of rotating electrical machines
IS/IEC	-	60079-0	Electrical Apparatus for explosive gas atmospheres – General requirements
IS/IEC	-	60079-1	Equipment protection flameproof enclosures “d”
IEC	-	60079-5	Equipment Protection by Powder filling “q”
IEC	-	60079-6	Equipment Protection by Oil immersion “o”
IEC	-	60079-7	Equipment Protection by Increased Safety Type “e”
IEC	-	60079-11	Equipment Protection by Intrinsic safety “I”
IS/IEC	-	60079-15	Electrical apparatus for explosive gas atmosphere – construction, test and making of type of protection “n” electrical apparatus
IS	-	2148	Flameproof enclosures for electrical apparatus
IS	-	7752	Guide for improvement of power factor- consumer installations
IS	-	5216	Guide for safety procedures and practices in electrical works.
IS	-	5571	Guide for selection of electrical equipment for hazardous area.
IS	-	7132	Guide for testing synchronous machines
IS	-	12075	Mechanical vibration of rotating electrical machines with shaft heights 56mm and higher - measurement, evaluation and limits of vibration severity
IS	-	7306	Methods for determining synchronous machines quantities from tests
IS	-	4889	Method of determination of efficiency of rotating electrical machines
IS	-	3716	Insulation coordination application guide.
IS	-	12065	Permissible limits of noise level for rotating electrical machines
IS	-	4722	Rotating electrical machines
IS	-	12802	Temperature rise measurement of rotating electrical machines
IS	-	4728	Terminal marking and direction of rotation for rotating electrical machines
IS	-	5422	Turbine type generators
IS	-	12824	Type of duty and classes of rating assigned to rotating electrical machines

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3.3 OISD STANDARDS

OISD	-	STD-113	Classification of Area for Electrical Installations at Hydrocarbon Processing and Handling Facilities.
OISD	-	STD-149	Design aspects for safety in electrical systems.
OISD	-	STD-173	Fire Protection System for Electrical Installations.
OISD	-	STD-116	Fire Protection Facilities for Petroleum Refineries and Oil/Gas Processing Plants
OISD	-	STD-147	Inspection and Safe Practices during electrical installations.
OISD	-	STD-137	Inspection of Electrical Equipment
OISD	-	STD-118	Layouts for Oil and Gas Installations.
OISD	-	STD-110	Recommended Practices on Static Electricity.

3.4 CONFLICT

Some requirements in this specification may be modified by specific requirements in the Purchase Specification. In case of conflict, the specific requirements supersede this specification.

3.5 DEVIATION

Any deviation from this specification must be approved, in writing, by OWNER. Such written approval must be obtained prior to the commencement of any work, which would constitute such a deviation.

3.6 ABBREVIATIONS

AC	Alternating Current
ASL	Above sea Level
BS	British Standards
DCS	Distributed Control System
DOL	Direct On Line
IEC	International Electro Technical Commission
IP	Ingress Protection
ISO	International Organization for Standardization
LED	Light Emitting Diode
RTD	Resistance Temperature Detectors
BTD	Bearing Temperature Detectors
CPCB	Central Pollution Control Board

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4.0 DEFINITIONS

The following definitions shall apply in this document:

OWNER	Oil India Limited
VENDOR	Equipment Supplier or Manufacturer
CONTRACTOR	Company or firm engaged to engineer, construct and commission the project.
SHOULD	The word “should” is understood to be strongly recommended to comply with the requirements.
SHALL	The word “shall” is understood to be mandatory to comply with the requirements
STANDARD	Standard means that the feature, accessory or test is provided in accordance with the applicable Standard, without additional specification by the Oil India Limited.

5.0 GENERAL

This specification document supplements the data sheets for each individual generator on which the operating conditions and special requirements are listed in detail.

Compliance by the Vendor with the provisions of this specification does not relieve the Vendor of the responsibilities for furnishing equipment of proper design, mechanically and electrically suited to meet operating guarantees at the specified service condition.

5.1 SERVICE CONDITIONS

The equipment and its entire component should be entirely suitable for service under the climatic conditions prevalent at the location of the intended installation and operation. For details of service conditions refer Data Sheet for Natural Gas Engine Generator Set.

5.1.1 Supply

Power: 415 volts $\pm$ 5%, 3 phase, 50 HZ $\pm$ 3% (3 wire)

5.1.2 Installation

Unless otherwise specified in the Data Sheet, the equipment shall be installed indoors.

5.1.3 Location and Type of Control

Local (manual) - with controls on or near controlled equipment.

Panel (manual) - with controls on station control panel.

Panel (automatic) - with controls on station control panel.

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5.2 NOISE REQUIREMENTS

The Vendor shall state in his enquiry the consideration included in his design to meet the noise requirements specified in the relevant Standards. [The noise \(sound\) level of the completed package system covered by this natural gas-generator specification shall be as per CPCB norms.](#)

6.0 DESIGN

6.1. General Conditions

- Gas engine with Genset shall be supplied with individual container.
- The gas engine selected shall be suitable for the continuous operation under given gas composition and site conditions after taking into consideration the requirement of the driven equipment, transmission losses, site deration and power requirements of auxiliaries and other parasitic loads. The net electrical efficiency output after deduction of genset auxiliaries of the offered model should not be less than 40 % at site rated condition. Tolerance shall be applicable as per ISO 3046/1.
- The engine shall be designed for continuous operation for the lowest methane number of the specified fuel GCV. The engine shall be capable of stable operation min 10% below the lowest methane number for the specified fuel lower range GCV.
- The Container should have sufficient space in and around the generator set to facilitate maintenance and operation of the set.
- All vent line in natural gas piping shall be vented to safe elevation as per OISD requirement. If any manual vent line is provided or valve with failure to open is considered the corresponding vent to be connected to the plant flare gas line.
- The engine exhaust emission shall meet the CPCB & local pollution control board norms.
- Container shall have acoustic treatment to reduce sound pollution to the optimum level [\(as per the CPCB norms\)](#).
- Vendor shall consider the deration due to altitude, ambient temperature, inlet and exhaust losses, relative humidity etc. Deration factor shall be worked out as per ISO 3046.
- Vendor shall provide in their offer, maximum kW rating of motor that can be started on DOL starter scheme, when GEG base load is 25%, 50%, 75%.

6.2. Gas Engine

- GAS Engine shall be of heavy duty, latest state of art machine with higher efficiency and lower NOx emission of proven design conforming to ISO 3046 / BS 5514.
- The inlet air to engine shall be turbo charged with exhaust gas followed by after cooler arrangement.
- The complete GE set with common base frame shall be provided with adequate number of anti-vibration pads suitable for mounting on Container.

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- d) The engine mechanical vibration limits shall be as per ISO 8528-9.
- e) A flywheel shall be provided at the power take-off end to smoothen out the variation in engine torque. It shall be rigidly bolted or keyed to the crankshaft. The flywheel shall be statically balanced and dynamically balanced at operating speed, prior to fixing on to the crankshaft.

6.3. Gas Engine Starting System

- a) The type of starting arrangement shall be battery starting.
- b) For Electric starting system, the same shall be complete, but not limited to the following:
 - Starter motor
 - Maintenance free batteries, with capacity suitable for minimum six (6) starts
 - Battery charger drawing power from AC mains
- c) For gas engine requiring pre-lubrication before start up, electric motor driven pre-lubrication pump connected to emergency power source with timer, suitably interlocked with the starting system shall be provided by vendor.

6.4. Lube Oil System

Lube oil system shall comprise of following items as minimum:

- a) Engine Mounted Lube oil sump.
- b) Engine operated Main lube oil pump and Electric driven Priming pump used for pre/post lubrication as recommended by OEM standard.
- c) Lube oil cooler and oil filters.
- d) Fresh lube oil tank and waste lube oil collection tank with transfer pumps.
- e) All necessary piping, valves, specialties, instrumentation and supports etc.

6.5. Fuel System

- a) The fuel system shall comprise of Gas pressure regulator, gas shut off valve, common gas conditioning system, filters, inlet fuel governor, associated instrumentation and control system.
- b) Gas supply pressure after regulator at full rated flow conditions shall be as recommended by the Gas engine vendor.
- c) Gas shut off valve for engine fuel gas line should close automatically when the engine is stopped.

6.6. Combustion Air Intake System

The combustion air intake system shall consist of air inlet filters, all necessary piping including specialties like bends, flanges, expansion joints, supports etc. to make the system complete or as per manufacturer's design and shall consist of all the required

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accessories. The filter shall be fitted with a differential pressure switch to show when the filter requires attention.

6.7. Engine exhaust system

Exhaust System shall consist of following items as minimum,

- a) Exhaust gas Silencer with spark arrestor.
- b) Exhaust piping from Gas Engine up to Exhaust stack including specialties' like bends, flanges, expansion joints and insulation. The Exhaust pipe material selected shall be suitable for engine outlet flue gas temperature.
- c) Individual exhaust stack shall be considered for each Gas engine.
- d) Exhaust stack shall be designed as per CPCB norms. The stack shall be complete with all accessories and insulated up to a height of two (2) meters from ground level.
- e) The outer surface of the stack shall be protected from the atmospheric corrosion by applying heat resistant aluminum coating. The nominal thickness of the coating shall be 0.18 mm (Minimum)
- f) The stack height shall be as per CPCB norms and the minimum height shall be 30m.
- g) Stack shall have openings for sampling flue gas, access ladders, platform, drain connections. Necessary lightning arrestors & aviation lamps with copper conductors shall be provided as per the requirement.
- h) Cage ladder shall be provided for exhaust stack with intermediate landings at every 6m and access platform as required.
- i) Exhaust stack shall be supported using Common support structure.

6.8. Engine Cooling System

- a) Gas engine cooling system (primary circuit) shall be closed circuit liquid cooled type including water circulating pumps (for HT & LT circuits), Dry type Radiator, temperature regulating device, thermostatic switch, expansion tank, makeup tank with transfer pump, protection & shutdown switches, level indicator for tanks and interconnecting piping.
- b) The fan, fan drive, and fan belts shall be covered with steel mesh guarding for personnel protection.

6.9. Base frame

- a) Gas engine and Generator shall be mounted on a common fabricated skid / steel base frame designed to support the engine and the alternator.
- b) The base frame shall be complete with Anti-Vibration mounting pads.

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7.0 ELECTRICAL REQUIREMENTS

7.1. Location

Details of the location and climatic conditions are as indicated in electrical design basis

Unit control panel, station control panels and other auxiliary panels will be housed inside the air-conditioned substation control rooms.

7.2. Design

Design and installation of all electrical components shall comply with the project specification. Electric motors shall comply with FGS-BJN-ELE-SPC-6005. Wiring shall meet the requirements of IEC 60364.

All equipment required to be certified for use in a hazardous area shall be IEC certified Ex 'd'. Where equipment approval is by others, it shall be the responsibility of the VENDOR to prove that the Certification Authority is acceptable to IEC.

Cables shall be rated at the required voltage with a minimum of 0.6/1kV. Conductors shall be copper.

The minimum cable core sizes shall be 1.5 mm sq. stranded for control and 2.5 mm sq. stranded for power.

7.3. Safety

Unless noted otherwise, all electrical equipment mounted on skid shall be certified for operation in a safe area.

All moving equipment shall be fitted with rigid metal guards for personnel protection.

Asbestos material will not be acceptable for any item of the equipment and the vendor shall propose suitable alternatives.

7.4. Utilities

The utilities normally available on site are listed in the relevant Data Sheets

VENDOR shall provide a summary of utility consumption rates.

8.0 SKID ASSEMBLY

Modular Design: For units which can be modularized, the skid shall be self-containing, shall be pre-fabricated and assembled in the standard size of containers, transported in containers and placed at site on concrete foundation. Modularization is to achieve minimum fabrication/ construction job at site.

8.1. Layout

Equipment and components shall be set out on the skid in a neat, orderly manner such that interconnections comply with good engineering practice whilst permitting access for operating and maintenance activities.

As part of the work scope the VENDOR shall review the purchaser's overall installation design with respect to equipment location, placement of auxiliaries and accessibility.

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8.2. Auxiliary Piping and Valves

Auxiliary piping systems shall comply with the standard requirements. Copper, copper alloy, zinc alloy or aluminium components shall not be supplied. Cast iron components shall not be used in systems containing hazardous or toxic fluids.

8.3. Remote Mounted Equipment

Equipment as required shall be mounted remote from the main equipment skid. This may include fuel treatment equipment, oil cooler, combustion air filter, exhaust silencer and unit control panel.

VENDOR shall design all remote mounted items and their interfaces with on-skid systems. Limitations regarding mounting positions and interconnection requirements shall be highlighted in the vendor data and drawings.

9.0 GENERATOR

9.1. General Requirements

- a) The line and neutral ends of each phase winding of the generator shall be brought out on six (6) suitably located terminals.
- b) The terminal box for the line terminals shall have sufficient space for the termination of cable size calculated for the capacity of the generator. The neutral box shall, in addition to space for neutral earthing cable, have sufficient room for current transformers used for protection of generator.
- c) All terminals shall be stud type. The terminal boxes shall be complete with suitable lugs and double compression cable glands to facilitate the entry of the cables. Suitable clamping arrangement shall be provided for connecting the cables to the machine terminals. The terminals shall be suitably enclosed to prevent short circuits by rodents etc. Appropriate phase markings shall be provided inside the terminal boxes, the markings shall be non-removable and in delible.
- d) Current transformers calculated for the capacity of the generator shall be supplied.
- e) Suitably rated 240 V single phase anti-condensation heaters shall be provided within the enclosure. Location and maximum surface temperature of the heaters shall be such that no damage can be caused to any insulation. The leads of the heater shall be brought to a separate terminal box.
- f) The generator shall be provided with two grounding terminals with clamps suitable for connection to the grounding grid.
- g) The generator shall be provided with winding and bearing RTDs.
- h) The generators shall be provided with under frequency relays to trip with time delay, in case of one of the generators trips.
- i) Alternator enclosure shall be rated for IP 23 as minimum.
- j) Insulation class shall be Class H and temperature rise shall be limited to Class B.

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9.2. Excitation System

- The generators shall be provided with solid state excitation system.
- The response ratio of the excitation system shall not be less than 0.50.
- The exciter capacity shall be at least 20% more than the maximum requirement at any time. The exciter winding shall be insulated with class 'F' insulation.
- The excitation system shall be so designed and/ or protected, that harmful over-voltage cannot occur at the main exciter commutator due to combined effect of maximum exciter field current and machine over-speed.

9.3. Voltage Regulator

- The generator shall be capable of operation over a range of $\pm 5\%$ of the rated voltage, unless specified otherwise in data sheet.
- The voltage regulator shall be supplied complete with cross-current compensation preferably of the static type. The regulator shall be supplied complete with voltage setting device, all accessories and alarm contacts.

9.4. Governing System

- The governor shall be digital speed governor and characteristics shall comply with the requirements of Class 'G2' as per ISO-8528-5.
- The governor shall be provided with an electrically operated speeder gear for remote adjustment of generator frequency, suitable for operation on DC voltage, if indicated in data sheet.
- The characteristics of the Gas engine governing and generator excitation system shall permit manual starting, running up to full speed and loading the Gas Engine Generator Set within three (3) minutes from the time generator breaker is closed.
- The governor shall be capable of responding to a step change of load either switch-in and throw-off as such that all operating parameters are within limits.

9.5. Instrumentation and Control

- PLC based control panel shall be provided for Gas Engine Genset within the Container with Air conditioning facility.
- MPC contractor shall provide all the instruments required for the complete operation of the system.
- The Control panel shall have serial interface connectivity (RS 485 or MODBUS TCP /IP over Ethernet).
- PLC based control panel shall have protection, meters and alarm annunciation windows.
- The following parameters of Genset - RPM, Voltage, Frequency, water temperature, Lube oil pressure etc. shall be monitored from the Central Control room.
- The system shall shut-down / trip in the event of following

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- High lubricating oil temperature
 - Low lubricating oil Pressure
 - High cooling water temperature
 - Engine over speed
 - Over crank
- g) Engine temperature monitoring system.
- h) Continuous online emission monitoring system (CEMS) for monitoring of NO_x and CO.
- i) The locally mounted instruments shall include the following:
- Pressure gauge for lube oil and fuel
 - Dial type thermometer for jacket water, lube oil etc.
 - Temperature regulator for jacket water temperature.
 - Other items, as required

9.6. Mechanical Design

VENDOR shall provide a comprehensive description of the generator mechanical design. This shall include details of bearings, bearing housings, lubrication, sealing, rotor design, bracing, axial movement and cooling system design.

The generator shall be a foot mounted machine of the two-bearing type.

Anti-friction bearings may be grease lubricated. Journal bearings shall be oil lubricated by the engine lubrication system.

Each bearing shall be fitted with an ungrounded type RTD (Resistance Temperature Detector) and BTD (Bearing Temperature Detectors) connected to the monitoring/alarm panel which also monitors the stator RTD's.

Stiff rotor design is preferred. Rotors shall be electrically and mechanically braced, and shall be dynamically balanced and overspeed tested to 120 percent of generator synchronous speed. Shaft axial electrical centre position indicators shall be fitted.

Rotors shall be free from inherent axial thrust and the fans shall be of corrosion resistant material. Interconnection between field winding coils shall be securely fastened to rotor shaft.

Generator enclosure protection and cooling arrangement shall be as indicated on the data sheets. Ventilation fans shall be manufactured from corrosion resistant, non-sparking material and shall be direct driven from the generator shaft.

Generators are to be provided with acoustic enclosure mounted inside an open generator shed. The environment is with heavy rainfall during some periods. Hence vendor to consider these factors and offer the most suitable degree of protection and type of cooling and justify the selection to the OWNER.

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Generator cooling air will be taken from the area surrounding the generator. Exhaust air will be ducted away by vendor. Inlet air shall be filtered. Details of materials and construction of the air-to-air heat exchanger shall be provided.

The emission from the flue gas stack should meet the CPCB regulations. The stack shall be provided with sampling points for monitoring the flue gas.

10.0 CONTROL SYSTEM

10.1. General

The instrumentation and control system shall be of reliable, proven design.

Details of relevant experience with similar equipment and environmental conditions shall be supplied with the quotation. DC electrical controls will be preferred.

The control system shall be designed for remote monitoring, start-up and shut down. Control of the units shall be from the unit control panels which will be installed in the switchgear room. A local skid mounted gauge panel for each unit shall also be provided with auxiliary gauges and provision for machine emergency shut down.

The overall engine-alternator control system to be supplied by VENDOR shall include provision for:

- Automatic start up, synchronisation and bringing on line of a preselected standby unit upon malfunction shutdown of an operating unit, or due to derating of operating units, as a result of high ambient temperatures.
- Automatic load shedding, to initiate shut-down of preselected loads in a predetermined order, as nominated by the OWNER, in case of malfunction of operating units or failure to start of standby unit. Switchgear control scheme to be designed and co-ordinated with Generator control panel to suit this requirement.

Common components (e.g., automatic synchroniser, selector switches, etc.) shall be mounted in a separate matching cabinet to be installed adjacent to the unit control panels.

All generator sets shall be capable of operating satisfactorily on varying loads.

VENDOR shall provide full list of parameters and functions available for monitoring from OWNER's PCS.

A 24V, DC SMPS type power supply module for generator controller operation shall be provide by vendor.

Where OWNER preferred equipment list is included with the data sheets, VENDOR shall offer maximum possible compliance for purposes of standardisation, provided this does not affect safety or reliability of the control system.

This Specification does not attempt to detail all VENDOR supplied hardware, software or equipment that will be needed for the systems to perform all the function required herein. The responsibility of ensuring that the system will be fully operational within the intent of this specification rests with the VENDOR.

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10.2. Gauge Panel

A gauge panel shall be mounted on each unit and shall group conveniently those indicators which are not essential for operation of the set but are required for condition monitoring and trouble-shooting. This shall include, as a minimum.

- Water temperature (IN and OUT)
- Oil temperature (IN and OUT)
- Air temperature - Engine (IN)
- Air temperature - Alternator
- Oil pressure
- Speed (tachometer)

A 'start/stop' pushbutton shall be included on the local engine panel

10.3. Generator Control Panel

The Generator control panels shall be suitable for remote installation in a substation room.

The generator control panel shall be free floor standing back-to-wall type for location near the generating set or for remote installation in substation room. The panel shall be of sheet steel construction, dust and damp protected to IP 55 with hinged lockable access doors, removable lifting legs, and fitted with suitable vibration isolators. The panel shall be designed so that all internal equipment is accessible and connections to external devices and equipment may be made with front access only. Control panels shall be designed for bottom cable entries and shall be supplied with removable gland plates. Pneumatic or hydraulic systems and components shall not be used on the unit control panel. All cabling between the panel and the set shall be provided by the vendor.

The GCP shall be provided with a microprocessor-based control system installed in control panel, which is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control.

The Vendor shall provide and mount on the local control panel with sufficient mechanical and electrical instruments and electrical equipment's to monitor the variables required for the successful operation of the following systems:

- Engines
- Starting system.
- Lubrication system.
- Fuel system.
- Cooling water system.
- Air intake system.
- Gas exhaust system.

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- Generators.
- Excitation system.
- Voltage regulation system.
- Governor system.
- Auxiliary electrical system.

Location of the control room will be in a non-hazardous (safe) area.

The control panel for generators shall include all the starters for auxiliary motors, switches, instruments, relays, protective and indication devices to provide complete control of the generator set. The devices shall include but not be limited to the following:

- 1 Set automatic mains failure starting equipment, to be initiated by one pair of volt free contacts, from the OWNER's equipment, signaling 'mains failure'.
- 1 Set automatic weekly start/stop with all necessary control circuitry and weekly timer.
- 1 Duty selector switch for 'OFF', 'TEST', 'MANUAL', and 'AUTO'.
- 1 Set start/stop push button for manual operation.
- 1 Set remote start/stop control relays to receive remote signals, when in 'AUTO' position.
- 1 Set control relay to initiate automatic opening of mains circuit breaker and closing of the generator circuit breaker (which are part of OWNER's switchboard) when the generator is ready to accept load.
- 1 Set automatic synchronizing operation facility.
- 1 Set control relay to trip circuit breaker in the event of a generator fault.
- 1 Fuel solenoid 'ON' indicator lamp.
- 1 Remote Alarm-Set failed to start
- 1 Set fault (common-alarm)
- 1 Speed control switch.
- 1 Fail to start indicator lamp.
- 1 Panel illuminating lamp and switch.
- 1 A.V.R. Failure Alarm.
- 1 Low fuel alarm
- 1 Set running unloaded alarm and trip (0 - 30 min. adjustable timer).
- 1 Audible alarm unit with alarm accept/reset and simulated fault test facilities.
- 1 Anti-condensation heater
- 1 Mains return timer adjustable (0 - 30 minutes)

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- 1 Auto shutdown over-speed relay and indicating lamp.
- 1 automatic start relay.

Generator sets shall be supplied with all auxiliaries and synchronizing panel complete with protection, control and monitoring systems. Generator sets shall be suitable for parallel operation and shall be capable of maintaining electrical output parameters within the specified ranges for all normal operating scenarios. It shall be possible to change over without power interruption.

Particular attention is drawn to the requirement for reliability at high ambient temperature.

All internal wiring shall be carried out in high temperature grade PVC insulated cable using stranded copper conductors, minimum cross-sectional area 2.5 mm². All panel wiring shall be neatly laid up or loomed and clamped.

All annunciator lamps (LED type) shall operate on the 'first out' principle. The annunciator shall include audible alarm silence and lamp test push buttons. Alarm shall also be connected to provide a common alarm wired out to terminals for the OWNER's use.

10.4. Common Power Plant Control Panel

Common power plant control panel shall be able to control paralleling of gensets synchronously. The common power plant control panel shall be free floor standing back-to-wall type for remote installation in substation room. The panel shall be of sheet steel construction, dust and damp protected to IP 55 with hinged lockable access doors, removable lifting legs, and fitted with suitable vibration isolators. Control panels shall be designed for bottom cable entries and shall be supplied with removable gland plates. All cabling between the panel and the Generator control panel shall be provided by the vendor.

Following devices should be furnished as minimum:

- System function selection switch: continuous/peak shaving
- Load demand on/off switch
- Test/Auto select switch
- Manual/Auto synchronous controller (at least include auto frequency regulator relay (15), auto-voltage balance regulator relay (60), synchronous relay (25).
- Load sharing, controller, automatic proportional share of the total load on the system bus to each Gas Genset or DG unit.
- Load monitor:
- Control the numbers of Gas Gensets or DG units starting/stopping automatically according to the load capacity
- Cross current compensation:
- The function of cross current compensation is to monitor current between generator sets, and adjust exciting voltage automatically to minimize the current.
- Load priority controller-provide 3 normal open contacts for each level.

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- Active power controller
- Reactive controller
- Voltage meters and frequency meters (numerical).
- Synchronous scope and selection switch.
- Multi-meter package: at least shall provide the following measured parameters & provide communication ports.
- The Communications port of the unit supports the RS-485.
- Annunciator panel: contains following status/alarm indicator lamp
 - Load demand
 - System test
 - Bus under frequency
 - DG unit running (one lamp per DG unit)

10.5. Control Panel Wiring

Panel wiring shall be single core 0.6/1kV PVC insulated and PVC sheathed copper conductor to the appropriate IEC standard. Power protection and metering wiring shall be carried out in either 7/0.67 or 50/0.25 (2.5mm²) wire as a minimum.

General control wiring shall be carried out in either 7/0.5 or 30/0.24 (1.5mm²) wire.

Wiring shall be neatly and securely bunched or cleated or shall be enclosed in ducts or conduits.

The bunching of wiring shall be accomplished by means of approved non-metallic fasteners or by means of plastic lacing.

Wires shall be grouped logically but in no case shall the number in one bundle exceed nineteen. A minimum of 75mm free length between conductor bunch and connector shall be available.

Each wire shall be ferruled at each end by means of cable markers which fully encircle the wire. All markers shall be left so that the markings can be easily seen.

Stranded conductors may be terminated directly into approved tunnel type terminals. Flexible conductors must be fitted with crimp pins before so terminating. Conductors terminating on stud type terminals shall be fitted with crimp lugs.

In no case shall a terminal screw bear directly on a conductor.

Tunnel type terminals shall be Klipon Type SAK 6N or approved equivalent. Only one wire shall be terminated in each side of a terminal.

Terminals shall be numbered consecutively unless part of a standard manufactured item.

Spare terminals equal to 20% of the used terminals shall be provided as a minimum.

Wiring for electronic or transistorised circuits shall be as agreed upon by the equipment manufacturers.

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If manufacturers of equipment provided by the vendor specify the use of shielded conductors, the vendor shall use twisted pair 1.5mm² stranded copper wire with 600V thermoplastic insulation over each pair of conductors and a suitable tinned copper braid or aluminised Mylar tape (with copper drain wire) over both conductors and a jacket over all.

Instrument cables, or other low level signal cables shall be in separate bundles or raceways. These shall be separated as far as practical from all power carrying cables and at right angles to such wiring where spacing is less than 300mm.

The various items of equipment mounted on or within the control panel shall be so spaced and the wiring connections to them so arranged that they will not interfere with maintenance and testing of the equipment.

10.6. Instrumentation Requirements

All instrumentation shall be designed and installed in accordance with the project specification; Specification for General Instrumentation FGGS-BJN-INT-SPC-7001, so far as it does not directly affect the integrity or safety of the engine control system.

Instruments related to gas generator and auxiliaries shall be designed for safe area operation.

10.7. Controls and Indication Functions

Parameters requiring control and/or monitoring from Purchaser's DCS shall be via a serial communicating link, unless specified otherwise.

ITEM	LOCATION
Engine speed Isoch/Droop select	Unit Control Switch Panel &DCS (Indication only)
Voltage adjustment rheostat	Unit Control Panel
Power Factor Meter	Unit Control Panel & DCS
Ammeter with Selector Switch	Unit Control Panel & DCS
Voltmeter with Selector Switch	Unit Control Panel & DCS
kW / kVAR Meter with External	Unit Control Phase Shift Panel & DCS
Frequency Meter	Unit Control Panel & DCS
Under Voltage	Unit Control Panel
Over Voltage	Unit Control Panel
Synchronising Check Relay	Unit Control (including dead bus) Panel
Synchronising Lights (white)	Unit Control Panel
Synchroscope	Unit Control Panel
Circuit Breaker Control Switch	Unit Control Panel
Circuit Breaker Lights	Unit Control Panel
Alternator Bearing and Stator	Unit Control Winding RTD Panel

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Automatic Synchroniser	Auto Start Panel
Alternator Running Lights	Auto Start Panel& DCS
Alternator Ready to Start Light	Auto Start Panel (Unit Ready)
Alternator Malfunction Lights	Auto Start Panel (Unit Shutdown) & DCS
Standby Alternator Select Switch	Auto Start Panel
Standby Alternator Run Light	Auto Start Panel
Standby Alternator Manual	Auto Start Panel Start Switch
Standby Alternator Circuit Breaker	Auto Start Panel, Auto/Manual Switch

10.8. Alarm and Shutdown Functions

A single, common alarm for all the following alarms shall be initiated on OWNER PCS via serial communications link. The shutdown of individual Generator shall be from the generator control panel. Any process related shutdown initiated from the ESD system shall shut down the generator or the power plant as a whole. Provision for receiving the ESD signal shall be provided in the panels.

	Alarm / Indication Only	Alarm / Indication and Shut Down
Alternator System:		
Winding temperature, high	X	
Winding temperature, high high		X
Under/Over voltage		X
Bearing temperature high	X	
Bearing temperature high high		X
External Systems:		
Process Shutdown	X	

11.0 LOAD MANAGEMENT SYSTEM

The following philosophy defines the basic operating requirements of the Load Management System. It should be a general aim to minimise engine starts and stops (thermal cycling) consistent with load requirement. Thus, in many cases it should be possible to enable operator intervention to prevent shutdowns based on operating information.

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11.1. Alternator Normal Status

Depending upon the load requirements, the appropriate number of engine-alternators will be on-line.

In normal operation the on-line engine-alternator governors will be set for isochronous operation.

Assuming that four engine-alternators were installed and available, if the load was such that two engine-alternators were sufficient to supply the entire load, the alternator status will be:

- Two engine-alternators on-line.
- Two engine-alternator stopped, stand by.

11.2. Load Sharing

Load management system shall include automatic load sharing control functions to allow isochronous load sharing for both kW and kVAr between the gensets in parallel. Load sharing between gensets in parallel shall be within 1% of equal for all loads from no load to full load.

11.3. Load Govern Mode

Load govern mode becomes active when the genset is paralleled within an infinite source such as utility (mains) service. Though utility service is not available now this function shall be inbuilt with the load management system for use in future if needed.

11.4. Load Shedding

When the load on the on-line alternators reaches a point where they can no longer maintain supply, load shedding shall be initiated. Typical situations which would require load shedding are:

- In the event of an on-line unit tripping or shutting down.
- In the event of an electrical system fault.
- If a larger load was suddenly added to the electrical system.

The loads available for shedding shall be user defined with a user defined priority.

The means of detecting the occasion for load shedding and the amount of load to shed shall be based on a combination of engine speed and frequency.

Load shedding shall only occur when the engine kW of any engine has reached a set level, higher than that which would initiate adding another alternator unit and lower than that which would initiate a shutdown. At this set point the governor shall be controlled such that fuel is restricted, which will cause frequency to reduce. The degree to which frequency reduces will allow the Load Shedding System to determine the types of loads to be shed.

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For specific situations, such as where an engine unit trips, the Load Management System shall be capable of determining a predicted shortfall in capacity based on the available capacity of the tripped machine and the reserve capacity prior to the trip.

In the event that an engine unit is shut down due to low speed after the load shed system has operated, the unit control system should automatically lock-out a restart until maintenance has confirmed the engine condition. It will be assumed that the load shedding has been unsuccessful.

If there is a total shutdown an auto start shall be initiated for the emergency 'black start' generator. Once the emergency generator is on-line the feeder to the Essential Services Switchboard can be automatically restored.

All further restoration of power will be achieved manually. This will include the start-up and synchronising of any engine-alternator units. The Load Management System will not be required to reinstate any loads, which were disconnected during load shedding.

12.0 MAINTENANCE REQUIREMENTS

The complete engine-alternator set shall be designed and constructed with a view to facilitating maintenance. Under normal conditions the set will be required to run continuously and lube oil change / filter change shall be carried out as per OEM maintenance schedule. Period between major overhauls shall be at least 60,000 operational hours.

All layout and outline drawings submitted for approval shall show dimensions of major sub-assemblies as well as clearances required for lifting and disassembly.

Details of engine and generator removal procedures shall be provided with the quotation. This shall include required access, lifting device, degree of enclosure disassembly, limitations on direction of access and weights of engine, generator and sub-assemblies.

Consideration shall be given to performance and mechanical condition monitoring. Apart from visual observation of the specified indicators and monitors, it shall be possible to connect the relevant devices to a data acquisition system and vendor shall be prepared to liaise with the OWNER on interfacing with the equipment instrumentation and control system.

Vendor shall show separately in the quotation all required special tools for normal operation and maintenance of the equipment. This shall include a suitable hot alignment system.

Where access platforms or ladders are required for routine operation and maintenance these will be supplied and installed by purchaser in accordance with the vendor's recommendation.

Detailed recommendations regarding inspection frequencies for the complete package (in an integrated format) and maintenance procedures shall be included in the operating and maintenance manuals along with a list of recommended lubricants for the equipment supplied.

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13.0 TOOLS AND SPARE PARTS

The Vendor shall supply a set of any special tools necessary for commissioning and maintenance purposes.

The Vendor shall also include 2 years maintenance spare parts along with the commissioning spare parts for gen set.

All spare parts shall comply with the same standards, specifications and tests of the original equipment and shall be fully interchangeable with the original parts without any modifications at the site.

They shall be correctly marked in accordance with the OWNER Spare Parts Lists and Interchangeability Record giving the purchase order number and be preserved to prevent deterioration during shipment and storage in humid tropical climates.

Spare parts shall be guaranteed to be supplied by the Vendor during the life of the equipment covered by the purchase order.

Vendor shall include all critical items like control system cards, relays, control fuse, indication lamps in the spares offered by them.

The OWNER Spare Parts List and Interchangeability Record form (SPIR form attached) shall be filled in completely.

14.0 PAINTING

All surfaces to be painted shall be done in compliance with General Specification.

Sufficient paint for touch up shall be sent to site.

15.0 INSPECTION & TESTING

The testing of Gas Engine Generator shall necessarily be carried out at factory / manufacturer premises in presence of representatives of OIL / EPCM. MPC Contractor or its representative shall give a notice in advance of minimum four weeks for carrying out pre-delivery inspection and shall arrange staff / fuel and any other consumable for test run at his cost.

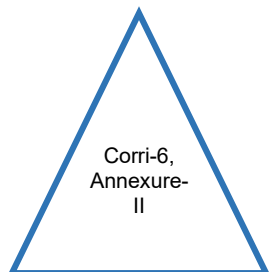
All major items / equipment's i.e., engine, alternator and associated electrical control panels etc. shall be offered for inspection and testing assembled as unit.

15.1. Gas Engine Generator Test

- Inspection and testing shall be followed as per OIL / EPCM consultant approved ITP.
- Vendor shall also furnish material test certificates of all major components of the gas generator package as per requirement of approved QAP.
- The gas generator set shall also be tested at site based on the available load to generate the required power and voltage at the alternator terminals.
- Performance testing for power, efficiency, speed, fuel consumption and lubricating oil consumption etc for the Gas Engine shall be carried out ISO-3046, BS:5514 or IS:10000 or any internationally accepted code & standard.

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- e) The generator with all auxiliaries and control panel shall be tested as per relevant IS/BS standard.
- f) MPC Contractor shall perform Measurement of Vibration level for generator.
- g) **The routine load test and fuel consumption test for the complete Gas engine Generator shall be done at factory for following duration:**
 - Part Loads (50% & 75%) - 30 min each
 - Full Loads (100%) - 4 hours

MPC Contractor shall perform the Site acceptance test after installation of Gas Engine Generator at site. MPC Contractor shall provide load bank for 100% load testing during site acceptance test.

16.0 TRAINING

Minimum one week on site training to be conducted to get the maintenance team familiar with the equipment. The training shall be repeated upon buyer request with agreed terms.

17.0 PREPARATION FOR SHIPMENT

The units shall be suitably packed and protected against all damages or defects which may occur during handling, sea shipment to the port and rough road haulage to site and extended tropical open-air storage, generally fulfilling the following minimum requirements set in this document and as per the specification for protection of goods during shipment (FGGS-BJN-MEQ-SPC-4001).

All surfaces are to be thoroughly cleaned free of all rust, scale, grease, dirt and moisture before being painted. Grease and oily matter are to be removed by means of a suitable solvent.

After surface preparation as above, the engine shall be coated with a good quality red lead, or oxide type primer, unless otherwise called for.

After successful conclusion of the tests, each engine is to be thoroughly cleaned, coated with a good quality anti-rust composition and closed and rejointed ready for service.

Adequate protection shall be provided against mechanical damage and atmospheric corrosion in transit.

All equipment shall be packed, securely anchored (skid-mounted when required) and weather-protected for the shipment. Separate, loose items and all spare parts shall be completely boxed. All pieces of equipment and spare parts shall be identified by OWNER item number and service, and marked as specified in the purchase order on both inside of each individual package or contained.

Exposed finished and machined surfaces, including bolting, shall be given a heavy coating of rust inhibiting compound. Internal metal surfaces shall be sprayed or coated with a suitable rust preventative. All openings shall be suitably tagged to indicate the type of rust preventative applied.

Bearing, bearing housings, and oil systems including reservoirs, air coolers, filters, and piping shall be thoroughly cleaned of metal particles, dirt and debris, and coated with a

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suitable rust preventative. All openings shall be suitably tagged to indicate the type of rust preventative applied.

Solid steel plugs shall be used instead of plastic plugs for any part that is pressurized during start-up or operation.

All flanged openings shall be protected with metal cover plates to prevent damage during shipment. Covers shall be a minimum of ¼" thick and shall be installed with a suitable gasket using a minimum of four (4) full diameter bolts. Larger diameter flanges will require enough full diameter bolts to seat the cover all around. The cover and flange shall be taped for waterproof protection.

Bracing, supports and rigging connections shall be provided to prevent damage during shipment, lifting or unloading.

One complete set of the Installation, Operation, and Maintenance instructions shall be packed in the boxes or crates with the equipment.

18.0 GUARANTEE

The equipment is to be guaranteed without qualifications and for satisfactory application in every other respect to the operating conditions specified. The Vendor will further guarantee the equipment furnished by him against defective design, materials and workmanship for a period of one year after being put into regular operation, total period not to extend 18 months from date of shipment and will promptly repair or replace, without cost to the OWNER any defective part, or parts. All parts of packages and equipment supplied by sub-Vendors shall also be guaranteed by the Vendor.

The performance guarantee shall cover the following parameters:

- a) Engine (kW) output (@ alternator terminal after deducting all essential independent auxiliaries)
- b) Fuel gas consumption at specified site condition and gas composition
- c) Electrical efficiency
- d) Starting of largest motor in worst condition keeping voltage drop at generator terminal as per electrical specification.
- e) Noise level
- f) Vibration value

19.0 WARRANTY

The VENDOR shall warrant all equipment, accessories and parts furnished with the engine-generator package. The complete package and all components must have a minimum warranty period of 1 year, commencing from date of acceptance.

The Vendor shall include warranty statement in his quote.

If any performance deficiencies or defects occur during warranty period, The Vendor shall take all the necessary immediate action to alter, repair and replace free of charge the defective parts.

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Upon commissioning of generator, vendor shall provide contact telephone number and mobile number of the service engineer who shall be responsible for answering any queries raised by buyer field personnel during any time of day/night. Vendors shall be responsible to attend the major defects and deficiencies within no more than 48 hours.

20.0 DRAWINGS AND DATA REQUIREMENT

The Vendor shall provide the OWNER with the following drawings and data in English at no cost to the OWNER.

20.1. With Quotation

1 set of:

- Complete technical Vendor's products catalog.
- Comprehensive catalogues, technical data, dimensional outline drawings, proposed test procedure, service facilities, etc. of the equipment offered and its various components.
- Preliminary connection and wiring diagrams, dimensional and cross-sectional drawings, control system diagram.
- Declaration of confirmation with the set standards and/or clear indication of deviations from the standards and this specification.
- Vendor's design calculation, necessary documents and/or data for the calculation of the power output of the engine in respect to the site and climatic condition detailed in data sheet.
- Derating curves.
- Recommended commissioning and 2 years running consumable and spare parts separately listed, numbered, referenced and duly priced.
- Shipping dimensions (length, width and height) and weight with shipping schedules.
- Tabulation of all connections to which OWNER connections, giving size, rating, facing etc.
- Scheme of fuel circuit.
- Scheme of lube oil circuit.
- Scheme of starting system.

20.2. Immediately Following the Placing of Order (Not Later Than 60 Days)

2 sets of:

- Piping, wiring, preliminary control system diagram and dimensional outline drawings, dimensional outlines of all accessories of various connections details for OWNER approval.
- Foundation plan/anchor bolts location weight of all components shown on drawing, weight of the heaviest piece for maintenance, and support drawing of intake and exhaust system.

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- Proposed tests procedure for OWNER approval.
- Prints of certified drawings as well as agreed and approved test procedure and reports of all tests carried out on the equipment.
- Component list with manufacturer, model and technical characteristic specified.
- Local panel dimensions and cutouts, with interconnection details.
- Single line and wiring diagrams of control and electrical panels (as applicable) with indication of characteristic of control alarms and shutdown devices.

20.3. 90 Days (At Least) Before Delivery

For each unit 2 sets of:

- Installation, Operation and Maintenance manuals consisting of (min.):
 - Codes and standards compliance certificates.
 - Final connection and wiring diagrams.
 - Cable list and layout.
 - Panels layout, wiring, connections and interconnections.
 - Auxiliary system schematics.
 - Factory test certificates, including test data and calculated results.
 - Illustrated and numbered parts list and two years running spare parts list final revision. (Refer to the attached Spare Parts List and Interchangeability Record).

One set of reproduction of all civil, mechanical, control and electrical drawings with "As Built" mark shall be supplied by Vendor.

21.0 LABELLING

A stainless-steel nameplate must be provided for each piece of equipment as shown below:

Manufacturers may add the data required to their standard plates provided that they are made from the above-mentioned material. The data called for must be legibly stamped or preferably engraved on the plate which shall be fixed to an accessible part of the equipment.

The nameplate shall be securely fixed to the equipment, but the method of fixing shall not involve drilling into the wall of a pressure part.

Equipment Identification No:

Order No.: Order Placed By:

Manufacturer's Name:

Type and Size: Serial No:

Bore and Stroke, mm:

Rated, KW: R.P.M:

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Firing Order:

Weights - Total Net Wt. Equipment: Kg

Base frame: Kg

Heaviest Removable Component: Kg

For Overhaul: Kg

22.0 OPERATIONS INSTRUCTION AND MAINTENANCE MANUAL

Vendor shall provide Operating Instructions and Maintenance Manual in accordance with attached General Specification for Operating Manuals and Data Books.

Vendor shall also be responsible for providing manuals and other training aids such as videos for operator training.

23.0 FUEL GAS COMPOSITION

MPC Contractor shall refer the below appendix for Fuel gas composition available in Field Gas Gathering Station (FGGS) for augmenting natural gas production facility at Baghjan field in Upper Assam, India.

COMPOSITION OF FUEL GAS

GAS COMPONENTS	GAS COMPOSITION (VOL%)
Methane	90.05
Ethane	4.43
Propane	1.29
i-Butane	0.22
n-Butane	0.29
i-Pentane	0.11
n-Pentane	0.09
n-Heptane	0.00
n-Octane	0.00
n-Nonane	0.00
n-Decane	0.00
n-Hexane	0.17
Nitrogen	1.15
CO ₂	2.21
H ₂ O	0.00



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IN UPPER ASSAM FOR OIL INDIA LTD**



SPECIFICATION FOR NATURAL GAS GENERATOR SETS

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PROPERTIES OF FUEL GAS

PROPERTIES	UNIT	VALUE
Vapour Fraction		1
Temperature	°C	30
Pressure	KSC(g)	3.5
Heat Flow	KJ/hr	-2.151 x 10 ⁸
Cp/Cv		1.301
Mass Heat Capacity	KJ/Kg°C	2.124
Z Factor		0.9897
LHV (Std),	BTU/SCF	915
HHV (Std)	BTU/SCF	1007
Mass Density	Kg/m ³	3.157
Molecular weight		17.74
Viscosity	cP	0.01162

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SPECIFICATION FOR DIESEL GENERATOR

REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT
0	Issued for ITB	16-07-19	AS	KPS	CK	
B	Issued for Approval	22-05-19	AS	KPS	CK	
A	Issued for Review/Approval	22-03-19	AS	MKV	CK	

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1.0 INTRODUCTION

M/s OIL India Ltd (OIL) is a Navaratna Company under the Ministry of Petroleum and Natural Gas, Govt of India. As an integrated upstream company with pan India presence and overseas wings spreading over different parts of the globe, OIL is engaged in exploration, production and transportation of crude oil and natural gas and production of LPG with its headquarter at Duliajan, Assam. In line with OIL's strategy for balanced growth, an ambitious plan for development of non-associated gas fields is presently underway in OIL's Upper Assam operational area. As a part of this development scheme, OIL desires to construct a modular Field Gas Gathering Station (FGGS) for augmenting natural gas production facility at Baghjan field in Upper Assam, India.

Jayathe Petrotech Engineers and Consultants (JPEC) have been awarded the contract for Engineering and Project Management Consultancy for developing the engineering and managing project execution.

1.1 PROJECT OBJECTIVE

The Baghjan field is having huge amount of Non Associated Gas (NAG) potential and the expected gas production from this area in 7.5 MMSCMD. To explore these resources one modular Field Gas Gathering Station (FGGS) having the facilities for production of natural gas is to be created. The proposed FGGS shall have Non Associated Gas (NAG) processing facility for 5.0 MMSCMD (2 trains x 2.5 MMSCMD) and provision to feed Associated Gas (AG) of 0.5 MMSCMD along with the NAG to a Glycol based Dehydration facility (5.0 MMSCMD) for achieving water dew point less than or equal to (0) Zero Deg C. The facility shall include Production and Test Manifolds, Gas /Condensate/Water Separators, Gas Dehydration, Flare system and Effluent Treatment and disposal system along with all the required utilities and auxiliary systems. Space provision will be made within the plant to augment its capacity by installing one more train of 2.5 MMSCMD in future.

2.0 PURPOSE

This specification covers the requirements for design, manufacture and testing of diesel engine driven generator sets. This diesel generator will be used for the emergency load and black start (if required) of the CPP gas generator set.

3.0 CODES, REGULATIONS, AND STANDARDS

Vendor shall meet or exceed the requirements of the latest edition of the following codes, regulations and standards, except as superseded herein. In cases where more than one code, regulation or standard apply to the same condition, the most stringent shall be followed. In the event of a conflict between these specifications and other specifications or correspondence, the OWNER shall be consulted and a ruling, in writing, shall be obtained before any work is started. The following codes, regulations and standards shall be referred to:

3.1 INTERNATIONAL ELECTRICAL CODES (IEC)

IEC 60034	Rotating Electrical Machines
IEC 60072	Dimensions and Output Ratings for Rotating

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Electrical Machines

IEC 60050	International Electro technical vocabulary
IEC 60085	Electrical Insulation - Thermal evaluation and designation
BS 4999	Specification for Voltage regulation and parallel operation of A.C. Synchronous Generators
ISO 9001-2000	Quality Management System Requirement
ISO 9004-2000	Quality Management Guidelines for performance Improvement Systems
ISO 19011	Guideline for Quality/ Environmental System Auditing

3.2 NORTH AMERICAN STANDARDS

- American National Standards Institute (ANSI)
- American Society of Mechanical Engineers (ASME)
 - : Boiler and Pressure Vessel Code, Section VIII - Unfired Pressure Vessels
 - : Boiler and Pressure Vessel Code, Section IX - Welding and Bracing Qualifications
- American Society for Testing and Materials (ASTM)
- Diesel Engine Manufacturers Association Standards (DEMA)
- Internal Combustion Engine Institute Standards (ICEIS)
- National Electric Manufacturers Association (NEMA): NEMA MG-1 Motors and Generators
- Society of Automotive Engineers (SAE): SAE J1349 (Engine)
- Performance Standards

3.3 BRITISH STANDARDS (BS)

BS EN 55014:2006+A2:2011	Electromagnetic compatibility.
BS ISO 5011:2014	Inlet air cleaning equipment for internal combustion engines and compressors. Performance testing
BS EN 60085:2008	Electrical insulation. Thermal evaluation and designation

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BS 2869:2010+A1:2011

Fuel oils for agricultural, domestic and industrial engines and boilers. Specification

BS EN 60034

Rotating electrical machines

BS ISO 3046

Reciprocating Internal Combustion Engines

BS EN 61496 :2013

Safety of machinery. Electro-sensitive protective equipment.

Codes, Regulations and Statutes of Authority having jurisdiction in the location of installation.

The following general specifications shall be used in conjunction with this specification where applicable.

FGGS-BJN-PIP-SPC-5004

Specification for Painting

FGGS-BJN-MEQ-SPC-4001

Specification for protection of goods during shipment

FGGS-BJN-MEQ-SPC-4007

Specification for Equipment Noise Level

FGGS-BJN-MEQ-SPC-4005

Specification for Spare Parts requirement

3.4 INDIAN STANDARD

IS	-	14122	Built in thermal protection for electric motors rated up to 660 V AC
IS	-	5572	Classification of Hazardous Area (other than mines) having flammable gases and vapours for electrical installation
IS	-	8239	Classification of maximum surface temperatures of electrical equipment for use in explosive atmosphere.
IS	-	3202	Code of practice for climate proofing and electrical equipment
IS	-	2274	Code of practice for electrical wiring installation – system voltages exceeding 650 V.
IS	-	732	Code of practice for electrical wiring installations –system voltages not exceeding 650 V.
IS	-	13408	Code of practices for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining application or explosive processing & manufacture)
IS	-	3043	Code of practice for Earthing

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IS	-	2253	Designation for type of construction and mounting arrangement of rotating electrical machines
IS	-	4691	Degrees of protection provided by enclosure for rotating electrical machinery
IS	-	6362	Designation of methods of cooling of rotating electrical machines
IS/IEC	-	60079-0	Electrical Apparatus for explosive gas atmospheres – General requirements
IS/IEC	-	60079-1	Equipment protection flameproof enclosures “d”
IEC	-	60079-5	Equipment Protection by Powder filling “q”
IEC	-	60079-6	Equipment Protection by Oil immersion “o”
IEC	-	60079-7	Equipment Protection by Increased Safety Type “e”
IEC	-	60079-11	Equipment Protection by Intrinsic safety “I”
IS/IEC	-	60079-15	Electrical apparatus for explosive gas atmosphere – construction, test and making of type of protection “n” electrical apparatus
IS	-	2148	Flameproof enclosures for electrical apparatus
IS	-	7752	Guide for improvement of power factor- consumer installations
IS	-	5216	Guide for safety procedures and practices in electrical works.
IS	-	5571	Guide for selection of electrical equipment for hazardous area.
IS	-	7132	Guide for testing synchronous machines
IS	-	12075	Mechanical vibration of rotating electrical machines with shaft heights 56mm and higher - measurement, evaluation and limits of vibration severity
IS	-	7306	Methods for determining synchronous machines quantities from tests
IS	-	4889	Method of determination of efficiency of rotating electrical machines
IS	-	3716	Insulation coordination application guide.
IS	-	12065	Permissible limits of noise level for rotating electrical machines
IS	-	4722	Rotating electrical machines
IS	-	12802	Temperature rise measurement of rotating electrical machines
IS	-	4728	Terminal marking and direction of rotation for rotating electrical machines
IS	-	5422	Turbine type generators
IS	-	12824	Type of duty and classes of rating assigned to rotating electrical machines

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3.5 OISD STANDARDS

OISD	-	STD-113	Classification of Area for Electrical Installations at Hydrocarbon Processing and Handling Facilities.
OISD	-	STD-149	Design aspects for safety in electrical systems.
OISD	-	STD-173	Fire Protection System for Electrical Installations.
OISD	-	STD-116	Fire Protection Facilities for Petroleum Refineries and Oil/Gas Processing Plants
OISD	-	STD-147	Inspection and Safe Practices during electrical installations.
OISD	-	STD-137	Inspection of Electrical Equipment
OISD	-	STD-118	Layouts for Oil and Gas Installations.
OISD	-	STD-110	Recommended Practices on Static Electricity.

3.6 CONFLICT

Some requirements in this specification may be modified by specific requirements in the Purchase Specification. In case of conflict, the specific requirements supersede this specification.

3.7 DEVIATION

Any deviation from this specification must be approved, in writing, by OWNER. Such written approval must be obtained prior to the commencement of any work, which would constitute such a deviation.

4.0 ABBREVIATIONS

AC	Alternating Current
ASL	Above sea Level
BS	British Standards
DCS	Distributed Control System
DOL	Direct On Line
IEC	International Electro Technical Commission
IP	Ingress Protection
ISO	International Organization for Standardization
LED	Light Emitting Diode
RTD	Resistance Temperature Detectors
BTD	Bearing Temperature Detectors
CPCB	Central Pollution Control Board

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5.0 DEFINITIONS

The following definitions shall apply in this document:

OWNER	Oil India Limited
VENDOR	Equipment Supplier or Manufacturer
CONTRACTOR	Company or firm engaged to engineer, construct and commission the project.
SHOULD	The word “should” is understood to be strongly recommended to comply with the requirements.
SHALL	The word “shall” is understood to be mandatory to comply with the requirements
STANDARD	Standard means that the feature, accessory or test is provided in accordance with the applicable Standard, without additional specification by the Oil India Limited .

6.0 SITE CONDITIONS

The VENDOR shall ensure that the equipment supplied shall work properly under the site conditions as specified in the design basis documents and equipment datasheet.

The equipment and installation shall be suitable for the minimum environment conditions, unless otherwise specified.

7.0 GENERAL

This specification supplements the data sheets for each individual generator on which the operating conditions and special requirements are listed in detail.

Compliance by the Vendor with the provisions of this specification does not relieve the Vendor of the responsibilities for furnishing equipment of proper design, mechanically and electrically suited to meet operating guarantees at the following specified service conditions:

7.1 SERVICE CONDITIONS

The equipment and all its components should be entirely suitable for service under the following conditions.

- The generator sets shall be capable of producing the rated output with the specified fuel and site conditions and appropriate derating for accessory losses. If the units require electrical accessories such as remote cooler fans or lube oil pumps, the output rating shall be that specified plus the accessory requirements.
- Voltage regulation shall maintain the generator output voltage within +1% of rated voltage for all steady state conditions from no load to full load and for +5% frequency variations. A manual adjustment of +10% rated output shall be possible.
- The engine governor shall maintain isochronous frequency regulation from no load to full load. Steady state frequency band width shall be +0.25%.
- The voltage drop shall not exceed 15% of rated voltage upon starting of the largest electric motor as specified. The voltage drop shall be calculated based on the

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generator transient reactance (X'd) without consideration of the possible effect of voltage regulator action.

- The generator sets shall be capable of delivering full load at rated voltage and frequency within 20 seconds upon receipt of a signal to run. They shall be capable of supplying 110% full load for one hour in any period of 12 hours.
- When a new design or component is offered that has not been proven in service for at least two years, proposals shall indicate which components are affected and the extent of experience with such components.

7.2 ENVIRONMENT

The equipment shall be suitable for the climatic conditions prevalent at the location of the intended installation and operation.

7.3 POWER SUPPLY

The power supply shall be provided based on the following limits:

- 415 volts $\pm$ 10%, 3 phase, 50 HZ $\pm$ 5% (4 wires)
- 240 volts $\pm$ 10%, 1 phase, 50 HZ $\pm$ 5% (2 wires)

7.4 INSTALLATION

Unless otherwise specified in the Data Sheet, the equipment shall be installed indoors.

7.5 LOCATION AND TYPE OF CONTROL SHALL BE AS FOLLOWS

- Local (manual) - with controls on or near controlled equipment
- Panel (manual) - with controls on station control panel
- Panel (automatic) - with controls on station control panel

7.6 NOISE REQUIREMENTS

The noise (sound) level of the completed package system covered by this specification shall be as per CPCB norms.

8.0 DESIGN

8.1 GENERAL CONDITIONS

The Diesel Generator Set and all associated system shall be mounted on common skid and installed in the Generator shed.

The list of loads connected to the DG set and the sequence of starting shall be as per relevant Single Line Diagram/ Load List.

The set shall be capable of delivering 10% overload for one hour in any period of twelve hours continuous running. The set must be capable of accepting full load from cold start within 20 seconds.

The set shall be operated as a Black Start / emergency power supply unit only.

System characteristics are specified in the data sheets.

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Vendor shall provide the manufacturer's catalog, operation and maintenance instructions, and spare part list for supplied equipment.

Unless expressly excluded, any and all equipment and material required for the complete installation of the equipment shall be included by the Vendor. Any intended omission or deviations to the requirements of the specification must be included in the "Deviations to Specification" attached with the Bidder's Proposal

9.0 MECHANICAL REQUIREMENTS

The engine shall be furnished on a structural steel base which shall also accommodate the driven equipment, gearbox (when furnished), and all auxiliary equipment, including intake filters and silencers, securely mounted thereon.

The maximum prime duty rating of the engine and the generator shall be re-rated to cater for the Site Summer Conditions. This shall be based on operation of the set at rated generator RPM when equipped with all necessary operating accessories such as, but not limited to:

Air Cleaners	Radiator Fan
Lubricating Oil Pump	Exhaust Pipe
Fuel Transfer Pump	Silencer/Spark Arrester
Fuel Injection Pump	Generator
Jacket Water Pump	Exciter
Governor	Generator Cooling Fan

Fuel Tank (10M³ diesel tank is provided to supply the fuel to diesel generator)

The Vendor shall supply with the bid an engine performance curve showing torque, fuel consumption, engine speed, and power output. Power shall be based on actual conditions (see data sheet of diesel generator FGGS-BJN-ELE-DST-6002).

The engine shall have full compression ignition and operate on four stroke naturally aspirated or turbo-charged direct injection basis. It shall be of the vertical 'in-line' or 'V' cylinders type. The engine shall be heavy duty industrial type with maximum operating speed of 1000 rpm.

There shall be provision for manual barring over of the shaft system.

All gear, belts, couplings, pulleys, or similar shall be adequately guarded for personnel protection.

The diesel engine shall include class G3 governing as defined in ISO 8528 Part 1. An electronic type governor shall be provided.

All exhaust pipes and other hot surfaces shall be lagged or otherwise shielded for personnel protection.

All interconnecting piping and control wiring, including fuel piping and fittings from fuel tank to engine, shall be furnished and installed. The exhaust piping and spark arrester/silencer shall be mounted over the engine.

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Service connections and valves for draining and filling of lube oil system and cooling water system shall be easily accessible.

Vibration of the set both due to unbalanced mass forces and torsion vibration shall be kept to a minimum.

Skid shall be arranged to permit removal of crankcase oil pan, or access to the crank through the access door. All walkway flooring and ladder treads, where applicable, shall be in solid steel plate with raised diamond, non-slip pattern. All piping for connection to the external system shall conform to ANSI standard flanges (other types of connections shall be approved by OWNER).

Skid shall have adequate inherent rigidity without the need for grouting. Provision for adequate holding down bolting to OWNER concrete foundation shall be made. Vendor shall recommend size, type and location of bolts to be provided by OWNER.

Jacking pockets or pads shall be furnished for easy location of the machine on foundation over bolts. Skid shall include 4-point lifting lugs to the manufacturer's standards.

9.1 FUEL SYSTEM

The fuel system shall consist of following items as minimum,

- Fuel day tank, fuel pumps, Pre-filters, duplex filters, fuel governor, etc.
- Fuel day tank along with interconnecting piping / hoses, hand pump for tank filling, necessary instruments as required for the safe and uninterrupted operation of the engine shall be provided.
- The capacity of the fuel tank shall have storage capacity to cater minimum eight hours of engine operation at full load. Necessary interconnecting piping between the day tank and the engine shall be supplied by Vendor.
- Duplex filters shall be of the replaceable element type and readily accessible for maintenance. A differential pressure gauge shall be provided across the filter to monitor the filter condition.
- Duplex filters and pre-filters shall be fitted with sediment drain valves and vent valves for purging any air trapped in the filter.

Diesel for the DG set will be made available by OIL in barrels.

9.2 LUBRICATION SYSTEM

The frame lubrication system shall be a pressure system with the following specific requirements as minimum:

- The engine shall have an integral engine driven gear type lubricating oil pump for supplying oil under pressure to main bearings, crank pin bearings, pistons, piston pins, timing gears, camshaft bearings, and valve rocker mechanism.
- The engine shall have a suitable lubrication oil cooler, air coiled type with thermostatically controlled bypass valve on the oil line to maintain oil temperature.

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- (c) Full flow replaceable cartridge type lube oil filter located at a convenient point for servicing shall be provided with a bypass valve to ensure oil circulation if filter is clogged. A magnetic device shall be included in lube oil sump for collection of metallic particles which may be deposited in lube oil sump.
- (d) The lube oil reservoir shall be the sump under the engine crankcase. The reservoir shall have fill, vent and drain connections and level gauge.
- (e) A lube oil controller shall be furnished in the crankcase. Vendor shall also furnish the required lube oil make-up tank, which shall be installed inside the engine house close to the engine. If the engine design does not require lube oil makeup, then Vendor shall specify the minimum continuous running hours of the engine without any compensation of lost lube oil.
- (f) If a pre-lubrication pump is required, it shall be DC driven and shall be interlocked with starting controls to ensure proper lubrication prior to starting.

9.3 STARTING SYSTEM

The engine shall be equipped with a 24 volt battery powered, electric starting system of sufficient capacity for a minimum of 3 cranking cycles, each 15 seconds crank and 15 seconds rest.

The battery shall be heavy-duty and electrolyte should be gel type, preferably mounted on the set with dust cover

A battery charger with a high and low rate, shall be provided, and shall have a manual switch to select an adjustable trickle charge rate. The charger shall operate from normal mains supply to maintain the battery fully charged for engine starting.

Battery charger shall have an external power supply.

An automatic changeover switch shall be provided to change from mains to engine driven alternator charging when the set is running.

Automatic controls shall be furnished to provide automatic cranking of the engine when normal power fails. The equipment shall be fitted with means to prevent excessive cranking which could damage the cranking motor. If at the end of the cranking sequence, the engine fails to start, a signal light shall show engine failure. When the set is running, an engine driven alternator with rectifier and control system shall take over the battery charging and shall have the capacity to boost charge the battery.

9.4 COOLING SYSTEM

The engine shall be furnished with a cooling system having sufficient capacity for cooling the engine when the set is delivering the full load continuously under site's summer operating conditions, plus the 10% overload capacity. The temperature rise of the circulating water through the engine under full load conditions shall not exceed 12°C.

The engine shall be provided with a thermostatic valve placed in the jacket water outlet, between the engine and the cooling source. This valve shall maintain the jacket water temperature as recommended by the engine manufacturer, under all load conditions. The valve trip setting should be stated by Vendor but shall not exceed 95°C.

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The engine shall be equipped with an engine driven, centrifugal type water circulating pump for circulating water through the engine jacket, cylinder heads, exhaust manifold cooler and radiator.

The engine cooling system shall include a forced air radiator with separate closed circuits for each cooling duty (i.e. lube oil, jacket water, and charge air cooling, where applicable). For design purposes the cooling air intake temperature to the radiator shall be taken as 40°C. The air temperature rise across the radiator shall preferably be 15°C or less, but should not exceed 18°C under full load conditions. These temperatures shall be based on a radiator fouling factor of 17%. The radiator fan shall be motor driven and enclosed in a screen for personnel protection.

The Vendor shall provide a diagram of the cooling water systems showing all connected equipment, with water flow rate, heat pick-up and volume of air required.

The cooling system shall have a thermostat controlled electric heater to maintain a Cooling Water temperature of 80°C during standstill to ensure rapid starting under emergency conditions.

The unit shall operate completely independent of any external cooling water supply and require make-up water only (no cooling water is available at site).

9.5 INTAKE AIR FILTER AND EXHAUST SILENCER

Vendor shall provide an industrial type intake air filter (Acc. to BS ISO 5011) with replaceable dry elements.

A residential type spark arrester/silencer with flexible exhaust connection shall be furnished with the engine. Silencer (mounted horizontally with up nozzles, rain cap and condensate drain) shall be properly sized for the engine and be complete with companion flanges and rain cap. Exhaust silencer will be connected to the exhaust system and mounted over the engine.

Flexible exhaust expansion joints shall be furnished for the exhaust outlet.

Vendor shall include elbow, flanges, straight pipes, rain traps, drain plugs and rain cover to provide a complete system, stated in data sheet.

Vendor shall advise the exhaust gas temperature in his proposal.

All exhaust pipes and other hot surfaces shall be lagged or otherwise shielded for personnel protection.

Air intake and exhaust systems shall be supplied complete with supporting stands for outdoor installation and interconnecting pipe work from engine with necessary support plates.

9.6 ENGINE'S PROTECTIVE AND MEASURING DEVICES

Engine's protection devices shall include the following:

- (a) Over speed trip
- (b) Cooling water high temperature alarm and trip
- (c) Lube oil low pressure alarm and trip

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- (d) Lube oil low/high temperature alarm and trip

Engine indicating instruments shall include the following:

- (a) Water temperature
- (b) Oil temperature
- (c) Oil pressure
- (d) Speed (tachometer)
- (e) Battery charger ammeter
- (f) Hours run counter (5 digits minimum)
- (g) Alarm/trip indicator lamps
- (h) Low battery voltage indicator lamp

These instruments shall be mounted on a local engine panel located near the generator set. A 'start/stop' pushbutton shall be included on the local engine panel.

The torsion vibration of engine shall be limited to the requirements of ISO 3046.

9.7 EXHAUST SYSTEM

Exhaust stack shall be separate for each set. The height of the stack shall conform to the requirements of central pollution control board (CPCB). Sampling points shall be provided as required.

The design of the stack shall be taken into account maximum wind velocity and shall be subject to approval of the owner. The stack shall be galvanized both inside and outside to retard corrosion. The thickness of aluminization shall not be less than 150 microns. The agency carrying out installation shall be subject to approval of the owner.

All tools and tackles used for the erection shall have valid safety certification. Design and engineering of support structure for exhaust pipes shall form the responsibility of DG vender and shall be certified by the structural EPCC Contractor.

10.0 ELECTRICAL REQUIREMENTS

10.1 LOCATION

Details of the location and climatic conditions are as indicated in electrical design basis.

Unit control panel, station control panels and other auxiliary panels will be housed inside the air conditioned generator control rooms.

10.2 DESIGN

Design and installation of all electrical components shall comply with the project specification. Electric motors shall comply with FGGS-BJN-ELE-SPC-6005. Wiring shall meet the requirements of IEC 60364.

All equipment required to be certified for use in a hazardous area shall be IEC certified Ex 'd'. Where equipment approval is by others, it shall be the responsibility of the VENDOR to prove that the Certification Authority is acceptable to IEC.

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Cables shall be rated at the required voltage with a minimum of 1.1 kV. Conductors shall be copper.

The minimum cable core sizes shall be 1.5 mm sq. stranded for control and 2.5 mm sq. stranded for power.

10.3 SAFETY

Unless noted otherwise, all electrical equipment mounted on skid shall be certified for operation in a Class 1 Zone 2, IIB, T3 hazardous area.

All moving equipment shall be fitted with rigid metal guards for personnel protection.

Asbestos material will not be acceptable for any item of the equipment and the vendor shall propose suitable alternatives.

10.4 UTILITIES

The utilities normally available on site are listed in the relevant Data Sheets

VENDOR shall provide a summary of utility consumption rates.

11.0 SKID ASSEMBLY

Modular Design: For units which can be modularized, the skid shall be self-containing, shall be pre-fabricated and assembled in the standard size of containers, transported in containers and placed at site on concrete foundation. Modularization is to achieve minimum fabrication/ construction job at site.

11.1 LAYOUT

Equipment and components shall be set out on the skid in a neat, orderly manner such that interconnections comply with good engineering practice whilst permitting access for operating and maintenance activities.

As part of the work scope the VENDOR shall review the purchaser's overall installation design with respect to equipment location, placement of auxiliaries and accessibility.

11.2 AUXILIARY PIPING AND VALVES

Auxiliary piping systems shall comply with the standard requirements. Copper, copper alloy, zinc alloy or aluminium components shall not be supplied. Cast iron components shall not be used in systems containing hazardous or toxic fluids.

11.3 REMOTE MOUNTED EQUIPMENT

Equipment as required shall be mounted remote from the main equipment skid. This may include fuel treatment equipment, exhaust silencer and unit control panel.

VENDOR shall design all remote mounted items and their interfaces with on-skid systems. Limitations regarding mounting positions and interconnection requirements shall be highlighted in the vendor data and drawings

12.0 DESIGN CRITERIA

Diesel Generator shall operate in emergency/blackstart, so DG should operate without injurious heating at the rated KVA.

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Diesel Generator sets shall be capable of delivering the rated current at a voltage equal to 110 percent of the rated voltage without out exceeding the limiting temperature rise. Load test will be witnessed by owner before dispatch at manufacturer's works.

Unless otherwise specified, the equipment shall be designed for operation at a frequency of 50 Hz. Unless otherwise stated, the set shall be capable of operating continuously, in accordance with the applicable standard loading guide at their kVA.

Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminal bushings or other auxiliary equipment shall apply.

Care shall be taken to ensure that the design and manufacture of the equipment shall be such as to reduce noise and vibration. The supplier shall ensure that the noise level shall not be more than specified in the standards.

The equipment shall be designed with particular attention to the suppression of harmonic voltage, especially the third and fifth, so as to eliminate wave form distortion and form any possibility of high frequency disturbances reaching such a magnitude as to cause interference with communication system.

All rated quantities subject to the supplier's guarantees shall be within in the tolerances given in applicable standards.

13.0 ALTERNATOR

The Alternator shall be of Rated KVA output at 0.8 power factor and suitable for 3 phase, 4 wire, 415 volts, 50 Hz system rated confirming to IS 13364 -2.

The Alternator shall be of brushless type self-excited, self-regulated, provided with auto voltage regulator and fitted with static excitation unit. Band of voltage regulation shall be +/- 2% of rated voltage from no load to full load.

The Alternator shall be self-cooled fully tropicalized, screen protected, drip proof construction with insulation class 'H/H'. The terminal box shall be of detachable type and suitable for cable termination.

Auto voltage Regulator – AVR shall be suitable for independent running and parallel operation.

Stator core - Stator core shall be built up of silicon steel laminations compressed hydraulically and rigidly supported by either case iron or steel end rings. The core shall be designed for a minimum reactance, low voltage wave form distortion and maximum efficiency stator coils shall be wound with synthetic enamel coated copper wires and main slot insulation shall be of tropicalized mica or leather old. End windings shall be taped with fiber glass tape and the complete windings are impregnated with varnish and spray finished with moisture protection varnish. Otherwise, 100% epoxy impregnation with an overcoat of resilient insulating material shall be carried out.

13.1 END FRAMES

End frames shall be of well ribbed cast iron /fabricated sheet steel design. The end frames shall be spigot Ted to the stator frame and secured by easily available set

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screws dowels. Ventilation openings shall be cast into the vertical and bottom side faces which shall be screen protected and drip proof.

13.1.1 Bearings

The bearings shall be of heavy duty pre lubricated cartridge design, ball or roller bearings. Single / Double bearing alternators shall have self-aligning ball or roller bearings. The end frames of the rotor shall be removable (from stator) without disturbing the bearings.

13.1.2 The Rotor

Rotor shaft shall be turned either from a high tensile MS bar or from a MS forging. Field coils shall be wound with synthetic enamel covered or varnish bonded and glass covered copper strips of high conductivity. Poles shall be of bolt-up type made of sheet steel of high permeability. The insulation between the pole and coil shall comprise of varnished fiber glass cloth backed mica around the body and thick insulating washers on the top and bottom of the coil. Coils shall be impregnated with resin and the complete rotor is spray finished with a moisture protection varnish suitable for tropical Conditions. However, 100% epoxy impregnation and an overcoat of resilient insulating material shall be preferable.

13.1.3 Damper windings

Damper windings shall be provided to assist parallel operation of alternators. The damper bars of copper brazed to heavy copper and connectors shall be located in a semi-closed circular slots situated in the pole faces.

13.1.4 Ventilation

Axial ventilation shall be employed.

13.1.5 Terminals

Terminals shall be housed in a suitable cast iron box fixed on to the stator frame. The terminals shall have ample clearance between phases and between phases to earth and shall be readily accessible. The terminals shall be suitable for connection of cables suitable for KVA.

13.1.6 Temperature rise

The alternator shall be suitable for ambient temperature of 40° C and shall be capable of withstanding 10% over load for one hour continuously. Temperature sensors to be provided for measuring the bearing temp (BTD). rise and winding temp. rise as per IS 2848.

13.1.7 Brushless Exciter – Voltage Regulators

The exciter shall be overhung, rotating type without any bearings. Exciter of semiconductor type to be provided. Solid-state voltage regulator with all accessories and relays shall be provided for proper voltage regulation.

13.1.8 Balancing

The alternator rotating parts shall be dynamically balanced to 10 micron level to ensure smooth vibration free running.

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14.0 DIESEL ENGINE

Diesel Engine shall be of heavy duty robust construction, suitable for Prime duty. Engine shall be of enclosed construction and engine case shall be made of grey iron castings. The cylinder heads shall be of cast iron (Tensile strength of 35000 PSI) and shall accommodate one suction valve, one exhaust valve, one injection valve and one safety valve etc., (For each cylinder head). Pistons shall be of cast aluminium and shall be provided with adequate number of sealing rings and scraping rings. The big and small ends shall be fitted with bearings.

Direct injection "Diesel Engine of suitable BHP, turbo charged, Air cooled, 4 stroke multi cylinder vertical in line, suitable for cold weather starting, heavy duty industrial design continuous rating, low noise, with 10% Over Loading for one hour in any 12 Hours continuous operation in standard operating conditions. The engine should be able to take 100% load without duration up to 50° C ambient temperature and the accessories as specified mounted on a common base frame, suitable for erection on AVMs.

The diesel engine shall be provided with the following:-

Electronic governor with all accessories suitable for parallel operation.

Lubricating oil distribution arrangements shall be of force feed type with gear pump, oil pan, oil filters and high pressure relief valve and lubricating oil cooler.

Fuel injection system comprising of a common fuel pump for all cylinders with fuel pumps for individual cylinder with filters etc.

Starting system of 24 V DC electric motor operated by battery (gel type electrolyte).

Cooling water pump with high water temperature safety trip and thermostat to keep the temperature of the water in the engine at all loads around 85° C.

Air cleaner dry type/oil bath filter with suction pipe.

Exhaust pipe with flexible coupling (flanged type) with necessary flanges, "B" class pipe glass wool insulation of density not less than 46Kg/Sq.m with aluminum sheet cladding and industrial/residential silencer as mentioned in data sheet.

Radiator Cooled Fan.

Engine speed adjusting /stopping lever.

Sensors for safety alarm and trips like over temperature, low lube oil pressure, over speed etc.

Suitable 'stop' device to stop the engine in case of any of the controlled variables exceed the upper or lower limit

(Temperature of cooling water and lubricant oil and pressures of lubricant oil).

15.0 COMMAND CONTROL PANEL

The Control Panel is a microprocessor-based module for monitoring, metering and control system.

The Controller offers integrated electronic governor and integrated AVR controllers. The advantages are fewer components, faster response time, high reliability, better

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serviceability and minimal wiring. The programmable starting eliminates human intervention and remote starting. The Controller can be used in both Full-Authority Engines (FAE) and hydro mechanical engines. The control panel shall be designed and tested to perform in the harsh environmental conditions typical of oil and gas applications.

Features

- 320x240-pixel graphic LED-backlit LCD
- Multiple-language support
- Automatic digital frequency synchronization and voltage matching
- Isochronous load sharing
- Droop kW and kVAR control
- Real-time clock for fault and event time-stamping
- MODULE monitoring and protection
- AC bus metering and protection
- 24-V DC battery operation
- Modbus/relevant protocol interface for interconnecting to customer equipment
- Comprehensive warranty

15.1 CONTROL MODULE

The Control Module is suitable for use on paralleling applications and is compatible with Permanent Magnet Generator (PMG) excitation style. Power for the panel is derived from the starting batteries.

Features

- Digital voltage regulation – includes three-phase full-wave Field Effect Transistor (FET)-type regulator compatible with PMG systems
- Full-authority engine communications (where applicable) provide communication and control with the Engine
- Control Module (ECM)
- Status monitoring of all critical engine and alternator functions
- Sync check – has adjustments for phase angle window, voltage window, frequency window and time delay
- Advance serviceability – using In Power, PC-based software service tool
- Environmental protection – designed for reliable operation in harsh environments; the main control board is fully encapsulated to protect it from the elements

15.2 ALTERNATOR CONTROL

The control includes an integrated three-phase line-to-line sensing voltage regulation system that is compatible with PMG excitation systems. The voltage regulation system is a three-phase full-wave rectified and has FET output for good motor starting capability. Major system features include:

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Digital Output Voltage Regulation – Capable of regulating output voltage to within +/-1% for any load, from no load to full load. Voltage drift will not exceed +/-1.5% for a 40°C (104°F) change in temperature in an eight-hour period.

On engine starting or sudden load acceptance, voltage is controlled to a maximum of 5% overshoot over nominal level. The automatic voltage regulator feature can be disabled to allow the use of an external voltage regulator.

15.3 PARALLELING FUNCTIONS

First Start Sensor System – The First Start Sensor system is a communication system among the MODULEs that allows them to work together to determine which MODULE in a system should be the first to close to the bus.

Synchronizing – Power Command incorporates a digital synchronizing function to force the MODULE to match the frequency, phase and voltage of another source. The synchronizer includes provisions to provide proper operation, even with highly distorted bus voltage waveforms. The synchronizer can match other sources over a range of 60 percent to 110 percent of nominal voltage and -24 to +6 Hz.

Load-Sharing Control – The MODULE control includes an integrated load-sharing control system for both real (kW) and reactive (kVAR) loads when the MODULE(s) are operating on an isolated bus. The control system determines kW load on the engine and kVAR load on the alternator as a percentage of MODULE capacity and then regulates fuel and excitation systems to maintain system and MODULE at the same percent of load without impacting voltage or frequency regulation. The control can also be configured for operation in droop mode for kW or kVAR load-sharing.

MODULE Metering – The control provides comprehensive three-phase AC metering functions, including: three-phase voltage (line-to-line and line-neutral) and current, frequency, phase rotation, individual phase and totalized values of kW, kVAR, kVA and power factor; totalized positive and negative kW hours, kVAR-hours and kVA-hours; and a three-wire or four-wire voltage connection with direct sensing of voltages upto 600V.

15.4 COMMUNICATIONS CONNECTIONS

PC Tool Interface – An RS-485 communication port allows the control to communicate with a personal computer running In Power software.

Modbus RS-485 Port – Allows the control to communicate with external devices such as Programmable Logic Controllers (PLCs) using Modbus protocol. (Note: An RS-232- or USB-to RS-485 converter is required for communication between PC and control.)

15.5 POWER COMMAND

This control panel includes an intuitive operator interface panel that allows complete MODULE control as well as system metering, fault annunciation, configuration and diagnostics. The interface includes five MODULE status LED lamps with both internationally accepted symbols and English text, to accommodate customer needs. The interface also includes an LED-backlit LCD display with tactile feel-soft switches for easy operation and screen navigation. It is configurable for units of measurement and has adjustable screen contrast and brightness.

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Features

LED indicating lamps

- MODULE running
- Remote start
- Not in auto
- Shutdown
- Warning
- Auto
- Manual and stop
- Circuit breaker open (if equipped)
- Circuit breaker closed (if equipped)

16.0 BASE & MOUNTING

16.1 COMMON BASE FRAME

The engine and alternator shall be coupled with flexible coupling aligned and mounted on a sturdily fabricated, welded construction and properly machined base frame made of high quality MS channels of cross section not less than 6mm thick and the recommended size by the engine manufacturer. The base frame shall be provided with lifting legs and foundation bolt holes suitable for permanent installation on anti-vibration mountings. Two separate earthing studs shall be provided for earthing the set with 2runs of suitable size GI strip.

16.2 MOUNTING

The set shall be mounted on anti-vibration mounts/pads. The bidder to indicate complete details with offer regarding weight of the total set etc. and mounting details and general arrangement details of the set.

17.0 EXCITATION SYSTEM

The generator shall be provided with brushless type solid-state self - excitation system with automatic voltage regulator. The excitation system shall include the automatic voltage regulator, AC exciter and rotary rectifier.

All components shall be mounted considering the effects of the centrifugal forces.

Automatic solid state voltage regulator shall be provided with the following features as a minimum

Short circuit protection

Manual voltage control

Voltage build up circuitry

Test mode

This shall be effective in Auto position of Auto / Manual selector button of AMF Relay located in command center control panel. The generator set shall normally be at rest. Upon failure of normal supply, an impulse shall be extended from Main LT panel 'LVM'

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equipment. Upon receipt of this impulse, generator set shall start automatically and rated speed and voltage shall be built up.

All accessories required for starting and completion of various sequence of operation for the above purpose shall be provided as a part of DG set.

Immediately after this, the power command control panel shall extend an impulse for closing generator breaker and necessary interlocking through PLC with EB breaker in Main LT Panel.

17.1 MANUAL START IN SERVICE MODE

This shall be effective in manual position of Auto / Manual Button of AMF Relay and service position of service / test selector switch located in control panel. The scheme of operation shall be same as of auto mode as above except that starting impulse shall be extended manually through the push button either in local control panel or DG Breaker Panel.

17.2 TEST MODE

This shall be effective in test position of service / test selector switch. The scheme of operation shall be same as that of manual start in service mode as above except that the closing impulse for generator breaker shall not be extended automatically.

17.3 SHUT-DOWN

Unless otherwise specified, stopping the generator set in all cases for a normal shut down shall only be done manually by means of push button in either local control panel or DG Breaker panel.

In case of any Emergency Stop Push Button Mushroom head type shall be located on the DG acoustic enclosure for local control / DG Breaker panel.

17.4 STARTING TIME

The total time from the receipt of the starting impulse for the generator set till reaches rated speed and generator reaches rated voltage shall not be more than 60 seconds. If this time is exceeded, an annunciation in the local control panel shall be provided with a facility for repeat annunciation in DG Breaker panel.

18.0 ACOUSTIC ENCLOSURE (Self Contained DG Set)

18.1 SCOPE

Supply and erection of Acoustic Enclosure for DG. The enclosure shall be suitable for outdoor installation to withstand the weather conditions mentioned.

18.2 CONSTRUCTION FEATURES

The construction and design of the Acoustic panels shall be very rugged, durable and shall be virtually maintenance free. The external body of the enclosure shall be made out of 16 SWG CRCA sheets bent/fabricated as per the required sizes for better performance, providing rust proof red-oxide and two coats of enamel paint; the colour scheme shall be approved by the OWNER. A glass window with 6 mm thick glass with frame shall be provided on either side to inspect the DG during running. Inner panels shall be made of 24 SWG GI sheets with 3 - 4mm perforation to allow noise to be

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absorbed by mineral wool. RP tissue shall be provided between perforated sheet and the mineral wool to prevent slipping of the mineral wool due to vibration. Silver colour paint shall be provided over perforated sheets to give better and final finish. The acoustic panels shall be filled with a special grade high-density mineral wool 150mm thick of density 64Kg/m³ retained by perforated GI sheets specially designed for optimum sound attenuation.

All structural members such as angles / channels used in the construction of the enclosure frame shall be of TISCO / SAIL make only. All materials used for Acoustic treatment shall be fire resistant / fire retardant grade. The sheet steel treatment shall consist of degreasing, de rusting and phosphating followed by two coats of zinc chromate primer, followed by two coats of Zinpholite surface for superior corrosion resistance and two coats of finish paint. For effective Acoustic sealing, necessary gasketing material shall be provided. All hardware and fittings used shall be passivated with zinc.

The enclosure shall be suitable for rated DG set with an air inflow suitable for aspiration of the engine to ensure engine develop rated output & also ensure that the temperature inside the DG enclosure is within the specified limits. Necessary air intake exhaust fans of suitable capacity & numbers shall be provided if the static of the engine radiator fan is not adequate to generate the required airflow.

Necessary intake & exhaust louvers of adequate size with acoustic treatment shall be provided.

18.3 PERFORMANCE

With the above treatment, the sound pressure levels when measured at a distance of 1mtr outside the DG enclosure louvers shall be as per CPCB norms. The enclosure shall be provided with suction fans to ensure that the adequate cooling and combustion air is made available to the engine and the temperature within the enclosure is limited to 5°C above ambient. The fan shall be designed with sufficient static to draw the requisite quality of air from the louvers provided for this purpose.

Calculations shall be furnished to prove the adequacy of the ventilation system offered. With the installation of the acoustic system, there shall not be any derating of the DG set. The maximum temperature of oil and water shall not exceed the limits prescribed by the manufacturer of the engine. The DG set shall give rated output continuously.

18.4 NOTES

- The above noise level is defined with all background ambient noise levels from any other source being less than as per CPCB norms so as not to influence this noise level.
- The section of the exhaust piping within the enclosure from the engine exhaust manifold onwards upto and including the Residential silencer, must be adequately cladded with thermal insulation to limit surface temperature as also reduce noise level to as per CPCB norms for DG set.
- Test report / certificate to be submitted for the noise level at OEM facility testing. I.e. before being dispatched to site or before installation at the vendor facility.

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- The scope shall include design and installation of efficient acoustic treatment to the D.G set in such a manner that the sound insertion loss shall be as per CPCB prescribed norms applicable presently.
- As such it is planned to install fresh air sound attenuators through which fresh air is drawn by means of the fans of the DG sets and the propeller type exhaust fans. The exhaust from the radiator will be through the radiator attenuators. It is planned to install fresh air openings with louver boxes for intake of cool air in to the room to maintain room temperature. Supporting fresh air fans are provided with attenuators. The entire wall of the room is acoustically treated with 100mm thick insulated panels. There will be suspended ceiling with acoustically treated panels. It is required that the pipe, duct opening has to be thoroughly sealed. The fresh air / exhaust fan attenuator and the radiator exhaust / fresh air attenuator shall be provided with aluminium powder coated louvers to prevent water entry into the same.
- Civil works such as opening in the walls, foundation works will be provided by the OWNER. However, MS frame work for the fans and attenuators as per the drawings will be in the scope of the contractor.
- Wiring for the exhaust fans will be done by others.
- The successful contractor has to ensure that the entire job is done in a good workmanship manner and the work not complying to the specifications and quality will be rejected by the EPCC Contractor / OWNER
- The Tenderer shall have the facility for good sheet metal fabrication of their works and shall have done similar works earlier.
- The contractor has to depute a qualified site engineer for the site meetings to receive instructions from the OWNER / EPCC Contractor or as and when required.

18.5 SHEET METAL WORK

All ducts shall be fabricated from galvanized sheet steel conforming to IS: 277. The coating of zinc shall be as per norms. Flanges and stiffeners used in duct sections shall be rolled steel angles. All nuts, bolts and washers shall be of zinc plated steel and all rivets shall be galvanized or made of aluminum alloy. Self-tapping screws need not be used. Gaskets shall be of 3 mm neoprene rubber and shall be leak proof.

Only new, clean and bright sheets without water marks shall be used. The owner reserve the right to reject the sheets not meeting the requirements.

18.5.1 Rectangular Ducting Insulation Work

- The scope of this section comprises supply and application of insulation for attenuators and the wall panels.
- Resin bonded fiber mat is used for insulating the attenuators and the panels and shall have a density not less than 24 kg/cum and a thermal conductivity not greater than 0.029 k-cal hr/sq.m/deg.c/m at 20 deg. C. Fiber glass shall be in the form of blankets. Alternatively rock wool of density 64 kg/cum. shall be used.

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- The EPCC Contractor / OWNER or their authorized representatives reserve the right to peruse the weights, dimensions etc. of the insulation material supplied. Samples of all insulation material specified in various forms shall be submitted by the successful contractor. The OWNER / EPCC Contractor shall have the right to reject all supplies which do not conform to the specifications and to the samples approved.

18.5.2 Sound Attenuator

The attenuator louver shall be fabricated using 20G (1 mm) thick galvanized perforated steel sheet as per the sizes indicated. The flanges / box sections shall be fabricated out of 50 x 50 x 3 mm thick MS angles or tubular sections as preferred. The attenuator duct and the angle frame shall be treated with zinc chromate primer and painted with two coats of approved synthetic enamel paint. The attenuator leaves shall be fabricated using GI sheet of 20G. The 100 mm thick leaves shall be packed with 2 layers of 50mm thick fiber glass of density 24 kg/cum or rock wool of 64 kg/cum density. The insulation shall be covered with RP tissue and sandwiched between 1 mm thick GI perforated sheets. The sheet shall have minimum 20% free area. The spacing of the leaves shall be as required and shall be rigidly supported. Whenever the height exceeds 1500 mm intermediate support has to be provided at the middle. The attenuator leaves shall also be in two layers and the height of each attenuator leaf shall not exceed 1500mm. The duct casing shall not be fabricated using multiple sheet joints. The sound attenuator shall be factory fabricated and shall be offered for inspection to the Owner prior to the site.

18.6 PROPELLER FANS

Propeller fans shall have MS power coated or epoxy coated diaphragm. The Ventilation ducting thickness should be minimum of 20 SWG. The impellers shall be die cast aluminium or MS powder coated with adequate gauge sheet.

The fan shall be statically and dynamically balanced. The fan shall be suitable for mounting vertically and should withstand higher temperatures. The fan shall be suitable for 1 or 3 phase operation. One No. Standby fan shall also be provided.

Tenderers are required to quote strictly as per the bill of quantities. The quoted price shall include freight, installation, charges, taxes and duties as applicable.

Technical Data

The Tenderer shall fill in the following technical data:

Make of propeller fans :

Diameter (mm) :

Speed in RPM :

Power in watts :

Whether single / three phase :

Make of fiber glass :

Density kg/cum :

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Thermal conductivity :

Make of GI sheet :

Class of GI sheet :

No. of Fans – Working :

No. of Fans – Standby :

18.7 DIMENSIONS

The overall dimensions of the enclosure shall be such as to provide free movement all-round the DG set inside the enclosure. Two sliding doors of adequate size shall be provided on either side of the DG set to facilitate easy inspection and carryout maintenance works.

19.0 INSTALLATION

The bidder shall undertake the installation work at site. The general scope of installation work shall include but not be limited to the following.

19.1 DIESEL GENERATOR SET

- The assembled Diesel Generator set shall be installed in the acoustic enclosure on anti- vibration mounts. The unit shall be visually inspected for any transit damage.
- The contractor shall arrange for the inspection of the set by the diesel engine manufacturer's authorized representative and obtain his approval before rolling the DG.
- The fuel oil day tank shall be installed over the drip tray at the location indicated.
- The batteries shall be fully charged, installed and connected.
- The battery charger shall be heavy duty.

19.2 FUEL PIPING

- The fuel piping shall include supply and installation of Class "C" MS pipes of adequate size with necessary valves and accessories required for the supply & return lines from day tank to the engines. The pipes shall be painted with primer over which 2 coats approved colour paint shall be applied.
- The joints in the line shall be properly sealed to avoid any leakage of fuel.

19.3 ELECTRICAL INSTALLATION

- The electrical power cabling from alternator to the panel will be carried out by electrical contractor. However the DG control cabling from the DG to the Main Panel will be carried out by the Electrical Contractor based on the details provided by the DG vendor.
- The contractor shall appoint an experienced full time engineer throughout the installation period till the set is handed over.

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- c) Overall responsibility of commissioning the DG sets with DG Breaker panel above alternator & earthing lies with the DG vendor. DG vendor to check all the electrical works carried out by Electrical Contractor related to the DG sets for the proper functioning of the DG sets.

20.0 TOOLS AND SPARE PARTS

The Vendor shall supply a set of any special tools necessary for commissioning and maintenance purposes. The Vendor shall also include any recommended spare parts for commissioning.

All spare parts shall comply with the same standards, specifications and tests of the original equipment and shall be fully interchangeable with the original parts without any modifications at the site.

The spare parts shall be correctly marked in accordance with the OWNER's Spare parts Lists and Interchangeability Record giving the purchase order number and be preserved to prevent deterioration during shipment and storage in humid tropical climates. Spare parts shall be guaranteed to be supplied by the Vendor during the life of the equipment covered by the purchase order.

The OWNER's Spare Parts List and Interchangeability Record form (SPIR form attached) shall be filled in completely.

21.0 PAINTING

All surfaces to be painted shall be done in compliance with Specification for Painting FGGS-BJN-PIP-SPC-5004.

Sufficient paint for touch up shall be sent to site.

22.0 INSPECTION & TESTING

22.1 INSPECTION

The generating set shall be subject to inspection by the OWNER, or their appointed representative at any stage of manufacture, testing or preparation for shipment.

Approval by any of the above inspectors shall not relieve the manufacturer of his commitments under the terms of the purchase order and this specification.

22.2 TESTING

22.2.1 At Manufacturer's Works

The routine tests and full load test on Engine, Alternator shall be carried out at manufacturer's work in accordance with applicable Indian standards and test certificates shall be submitted in triplicate.

22.2.2 Testing at 'OEA's Works

The purchaser or his authorized Representative may visit the works during manufacture of equipment to assess the progress of work as well as to ascertain that only quality raw materials are used for the same. He shall be given all assistance to carry out the inspection.

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Detailed test procedures along with the facilities available at vendor's works shall be furnished by the vendor.

22.2.3 Minimum Acceptance Tests

On completion and before handing over of the work, the following tests shall be carried out by the contractor to the entire satisfaction of the Engineer-in-Charge.

A) Phase-I Test:

- Insulation resistance test - Sectional and overall
- Continuity resistance test - Sectional and overall
- Earth resistance test
- All instruments and relays shall be tested under normal operating conditions
- Visual examination to ensure that the plant equipment and accessories are provided and the finish and
- general appearance of the work are as per contract specification
- A no load test for a period of 15 Minutes continuously to see that the engine, alternator and other
- accessories are functioning normally
- The duration of the test may be increased if necessary and as directed by the authorized representative of the EPCC Contractor / OWNER / PMC.
- All simulation tests for engine trip condition

B) Phase-II Test:

On completion of the Phase-I tests to the entire satisfaction of the authorized representative of the accepting officer. A load test shall be carried out at factory dispatch as given below.

25% Load : 1/2 hour

50% Load : 1/2 hour

75% Load : 1/2 hour

100% Load : 1 hour

110% Load : 30 minutes

All necessary arrangements for testing under artificial load conditions, such as cables, electrodes, fuels etc., shall be provided by the contractor at factory and the charge for the same is deemed to be included in the rate quoted in the schedule. However the engine shall be with the first filling of lubricating oil.

C) Tests on Alternator:

- Routine tests for alternator as per IS/IEC – 60034 -1
- Phase sequence test

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22.2.4 Site Testing

Following tests shall be conducted at site in the presence of the owner's representative before energization. The contractor shall provide all testing equipment, labour and consumables required for the testing.

- Checking the alignment by engine manufacturer's representative and obtaining approval.
- Insulation resistance test on alternator and control panel.
- Checking the AMF & Synchronization operation both on auto and manual mode.
- Checking the engine safeties for satisfactory operation.
- Checking vibration levels upto 5g.
- Testing of individual protective devices on engine and alternator and ensuring that the wiring is carried out properly.
- The guaranteed specific fuel consumption shall not exceed 150grams / BHP. HR with a tolerance of + 2.5 %. The same shall be proved during the load trial.
- The noise level at 1m from the enclosure and the temperature rise inside the enclosure shall be measured as per CPCB norms.
- Any deviation from the guaranteed parameters shall be made good and these performance parameters should be measured once again till the required results are achieved.
- The DG set shall be deemed to be commissioned after satisfactory performance of all associated equipment.

Successful conduct of the tests and after submission of performance test reports including equal load sharing like kVA, kW, kVAR when synchronized and running in parallel.

23.0 TAKING OVER

The OWNERS will take over the DG set for operation on completion of the following:

- a) DG set are installed, tested and commissioned as per the specifications.
- b) Original test certificates are furnished for engine, alternator and acoustic enclosure, centrifuge and all other bought out items.
- c) Load trials are successfully conducted including the performance of acoustic enclosure and ventilation fans.
- d) Approvals are obtained from Pollution Control Board and Electrical Inspectorate.
- e) 6 sets of As built drawings, documents, spare parts list, maintenance chart and operation and maintenance manual are to be submitted.
- f) The set shall be handed over with first fill of lube oil along with spares mentioned.

24.0 TRAINING

Minimum one week on site training to be conducted to get the maintenance team familiar with the equipment. The training shall be repeated upon buyer request with agreed terms.

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25.0 PREPARATION FOR SHIPMENT

The units shall be suitably packed and protected against all damages or defects which may occur during handling, sea shipment to the port and rough road haulage to site and extended tropical open air storage, generally fulfilling the minimum requirements set in this document and as per the Specification FGGS-BJN-MEQ-SPC-4001

All surfaces are to be thoroughly cleaned free of all rust, scale, grease, dirt and moisture before being painted. Grease and oily matter is to be removed by means of a suitable solvent.

After surface preparation as above, the engine shall be coated with a good quality red lead, or oxide type primer, unless otherwise called for.

After successful conclusion of the tests, each engine is to be thoroughly cleaned, coated with a good quality anti-rust composition and closed and re-jointed ready for service.

Adequate protection shall be provided against mechanical damage and atmospheric corrosion in transit.

All equipment shall be packed, securely anchored (skid-mounted when required) and Weather-protected for the shipment. Separate, loose items and all spare parts shall be completely boxed. All pieces of equipment and spare parts shall be identified by OWNER 's item number and service, and marked as specified in the purchase order on both inside of each individual package or container.

Exposed finished and machined surfaces, including bolting, shall be given a heavy coating of rust inhibiting compound. Internal metal surfaces shall be sprayed or coated with a suitable rust preventative. All openings shall be suitably tagged to indicate the type of rust preventative applied.

Bearing, bearing housings, and oil systems including reservoirs, coolers, filters, and piping shall be thoroughly cleaned of metal particles, dirt and debris, and coated with a suitable rust preventative. All openings shall be suitably tagged to indicate the type of rust preventative applied.

Solid steel plugs shall be used instead of plastic plugs for any part that is pressurized during start-up or operation.

All flanged openings shall be protected with metal cover plates to prevent damage during shipment. Covers shall be a minimum of ¼" thick and shall be installed with a suitable gasket using a minimum of four (4) full diameter bolts. Larger diameter flanges will require enough full diameter bolts to seat the cover all around. The cover and flange shall be taped for waterproof protection.

Bracing, supports and rigging connections shall be provided to prevent damage during shipment, lifting or unloading.

One complete set of the Installation, Operation, and Maintenance instructions shall be packed in the boxes or crates with the equipment.

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26.0 GUARANTEE

The equipment is to be guaranteed without qualifications and for satisfactory application in every other respect to the operating conditions specified. The Vendor will further guarantee the equipment furnished by him against defective design.

materials and workmanship for a period of one year after being put into regular operation, total period not to extend 18 months from date of shipment and will promptly repair or replace, without cost to the OWNER any defective part, or parts.

All parts of packages and equipment supplied by sub-suppliers shall also be guaranteed by the Vendor.

27.0 WARRANTY

The VENDOR shall warrant all equipment, accessories and parts furnished with the engine-generator package. The complete package and all components must have a minimum warranty period of 1 year, commencing from date of acceptance.

The Vendor shall include warranty statement in his quote.

If any performance deficiencies or defects occur during warranty period, The Vendor shall take all the necessary immediate action to alter, repair and replace free of charge the defective parts.

Upon commissioning of generator, vendor shall provide contact telephone number and mobile number of the service engineer who shall be responsible for answering any queries raised by buyer field personnel during any time of day/night. Vendors shall be responsible to attend the major defects and deficiencies within no more than 48 hours.

28.0 DRAWINGS AND DATA REQUIREMENT

The Vendor shall provide the OWNER with the following drawings and data in English at no additional cost with Quotation of 4 sets:

- Complete technical Vendor's products catalogues
- Comprehensive catalogues, technical data, dimensional outline drawings, proposed test procedure, service facilities, etc. of the equipment offered and its various components.
- Preliminary connection and wiring diagrams, dimensional and cross sectional drawings, control system diagram.
- Declaration of confirmation with the set standards and/or clear indication of deviations from the standards and this specification.
- Vendor's design calculation, necessary documents and/or data for the calculation of the power output of the engine in respect to the site and climatic condition detailed in data sheet.
- Performance curve showing torque, fuel consumption, engine speed and power output.
- Recommended commissioning and 2 years running consumable and spare parts separately listed, numbered, referenced and duly priced.

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- Shipping dimensions (length, width and height) and weight with shipping schedules.
- Tabulation of all connections to which OWNER connections, giving size, rating, facing etc.
- Scheme of fuel circuit.
- Scheme of lube oil circuit.
- Scheme of starting system.
- Scheme of cooling water system.

Immediately following the placing of order (not later than 60 days) 5 sets of the following shall be provided:

- Piping, wiring, control system diagram and dimensional outline drawings, dimensional outlines of all accessories of various connections details for OWNER's approval.
- Foundation plan/anchor bolts location weight of all components shown on drawing, weight of the heaviest piece for maintenance, and support drawing of intake and exhaust system
- Proposed tests procedure for OWNER's approval.
- Prints of certified drawings as well as agreed and approved test procedure and reports of all tests carried out on the equipment.
- Component list with manufacturer, model and technical characteristic specified.
- Local panel dimensions and cutouts, with interconnection details.
- Single line and wiring diagrams of control and electrical panels (as applicable) with indication of characteristic of control alarms and shutdown devices.

At least 90 Days prior to delivery of each unit, Manuals of Installation, Operation and Maintenance shall be provided. The Manuals shall consist of the following minimum sets:

- Codes and standards compliance certificates.
- Final connection and wiring diagrams.
- Cable list and layout.
- Panel's layout, wiring, connections and interconnections.
- Auxiliary system schematics.
- Factory test certificates, including test data and calculated results.
- Illustrated and numbered parts list and two years running spare parts list final revision. (Refer to the attached Spare parts List and Interchangeability of Records).
- One set of reproduction of all civil, mechanical, control and electrical drawings with "As Built" marks shall be supplied by Vendor.

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29.0 FACTORY ACCEPTANCE TEST (FAT)

Factory Acceptance Test (FAT) shall be provided for representatives assigned by the OWNER pursuing to confirm compliance of AFL system products with international standards such as the minimum recommended practices of ICAO.

30.0 LABELLING

A stainless steel nameplate must be provided for each piece of equipment. The nameplate shall have at least the following information:

Equipment Identification No:

Order No.: Order Placed By:

Manufacturer's Name:

Type and Size: Serial No:

Bore and Stroke, mm:

Rated, KW: R.P.M:

Firing Order:

Weights - Total Net Wt. Equipment: kg

Base plate: kg

Heaviest Removable Component: kg

For Overhaul: kg

Manufacturers may add the data required to their standard plates provided that they are made from the above mentioned material. The data called for must be legibly stamped or preferably engraved on the plate which shall be fixed to an accessible part of the equipment. The nameplate shall be securely fixed to the equipment, but the method of fixing shall not involve drilling into the wall of a pressure part

31.0 OPERATIONS INSTRUCTION AND MAINTENANCE MANUAL

Vendor shall provide Operating Instructions and Maintenance Manual in accordance with attached General Specification for Operating Manuals and Data Books.

Vendor shall also be responsible for providing manuals and other training aids such as videos for operator training.

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SPECIFICATION FOR HOT INSULATION

REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT
0	Issued for ITB	19-06-19	AW	RD	KPM	
A	Issued for Review/Approval	09-04-19	AF	RD	KPM	

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1.0 SCOPE

1.1 General

- 1.1.1** This Specification covers design and material requirements for above ground, external insulation of piping and equipment operating between Ambient Temperature and 600°C, for the purpose of Heat Conservation, Process Stabilisation, Temperature Maintenance, Acoustic Attenuation, Personnel and Fire Protection.
- 1.1.2** The insulation requirements of this Specification are suitable for use in both indoor and outdoor service with normal process plant atmospheres. Alternative designs and materials shall be considered if necessary for highly corrosive atmospheres or potential leaks and spills of chemicals.
- 1.1.3** All codes and standards mentioned in this specification shall be of latest issue.
- 1.1.4** This specification does not cover Cold service insulation.
- 1.1.5** This Specification does not cover Vendor designed insulation for Boiler or Fired Heater packages including Air heaters, Economisers, Gas Flues and Air Ducting.
- 1.1.6** This Specification does not cover Daily Service Tanks, Process or Large Product Storage Tankage nor insulated underground lines.
- 1.1.7** Piping, equipment, storage tanks and vessels requiring insulation shall be specified on the following project documents:-
1. Process & Instrumentation Diagrams (P&IDs) and Line Lists.
 2. Piping General Arrangements and Isometrics.
 3. Instrument Piping Details
 4. Project Specific Vessel and Exchanger Drawings
 5. Equipment Suppliers General Arrangement Drawings for equipment items.

2.0 REFERENCE STANDARDS

2.1 International Standards

API 521	Pressure-relieving and De-pressuring Systems
ASTM B209	Standard Specification for Aluminium and Aluminium-Alloy Sheet and Plate
ASTM C547	Mineral Fibre Preformed Pipe Insulation
ASTM C612	Mineral Fibre Block and Board Thermal Insulation

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ASTM C929	Handling, Transporting, Shipping, Storage, Receiving, And Application of Thermal Insulation Materials for use in Contact with Austenitic Stainless Steel
ASTM C692	Standard Test Method for Evaluating the Influence of Thermal Insulations on External Stress Corrosion Cracking Tendency of Austenitic Stainless Steel
BS 2972	Methods of Test for Inorganic Thermal Insulating Materials
BS 3533	Glossary of Thermal Insulation Terms
BS 3958	Thermal Insulating Materials
BS 5970	Code of Practice for Thermal Insulation of Pipe work and Equipment in the Temperature Range -100°C to +870°C
BS 5422	Method for Specifying Thermal Insulating Materials for Pipes, Tanks, Vessels, Ductwork and Equipment Operating within the Temperature Range -40°C to +700°C
OISD-STD-177	Inspection and Maintenance of Thermal Insulation
OISD-STD-111	Process Design And Operating Philosophies On Fired Process Furnace
ISO 15665	Acoustics - Acoustic insulation for pipes, valves and flanges
NFPA 58	Liquefied Petroleum Gas Code

2.2 Project Specifications:-

FGGS-BJN-PIP-SPC-5004	Specification for Painting

2.3 Definitions

- 2.3.1** 'APPLICATOR' shall be defined as the party that is responsible for installation of insulating materials.
- 2.3.2** 'MANUFACTURER' shall be defined as the party supplying the insulation, cladding or fixing materials.

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3.0 DESIGN – GENERAL

3.1 General

- 3.1.1** In this Specification, insulation for the prevention of heat loss is designed to provide economic thicknesses such that resulting cold face surface temperatures do not exceed 60°C with ambient temperature in still air conditions min. 11°C max. 42°C.
- 3.1.2** Insulation shall comprise a layer(s) of heat resisting fibre material enclosed within protective metal cladding sealed against the ingress of moisture and designed to allow differential expansion.
- 3.1.3** Internal refractory lined piping and equipment shall not be insulated. Over these areas personnel protection shall be achieved by the use of stand-off metal guards.
- 3.1.4** Insulation is not necessary for piping and equipment where heat loss is desired - other than for acoustic attenuation, personnel protection or to avoid thermal stress problems.
- 3.1.5** Personnel protection shall be achieved on surfaces having either a continuous operating temperature of 60°C to 200°C or is in intermittent service by the use of stand off metal cages, guards, shields or railings.
- 3.1.6** On surfaces with continuous operating temperatures greater than 200°C the use of insulation is acceptable. Insulation shall be designed to yield a cold face temperature of 60°C or less under ambient temperature and still air conditions.
- 3.1.7** Personnel protection for Fired Heaters shall be as per OISD 111.
- 3.1.8** The purpose for which insulation is required is identified by the applicable symbols in Table 1. Piping and Equipment to be insulated shall be identified by these symbols on P&IDs and Line Lists.
- 3.1.9** Instruments and associated piping subject to operating flow and/or temperature conditions approximating those in the piping or equipment to which they are connected, shall be insulated to the same requirements as that piping or equipment. The insulation requirements shall be classified by symbols in accordance with Table 1.
- 3.1.10** Carbon steel and low alloy piping and equipment shall be protected against corrosion by painting in accordance with Specification for painting FGGS-BJN-PIP-SPC-5004.
- 3.1.11** All insulated austenitic stainless steel piping and equipment shall be protected against external stress corrosion cracking by the application of a sacrificial aluminium foil system.
- 3.1.12** To assist corrosion prevention, insulation materials shall be of the correct chemical nature and shall include the following requirements
1. Carbon Steels - Insulation to be chemically neutral or slightly alkaline.
 2. Aluminium - Insulation to be chemically neutral or slightly acidic.
 3. Stainless Steels - Insulation shall be as free as possible of soluble chlorides (20 ppm maximum).

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4.0 DESIGN - PIPING INSULATION

4.1 General

- 4.1.1** Insulated piping systems shall have straight pipe, bends, tees and non flanged pipe fittings completely insulated.
- 4.1.2** Unless otherwise specified, all valves and flanged joints shall be completely insulated only in steam, condensate service, hot oil lines and in lines which are trace heated or jacketed to maintain temperatures.
- 4.1.3** Where insulation is used for Acoustic Attenuation, Class B and C, the system shall be completely insulated including equipment items, valves, flanged joints, pipe fittings and man ways.
- 4.1.4** For “Bucket” and “Float type” steam traps the inlet piping and trap shall be insulated.
- 4.1.5** Insulation on inlet piping to Thermostatic and Thermodynamic steam traps shall terminate a minimum of 450mm from the trap leaving the remainder of piping and the trap un-insulated.
- 4.1.6** Steam trap outlet piping shall not be insulated except for Personnel Protection considerations.
- 4.1.7** Insulation shall not be applied to the following unless otherwise specified for Acoustic Attenuation (Class B & C), Personnel Protection or other special reasons:-
1. Piping which becomes hot intermittently, such as relief valves, vents, steam-out and snuffing steam systems flare and blow down systems and by-passes at control valves.
 2. Supports for piping.
 3. Steam Traps. (Except as noted in paragraph 4.1.4/4.1.5).
 4. Valves, including control valves and flanges in process piping systems (except as noted in paragraph 4.1.2).
 5. Pipe union fittings.
 6. Thermo well bosses and pressure tapings.
 7. Expansion joints, hinged joints and hose assemblies.
 8. Sight flow indicators.
- 4.1.8** Piping shall be designed to provide an absolute minimum clearance of 25mm between the outside surface of any insulation finishing material and adjacent surfaces.
- 4.1.9** Where insulated horizontal piping is supported on steel shoes, the height of the shoe shall be such that the underside of the insulation finishing material is clear of the supporting structure upon which the shoe rests by 25mm minimum.
- 4.1.10** Vertical piping insulation shall be supported by bolted collars at intervals, (see figure 7 detail). Collars shall be supplied, fabricated and fitted by the APPLICATOR.

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5.0 DESIGN – EQUIPMENT INSULATION

5.1 General

- 5.1.1** Support skirts of insulated vertical vessels greater than 1200mm diameter shall be insulated both internally and externally for a minimum distance of 600mm below the bottom tangent line. On skirts which do not require fireproofing the insulation shall terminate not less than 300mm above the support concrete or steelwork. Where support skirts are to be fireproofed the insulation shall extend to the top of the fireproofed areas and galvanised steel finishing material shall be used to protect the area of skirt insulation below the bottom tangent line.
- 5.1.2** Support skirts of insulated vertical vessels of 1200mm diameter and less shall be insulated externally only, as described in paragraph 5.1.1 above.
- 5.1.3** Bottom heads of insulated vertical vessels fully enclosed by a support skirt shall be insulated without weatherproof cladding finishing material and shall be insulated only when the vessel outside diameter is greater than 1200mm.
- 5.1.4** Liquid ends of positive displacement pumps and casings of centrifugal pumps shall be insulated only when heat traced or covered.
- 5.1.5** Insulation shall not be applied to the following equipment unless otherwise specified for Acoustic Attenuation (Class B & C), Personnel Protection, Fire Hazard Protection or other special reasons.
1. Pumps with operating temperatures below 200°C unless pumped fluid has a pour point above minimum design ambient temperatures.
 2. Fans, compressors, blowers or other rotating or reciprocating equipment.
 3. Internally insulated or refractory lined equipment unless specially designed for metal temperature control.
 4. Heads of vessels fully enclosed by support skirts with vessel diameters 1200mm and less.
 5. Internal surfaces of fully enclosing support skirts of insulated vessels with vessel diameter 1200mm and less.
 6. Exchanger channel covers.
 7. Nozzles flanges, manholes, hand holes, and flanges of equipment.
 8. Surfaces of coolers and condensers.
 9. Nameplates on all equipment items.
 10. Thermo well bosses and pressure tapping's.
- 5.1.6** External Insulation for vessels and similar equipment shall be adequately supported or suspended, dependent on insulation material form, with clips, and support lugs, welded on at intervals around the equipment. VENDOR shall supply all clips and supports required in order to attach insulation to the Equipment.

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5.1.7 Vacuum stiffening rings on equipment shall be fully and independently insulated. The insulation finishing metal sheeting shall be sealed and allow for differential expansion. The sheeting shall be shaped to shed water.

6.0 DESIGN - TABLE 1 – INSULATION & PROTECTION SYMBOLS:-

INSULATION AND PROTECTION SYMBOL, CLASSIFICATION AND GENERAL CONDITIONS OF USE:-

SYMBOL	CLASSIFICATION	INSULATION THICKNESS TABLE NO. REF.	INSULATION THK SELECTION CONSIDERATION	NOTES
H	Heat Conservation	Table No. 3	Normal Operating temp. Of process fluid and nominal pipe size.	Each section of the Equipment having defined sections operating at different temperatures may be insulated to suit its individual temperature. For Shell and Tube Exchanger Shells and Channels use the higher of the inlet and outlet temperatures.
ST	Steam Tracing	Table No. 3	Normal Operating temp. Of process fluid and one pipe size greater than parent pipe.	Insulation where operating plant requires a protective heating system to protect piping, equipment and instruments against the effects of ambient temperatures (including hydrate formation, condensation, viscosity change and pour point suppression).
ET	Electric Tracing			
SJ	Steam Jacketing	Table No. 3	Normal Operating temp. of steam and nominal pipe size of jacket	

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DESIGN - Table 1 (continued)

**INSULATION AND PROTECTION SYMBOL, CLASSIFICATION AND
GENERAL CONDITIONS OF USE**

SYMBOL	CLASSIFICATION	INSULATION THICKNESS TABLE NO. REF.	INSULATION THK SELECTION CONSIDERATION	NOTES
FP	Fire hazard protection	Table No. 5 or special consideration but no greater than Table No.3	Special consideration	Insulate to prevent fast boil-off of liquids. Galvanised steel/stainless steel protective cladding to be used over insulation in place of standard aluminium sheet metal cladding.
PP	Personnel Protection (Insulation)	Table No. 4	Nominal pipe size and normal operating temp. Only applicable to operating Temp >200°C	Over unlined piping and equipment insulate or provide open mesh metal guards on operating plant which would normally be left un-insulated and which may be accessible during the performance of routine duties by operating (not maintenance only) personnel. SEE NOTE *
PG	Personnel Protection (Stand off metal- guard)	--	Operating in Temp <200°C	
IA - A IA - B IA - C	Acoustic attenuation for noise control at Various levels of requirement.	Table No. 6	Acoustic Category attenuation subject to Calculated insertion loss requirements.	The selected acoustic insulation symbol shall be added to any other thermal insulation symbol which applies e.g. HC A or STB or PPC etc. If no other insulation symbols are in use, acoustic symbols A, B or C shall be used alone.

NOTE* The intent of P&IDs, Line Classification lists, Insulation Summaries etc. which designate insulation for types PP and PG is to call attention only to the eligibility of such service. The actual extent of such insulation shall be determined by Field Construction Personnel and/or operating personnel using the following criteria:-

Exposed surfaces operating above 60°C and located with 600mm horizontally or 2100mm vertically of a normal access, walkway, or work area.

Pipe and Equipment designated for personnel protection ('PP' or 'PG') shall be fully painted in accordance with Project Specific Specification FGGS-BJN-PIP-SPC-5004 Specification for Painting.

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7.0 DESIGN - TABLE 2 – INSULATION, CLADDING & SECUREMENT

INSULATION AND METAL CLADDING, FORM AND SECUREMENT METHOD

ITEM	NOMINAL SIZE OF ITEM	INSULATION MATERIAL FORM	INSULATION MATERIAL SECUREMENT METHOD
Straight pipe	Up to 200 mm (8")	Preformed Pipe Sections	1.2 mm minimum diameter stainless steel tie (lacing) wire.
Straight pipe	250 mm (10") to 500mm (20")	Preformed pipe section or multi segments.	12mm wide stainless steel bands.
Straight pipe	Above 500mm (20")	Multi-segments	20mm wide stainless steel bands.
Welded valves and butt-weld tees, and reducers.	All sizes	As per straight pipe cut and shaped to fit.	As per straight pipe.
Flanged Valves, Flanged Joints	All sizes	Suitable Preformed	Prongs, studs, rivet, adhesive as necessary to secure to removable cladding.
Bends and Elbows	All sizes	As for straight pipe cut and shaped to fit.	As for straight pipe.
Equipment Heads (except bottom heads of Vertical Equipment)	All sizes	Preformed Blocks & Slabs cut and shaped to fit.	20mm wide stainless steel bands.
Equipment Shells	All sizes	Preformed pipe or Multi-pipe segments or slabs cut and shaped to fit.	20mm wide stainless steel bands
Vertical Equipment Bottom Heads without Skirt	All sizes	As for Equipment Heads	20mm wide stainless steel bands.
Vertical Equipment Bottom Heads with Skirt	All sizes over 1200mm (4ft)	As for Equipment Heads	Wire Netting and Lacing
Casings of Pumps, Turbines, Compressor etc. Manholes and Hand holes, and where required Exchanger Channels	All sizes	Preformed slabs cut to suit lining.	Prongs, stud, rivets, adhesive as necessary to secure to removable cladding.

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DESIGN Table 2 (Continued) INSULATION AND METAL CLADDING, FORM AND SECUREMENT METHOD

ITEM	INSULATION METAL CLADDING	OD OF THICKNESS OVER INSULATION	CLADDING THICKNESS	INSULATION CLADDING SECUREMENT METHOD
Straight Pipe	Flat Metal *	Up to 150mm	0.6 mm thick	12mm wide stainless steel bands.
Straight Pipe	Flat Metal *	150mm up to 450mm	0.8mm thick	12mm wide stainless steel bands.
Straight Pipe	Flat Metal *	450mm and above	1.0mm thick	12mm wide stainless steel bands.
Welded Valves and Butt-Weld Tees and Reducers	Flat Metal *	All sizes	As per straight pipe	As per straight pipe.
Flanged Valves Flanged Joints	Flat Metal * Removable Claddings	All sizes	1.0mm thick	12mm wide stainless steel bands and quick release toggle clips.
Bends and Elbows	Flat Metal * Stove pipe or pressed elbows	Up to 80mm	As for straight pipe.	As for straight pipe.
	Flat Metal * fabricated mitred elbows	80mm and larger	As for straight pipe.	Screws and rivets.
Equipment Heads (Except Bottom Heads of Vertical Equipment)	Flat Metal * 'Orange Peel' Fabrication	All sizes	1.0mm thick	Screws or rivets.
Equipment Shells	Flat Metal *	All sizes	1.0mm thick	20mm wide stainless steel bands.
Vertical Equipment Bottom Heads without skirt	Flat Metal * Fabricated to suit	All sizes	1.0mm thick	Screws or rivets
Vertical Equipment Bottom Heads With Skirt	Not required	-	-	-
Casings of Pumps, Compressors, etc, Manholes, Hand holes, and where required, Exchanger Channels	Flat Metal * sheet fabricated removable claddings.	All sizes	1.0mm thick	20mm wide stainless steel bands.

Note:- FOR FIRE HAZARD PROTECTION GALVANISED STEEL CLADDING SHALL BE USED. ALL OTHER AREAS TO BE CLAD IN ALUMINIUM SHEET.

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8.0 DESIGN - TABLE 3 – HEAT CONSERVATION

INSULATION THICKNESS FOR HEAT CONSERVATION

NOMINAL PIPE SIZE	NORMAL OPERATING TEMPERATURE (°C) AND THICKNESS (mm)										
	Upto 100	101 to 150	151 to 200	201 to 250	251 to 300	301 to 350	351 to 400	401 to 450	451 to 500	501 to 550	551 to 600
MM	THK	THK	THK	THK	THK	THK	THK	THK	THK	THK	THK
15	25	25	30	40	50	55	65	75	90	100	115
20	25	25	30	40	50	60	70	85	95	110	125
25	25	25	30	50	60	70	80	95	100	115	130
40	25	25	40	50	60	70	85	100	110	125	140
50	25	25	40	50	60	70	90	105	115	130	150
65	25	25	40	50	60	75	95	110	120	140	160
80	25	30	40	50	70	80	95	115	125	150	170
100	25	30	40	60	70	80	100	125	140	160	180
150	25	30	50	60	70	90	105	130	150	170	190
200	25	30	50	60	80	95	110	140	160	180	200
250	25	40	50	60	80	95	115	140	160	190	210
300	25	40	50	70	80	100	120	150	170	190	215
350	25	40	50	70	80	100	120	150	170	200	220
400	25	40	50	70	90	100	125	150	170	200	225
450	25	40	50	70	90	105	125	150	175	200	230
500	25	40	50	70	90	105	130	150	180	205	240
OVER 500 & FLAT	25	40	50	70	100	125	160	190	230	270	320
SINGLE LAYER						MULTI LAYER					

Design Basis: Maximum Heat Loss : 150w/m²

Ambient Temp.(max/min) : 40°C/7°C

Wind speed : 50 m/sec

Emissivity : 0.15

Density of Mineral wool preformed pipe section: 140 kg/m³

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8.1 Multi-Layer Thickness Table:-

Multi Layer shall be constructed with layer thickness as follows:

Thickness	1 st Layer	2 nd Layer	3 rd Layer
55	30	25	
60	30	30	-
65	40	25	-
70	40	30	-
75	50	25	-
80	40	40	-
85	60	25	-
90	60	30	-
95	70	25	-
100	50	50	-
105	80	25	-
110	80	30	-
115	90	25	-
120	90	30	-
125	100	25	-
130	100	30	-
140	100	40	-
150	100	50	-
160	100	30	30
170	100	40	30
175	100	50	25
180	100	50	30
185	100	60	25

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190	100	60	30
195	100	70	25
200	100	50	50
205	100	80	25
210	100	80	30
215	100	90	25
220	100	90	30
225	100	100	25
230	100	100	30
240	100	100	40
250	100	100	50
260	100	100	60
270	100	100	70

320 mm thickness shall be constructed with layer thickness: 100 + 100 + 90 + 30 mm.

9.0 DESIGN - TABLE 4 – PERSONNEL PROTECTION

INSULATION THICKNESS OVER PROCESS PIPING AND EQUIPMENT FOR PERSONNEL PROTECTION PURPOSES:-

NORMAL OPERATING TEMPERATURE (0°C) WITH STILL AIR AT 31° C TO GIVE SURFACE TEMPERATURES NO GREATER THAN 60° C.						
NOMINAL PIPE SIZE	60 to 200	201 to 300	301 to 400	401 to 500	501 to 550	550 and Over
mm	Thk	Thk	Thk	Thk	Thk	Thk
15	Personnel protection shall be by guards.	40	55	80	90	Personnel protection at elevated temperatures shall be subject to calculation
20		40	60	90	105	
25		50	65	95	110	
40		50	75	105	120	
50		50	80	110	130	
65		60	85	120	140	

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80		60	90	125	150	and special consideration.
100		60	95	140	160	
150		70	105	150	175	
200		80	115	160	190	
250		80	120	180	200	
300		80	125	180	200	
350		90	130	180	200	
400		90	140	180	200	
450		90	140	180	205	
500		90	140	180	210	
OVER 500 & FLAT		90	140	180	210	
SINGLE LAYER			MULTI LAYER			

Design Basis: Maximum Cladding temperature : 60°C

Ambient Temp.(max/min) : 40°C/7°C

Wind speed : 50 m/sec

Emissivity : 0.15

Density of Mineral wool preformed pipe section: 140 kg/m³

Multi Layer shall be constructed with layer thickness in accordance with the heat conservation layer thickness in section 8.1.

DESIGN - Table 5

MINIMUM INSULATION THICKNESS OVER EQUIPMENT FOR FIRE HAZARD PROTECTION PURPOSES

ITEM	MINIMUM THICKNESS mm	INSULATION MATERIAL	PROTECTIVE FINISH	NOTES
'FP' Specified Equipment	Refer to Table 3	Mineral Rock Fibre Fire Batts applied in two layers	Galvanised Steel /stainless steel sheeting secured with stainless steel bands to be used on this service.	For vertical steel vessels, i.e. towers, tall drums, etc., that require fireproofing, the fireproof insulation shall be applied to a height of 12m from grade or the nearest solid plate platform where a pool fire could form.

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When credit factors, per API Standard 521, for the insulation in determining the minimum pressure relieving device sizes for fire exposure are to be taken into account, galvanised steel/stainless steel cladding shall be used. Insulation applied to bottom heads of vertical vessels in an enclosed skirt shall be fully clad with stainless steel jacketing.

The Fire Proofing insulation system shall be capable of withstanding the force of fire hose stream impingement. Fire hose stream tests are described in NFPA 58, Appendix H-3.

DESIGN - Table 6

MINIMUM THICKNESS OF ACOUSTIC INSULATION

The level of acoustic attenuation is indicated by the Class Symbol below as required by Table 1. Where acoustic attenuation symbol A, B or C is combined with thermal insulation symbols the selected insulation thickness shall be the greater of the two requirements.

When the following acoustic insulation cladding thickness requirements differ from the thermal insulation protection sheeting requirements of the greater of the two thicknesses shall be selected.

CLASS	MINIMUM THICKNESS OF POROUS LAYER INSULATION mm	ACOUSTIC INSULATION CLADDING THICKNESS mm	CLADDING MATERIAL
A	50	0.70	Aluminium or galvanised steel
B	100	0.70	Galvanised steel only
C	100 (in two 50mm layers)	1.40 (in two 0.70mm layers)	Galvanised steel only

Classes A, B and C correspond to the classifications given in BS ISO 15665 (Acoustic-Acoustics insulation for pipes, valves and flanges).

Class C attenuation shall be achieved by applying two layers each of 50mm thick porous insulation and 0.70mm thick sound barrier acoustic insulation cladding sequentially.

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10.0 MATERIALS

10.1 General

- 10.1.1** All material shall be to the described form (Design Table 2) and the following, and shall be of high quality and good appearance.
- 10.1.2** Insulation materials shall be of low chloride content, chemically inert, non sulphurous, rot proof, vermin proof, impervious to hot water and steam, non injurious to health and non-corrosive to steel or aluminium, (even if soaked with water at ambient temperatures for extended periods).
- 10.1.3** Insulation materials containing ASBESTOS in any form are not permitted.
- 10.1.4** Insulation and cladding materials backed with paper or other flammable material are not acceptable.
- 10.1.5** Insulation materials shall be stored, transported, handled and applied as per ASTM C929.

11.0 MATERIALS – THERMAL INSULATION

11.1 General

- 11.1.1** Insulating material shall be preformed sections of either rigid Calcium Silicate or Fibrous Mineral Fibre with resin binder.
- 11.1.2** Preformed materials shall satisfy the minimum requirements of quality standard in accordance with BS 3958 (Parts 4 and 5), IS 9842/ASTM C547 and ASTM C612.
- 11.1.3** The insulation material shall be supplied plain faced in Manufacturer's Standard sizes and the average measured length, width and thickness shall not differ from the standard dimensions specified by more than plus or minus 3mm.
- 11.1.4** Insulation materials shall conform to the following physical requirements

Design Parameters	Fibrous materials (Rock wool & Glass wool)	Rigid materials (Calcium silicate)
Density	Minimum 140 Kg/m ³	200 to 280 Kg/m ³
Alkalinity (approx) PH	Between 6 and 10	-
Combustibility	Non-combustible	Non-combustible
Compression strength (av.) Minimum at 10% deformation	60-320 kg/m ²	
Hygroscopicity % volume	0.20 maximum	0.20 maximum

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Linear shrinkage (av. max)	Below 2%	Below 2%
Chloride content not to exceed 20 ppm	See Fig. 1 ASTM C795 wicking type Insulation over Stainless Steel	
Sodium plus Silicate content to exceed 40ppm		

Thermal conductivity

*Mean Temperature	Average 'k'	
°C	W/m °C	
	Rock wool	Calcium silicate
50	0.043	0.050
100	0.052	0.056
150	0.064	0.063
200	0.078	0.070
250	0.093	0.080
300	0.110	0.085

* Mean temperature is Hot face temp + Cold face temp

2

11.2 Material - Weatherproof Cladding:-

11.2.1 The selection of Aluminium material in both coil and flat sheeting form for use as the thermal insulation protective metal cladding shall take precedent over other metallic cladding with the exception of fire hazard protection where stainless steel/galvanised steel cladding shall be used.

11.2.2 Aluminium cladding shall be flat mill finished commercial grade of alloy AL-Mn which shall comply with BS 1470 or ASTM B209 under the following material designations:

BS 1470 - NS 3 - H6

ASTM B209 Alloy 3003 - H14 or H16

Galvanised steel cladding required for fireproofing purposes shall be flat mill finished grade 2B of steel to comply with BS 1449 or ASTM A167, A40. Steels to be SS304 or SS316

11.2.3 Aluminium metal cladding shall be supplied with factory applied reflective and protective barrier coating of polyethylene and aluminium foil which shall comply with BS 476 Class 1 (Surface Spread of Flame). The backing shall be directly laminated to the aluminium without use of adhesives or glue. Thicknesses shall be as indicated in Table 2.

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12.0 MATERIALS – ANCILLARIES

12.1 General

- 12.1.1** Aluminium foil shall be 0.06mm thick with a chemical composition of 98% minimum aluminium and shall not have an adhesive backing.
- 12.1.2** Binding and tie wire used where indicated to secure insulation materials and sacrificial foil over stainless steel surfaces shall be 18% Cr - 8% Ni stainless steel wire having a minimum diameter of 1.22mm. The wire shall be fully annealed.
- 12.1.3** Banding for use over insulation and over metallic finishing cladding shall be in handable coils ready to be cut to required lengths at site. Bands shall be as shown in Table 2 of this standard 20mm or 12mm wide x 0.5mm thick - fully annealed 18% Cr – 8% Ni stainless steel.
- 12.1.4** Expansion sections of banding where required to cater for differential expansion shall be of the same size and material as the flat bands and shall be of the 'Expand-R-Strap' type or 'Techalloy' Breather spring type or an approved equivalent.
- 12.1.5** Banding clips for use with securing bands shall be of the same stainless steel material as the banding and shall be of the 'Butterfly' type similar to 'Band-it-Valstrap Clips'.
- 12.1.6** Rivets required for metal cladding fabrication shall be the expanding Monel 'pop' blind eye type, 9.5mm long x 5mm diameter.
- 12.1.7** Screws required for metal cladding fabrication/securing shall be stainless steel slotted pan head self tapping type A No. 8 dia. x 12mm long to BS 4174 complete with neoprene washers under the head.
- 12.1.8** The material requirements of normal insulation accessories shall be as follows:
1. 'S' and 'J' clips - Formed from 20mm wide stainless steel banding.
 2. Removable cover fastenings - Shall be of the quick release, spring shackle lock type, material identical to the removable metal cladding.
 3. Metal cleats - Used as supporting angles on weatherproofing cladding shall be of similar material as described for the cladding material. The size shall be 65mm high x 50mm wide with the returned angle toe 13mm less than the insulation thickness. The cleats shall be 6mm thick.
 4. Floating rings - Shall be 10mm dia. carbon steel rod conforming to BS 4360 Grade 43A.
 5. Sacrificial foil - Use as a barrier material between stainless steel piping and equipment surfaces and insulation material shall be 0.06mm thick aluminium foil for operating temperatures of 500°C and below, and stainless steel foil at operating temperatures in excess of 500°C.
- 12.1.9** Sealing compound for use as metal sealant, sealing overlaps of metal cladding shall be a suitable flexible non-setting compound having properties which render materials waterproof, weatherproof, chemically resistant and fire resistant.

13.0 MATERIAL - ACOUSTIC INSULATION

13.1 General

- 13.1.1** Sound absorbent insulation material in use as the porous layer shall be preformed semi-rigid mineral fibre shapes as described for thermal insulation in Section 11.

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13.1.2 The impermeable outer cover sound barrier material in use as the cladding is described for weatherproofing and protection in Section 11.2. Acoustic attenuation Classes B and C (See Table 6) shall use Steel cladding to the exclusion of aluminium.

13.1.3 The anti-vibration seals used to prevent metal-to-metal contact shall be a closed cell polyurethane foam strip with pressure sensitive adhesive backing. The strip shall be a minimum of 3mm thick by 50mm wide and possess the following characteristics:

Density	90 kg/m ³
Water Vapour Transmission Less than	0.167 metric-perms
Combustibility Self Extinguishing Service Temperature Range	From minus 40°C to plus 82°C

13.1.4 Where anti-vibration seals are incompatible with operating temperature, such seals shall comprise of compressed porous layer material weatherproofed with a flexible mastic compound.

14.0 APPLICATION

14.1 General

14.1.1 The requirements of application, given in this specification in no way absolve the APPLICATOR from responsibilities of applying an insulating system that will give a satisfactory operational performance and the requirements given herein shall be regarded as directives and guidelines for the acceptable minimum. The APPLICATOR shall carry out the work in accordance with the best practices of insulation application with the minimum of waste and debris and the final job shall present a neat, efficient and workmanlike appearance.

14.1.2 All hydrostatic tests on piping and equipment, including steam tracing systems, shall be carried out before insulating material is applied. The APPLICATOR shall only insulate those sections of the plant that have been specifically released by Engineer in charge for such work. If however, it has been planned and decided to insulate prior to other work and before tests have been completed, insulation shall terminate a suitable distance before and after welded and flanged joints, and sealed against water ingress and also protected from mechanical damage which may be caused by others and during subsequent testing.

14.1.3 Surfaces to be insulated shall be clean, dry and free from loose rust scale. It shall be the Insulation Applicator's responsibility to remove the loosely adhering scale and dirt by an appropriate method which does not scar, score or damage the metal surface.

14.1.4 Insulated carbon and low alloy steel piping and equipment require protective coatings as specified in Specification for painting FGGS-BJN-PIP-SPC-5004.

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- 14.1.5** Where coatings are applied, repairs if necessary shall be carried out by the Painting contractor and the coatings shall be the subject of inspection by Site Engineer prior to the commencement of insulation application.
- 14.1.6** Insulated stainless steel piping and equipment shall be wrapped with sacrificial foil prior to insulation application. The foil shall be secured with stainless steel tie-wires at sufficient intervals to ensure the foil remains in place throughout the service life of the insulation. The supply and application of foil shall be the responsibility of the APPLICATOR.
- 14.1.7** The APPLICATOR shall NOT carry out any welding or drilling on piping or equipment, he shall however be responsible to carry out a check and confirm that all insulation supports, as indicated on fabrication drawings, have been installed and welded into position. The APPLICATOR shall also confirm that a sufficient and satisfactory number of supports have been provided in accordance with Figure 7.
- 14.1.8** Insulation shall be finished, sealed and weatherproofed at all terminal points including either side of temporary shop supports, lifting lugs, testing points etc. At these positions on shop insulated items closure pieces shall be designed and fabricated, to fit exactly at a later date on site, without impairing the weatherproofing. The Insulation Applicator shall remain totally responsible for the finished insulation.
- 14.1.9** Equipment nameplates shall remain visible after insulation has been applied. The surrounding edges shall be efficiently sealed against water ingress.
- 14.1.10** It is of extreme importance that acoustic insulation be protected from mechanical damage. Where cladding may be stepped on during operational use, separately supported steps shall be provided. The Insulation Applicator shall take whatever protective measures necessary to prevent damage occurring during transportation and/or handling and lifting.
- 14.1.11** The application of the insulation shall take into account expansion movements of piping, and equipment at normal operating temperatures and include provision within the insulating system for any differential expansion anticipated.
- 14.1.12** Shop applied insulation shall take into account not only thermal expansion and contraction movements but also movements of flexing and vibration created by on-off loading and transportation. The anticipated scope of these movements shall be outlined to the APPLICATOR by the item Fabricator.
- 14.1.13** Thermo well bosses, pressure tappings and weep hole nipples shall not be insulated but left accessible, the surrounding edges of insulation shall be positively sealed against water ingress.
- 14.1.14** Double layer construction shall be required when operating temperatures are over 316°C and/or the insulation thickness is greater than 100mm. Insulation installed in two or more layers shall be staggered joint construction and each layer shall be adequately secured in place.
- 14.1.15** Insulation shall be applied in large regular pieces cut to size where necessary and firmly butted together to minimise voids, and to keep edges of material under compression. Circumferential joints shall be staggered by one half sections.

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- 14.1.16** Wet or damaged insulation shall not be used under any circumstances. Installed material awaiting its protective cover shall be adequately protected from damage, rain, and contamination by others such as oils, spent welding rods, paint etc.
- 14.1.17** A minimum clearance of 25mm between the outside surface of any insulation finish and adjacent equipment, pipe or structural members shall be maintained. Care shall be taken where insulation is shop applied to ensure this minimum clearance.
- 14.1.18** Where voids occur in the insulation they shall be filled with suitable fibrous loose fill material. Loose fill used for shop applications shall be protected from possible damage during subsequent lifting and transporting.
- 14.1.19** Where installed, expansion joints shall comprise of compressible mineral fibre of sufficient density and composition to operate efficiently as both insulant and expansion facility at the given operating temperatures.
- 14.1.20** Insulation supports shall not project out of the insulation outer surface and shall be given sufficient coverage of insulating material to avoid hot spots on the insulation metallic weatherproof cladding at support positions.
- 14.1.21** Weatherproof cladding shall be designed and installed to shed water at ALL times. Flat horizontal surfaces are not acceptable. It shall be borne in mind throughout shop application that sloping planes in shop conditions may possibly become flat surfaces when finally positioned at site and continuous care shall be taken to ensure that final orientation is known by the Insulation Applicator.

15.0 APPLICATION - PIPING INSULATION

15.1 General

- 15.1.1** Preformed insulation shall be applied, supported and secured to straight length single pipe runs using two half sections up to the maximum manufactured sizes, above this size piping shall be insulated with the minimum number of cut segments.
- 15.1.2** Insulating material shall be applied to fit snugly against the contours presented to the applicator and neatly cut and shaped only where necessary to achieve this requirement. The insulation shall be carried out with the least number of material pieces as possible and all unavoidable gaps, cavities, and voids shall be suitably filled with compatible loose fill material.
- 15.1.3** Shop fabricated piping shall be amply supported and positioned in such a manner that allows complete all-round uninterrupted access to the work piece. At temporary support points during shop fabrication, insulation shall be terminated and sealed and closure pieces fabricated for later installation at site.
- 15.1.4** The insulation materials shall be secured to the pipes by means of circumferential tie wires or bands in accordance with Design - Table 2 of this Specification. Tie wires or bands shall be positioned sufficient to provide three ties or securing positions for each length of pipe insulation section. Ends of tie wires shall be turned into the insulation material.

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15.1.5 Each layer of insulation on piping requiring two or more layers shall be secured by exactly the same method as required by paragraph 15.1.4 above. Joints of each layer shall be offset by staggering.

15.1.6 Where necessary the insulation on vertical or near vertical piping (i.e. greater than 45° angle from horizontal) shall be supported by bolted-on metal clips provided and installed by the Insulation Applicator who shall assume responsibility of adequate pipe insulation support.

Support positions shall be at no greater distance apart than the following:

<u>Pipe Operating Temp °C</u>	<u>Support Spacing mm</u>
Up to 370	4500
From 371 to 480	3600
From 481 to 650	2700

15.1.7 Where multilayer insulation is used, supports shall be extended to provide for each layer. If support positions are used to create expansion joints, care shall be taken to ensure that expansion joints in each layer shall be offset at least 150mm from each other.

15.1.8 Over pipe bends and elbows the insulation shall be correctly sized mitre cut pipe sections or segments to suit the contour of the bends without gaps and ill fitting pieces. The mitred pieces shall be secured in place with at least two ties per complete mitred collar of insulation.

15.1.9 Preformed pipe sections or segments of insulation shall be carefully cut and shaped around 'tee' junctions and the insulating material of the tangential pipe shall be carefully and neatly cut to mate up to the material applied to the parent pipe without the creation of voids or gaps at the junction.

15.1.10 Insulation shall be stopped short of flanged joints and unions by a sufficient distance to permit easy removal of the flange nuts and bolts or breaking of the unions to take place without disturbance to and damage of the insulating material. At these positions the insulation shall be straight edged and sealed against water ingress with a metal closure.

15.1.11 Insulation at solid welded or clamped pipe supports shall be cut and shaped to fit around the support and tied securely to enable the insulation to be carried with the pipe movement. Pipe supports designed to allow the pipe to move independently shall be insulated to allow movement to take place without damage to the insulating material.

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15.1.12 Traced pipe and fittings shall be insulated with oversized insulating sections to allow accommodation of both parent pipe and tracer without damage or deformation of the insulation. Traced instrument lines and fittings shall be totally enclosed by the insulation in a similar manner and the designed warm air annulus shall be maintained throughout the traced pipe length.

15.1.13 Where specified, valves and flanged joints shall be insulated with lined removable covers held into position with bands or quick release toggle clips. Insulated valves shall be completely covered, but the insulation shall be cut and shaped around the valve stem and kept clear of the stuffing-box gland. Insulation covers shall overlap and totally enclose the sealed ends of piping insulation.

16.0 APPLICATION - PIPING CLADDING

16.1 General

16.1.1 The piping insulation protective metal cladding finish shall provide a weatherproofed and mechanical damage resistant cladding over the whole of the insulated areas and be applied and fitted in such a manner as to provide a close fitting assembly without gaps.

16.1.2 Straight pipe shall have metal cladding cut and machine rolled (approx. 1 metre long) wrapped around, with 50mm minimum overlaps on both longitudinal and circumferential overlaps. All laps shall be arranged to shed water.

16.1.3 A single bead shall be made on all circumferential overlaps. Longitudinal overlaps shall be 'cracked' with a 45° angle inward turn of the overlapping edge to ensure a tight metal to metal contact.

16.1.4 All the seams at overlap positions shall be rendered watertight by the use of a metal seam sealer which shall be applied between overlapping metal edges in sufficient quantity and care to ensure that insulation remains dry and un-wetted whether the possible water impingement is from rain, hose, or fire sprinklers.

16.1.5 The metal cladding shall be secured tightly around the insulated pipe and held in place with stainless steel bands on a maximum of 300mm centres. One band shall be located on each circumferential lap and the distance between laps divided at equal band spacing. The band securing seals shall be kept neatly in line and positioned away from viewing angles as much as is possible.

16.1.6 Vertical overlaps on vertical or near vertical piping shall be staggered to provide overlaps at 'North' and 'South' positions in alternate sections of cladding.

16.1.7 Each section of metal cladding on vertical piping with insulation OD's larger than 250mm shall be supported from the next lower section with two 'S' clips fabricated from banding material. The 'S' clips shall be of sufficient length to allow the minimum overlap of 50mm.

16.1.8 On vertical piping with insulation OD's of 600mm and larger, the securing bands shall be supported by 'J' clips fabricated from banding material. The 'J' clip spacing shall be a minimum of two per band. All 'J' clips shall be screwed into position and secured.

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16.1.9 Insulated bends and elbows in piping 80mm and larger, shall be metalled with 'lobster back' segments using 10mm minimum ball swage to assist shaping. The metal bands shall be screwed with self tapping screws and include metal sealants to provide a completely waterproofed arrangement.

16.1.10 Insulated bends and elbows in piping smaller than 80 mm may use complete pressed humped back flat metal elbows or fabricated 'stove pipe' elbows but these fitments shall be completely and positively waterproofed.

17.0 APPLICATION - EQUIPMENT INSULATION

17.1 General

17.1.1 The insulation over equipment shall be supported by rings, bars, clips etc., welded and fitted to the metal surfaces by the equipment fabricators. Maximum use shall be made of these provisions by the Insulation Applicator.

17.1.2 Sections and slabs shall be cut and shaped to fit the equipment contours using the minimum number of insulating pieces.

17.1.3 Heads of equipment shall be insulated with preformed material of a form best suited to the curvature of the equipment.

17.1.4 Insulating material shall be secured to equipment items by means of 20mm wide stainless steel bands at 300mm maximum centres. Bands shall be machine stretched and tensioned to take out slack only.

17.1.5 Insulation securing bands on equipment larger than 2135mm outside diameter shall be provided with expansion sections at 7620mm maximum spacing.

17.1.6 On vertical equipment an expansion gap of approximately 25mm shall be allowed beneath each support or stiffener ring. Expansion gaps shall be filled with an even distribution of compressed mineral rock fibres.

17.1.7 Expansion gaps shall be provided on horizontal equipment with mineral fibre as described in paragraph 17.1.6 above being compressed between joints of the equipment insulation at 3660mm maximum intervals.

17.1.8 Where specified equipment flanges, nozzles, channel covers, manway and handhole flanged covers shall be insulated with lined removable prefabricated covers secured with bands or quick release toggle clips.

17.1.9 Insulation shall be stopped short of un insulated flanges and nozzles etc., a sufficient distance to permit withdrawal of bolts without disturbing the remainder of the insulation. Insulation shall stop short by the bolt length + 50mm minimum. Insulation shall be weatherproofed and sealed at these positions.

17.1.10 Insulated bottom heads of shop insulated vertical equipment with fully enclosed support skirt, shall be provided with temporary weather resistant protection which shall efficiently prevent the ingress of water and weather during transportation, storage and lifting.

17.1.11 The insulation over pumps, compressors and turbines shall be in the form of lined removable metal covers. Removable covers shall be fabricated by the Insulation

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Applicator and be made up in sizeable pieces designed to be quickly and easily taken apart and reassembled. In the fully assembled state lined covers shall represent an efficient, weatherproof, waterproof and sound resistant covering.

18.0 APPLICATION - EQUIPMENT CLADDING

18.1 General

- 18.1.1** The protective metal weatherproof cladding over vertical vessel shells shall be constructed of rectangular sheet metal panels applied in a "wallpaper" pattern with the short width of panel in a circumferential direction parallel to the equipment insulation support rings and the longer length of panel in a parallel direction to the vessel centre line. The weight of the panel shall be taken on the equipment insulation support rings, via angle brackets bolted to the panel in accordance with Fig 3. There shall be a minimum of two brackets per panel. Shop applied insulation shall ensure that angle brackets remain in contact with support rings. The short width of panel shall be rolled to suit the outside curvature of the vessel insulation. The long side of panel shall be cut to suit the distance between insulation support rings.
- 18.1.2** The panels shall be applied commencing at the bottom of the vessel. Each circumferential ring of panels shall be tensioned by means of temporary tensioning bands until the final joint is screwed tight. 'S' clips shall be used as sheeting support at unscrewed circumferential overlaps. 'S' clips shall be riveted into position on shop applied systems, to prevent slippage during transportation.
- 18.1.3** The panels shall be held tight over the vessel insulation by means of circumferential bands and seals. The bands shall be positioned on all horizontal overlaps and at 450mm centres. Bands shall be held in their relative positions with 'J' clips and be machine stretched and sealed to remove slack only.
- 18.1.4** The panels shall have a minimum overlap of 80mm on both horizontal and vertical edges. The overlaps shall be arranged to shed water at all times.
- 18.1.5** The vertical and horizontal overlaps shall be secured with self tapping screws at 75mm pitch except the horizontal overlaps pre-selected to act as expansion joints, these shall be constructed with a 150mm overlap and shall remain unscrewed and left free to permit expansion. All overlaps shall be rendered watertight by use of a metal sealant positioned between overlapping metal edges.
- 18.1.6** All equipment projections such as nozzles shall have the metal cladding sealed using a metal flashing cut to fit the projection and extend over the cladding by at least 75mm. The seal between the flashing and cladding shall be made water tight by use of self tapping screws and metal sealing mastic.
- 18.1.7** Horizontal cylindrical equipment shall be finished with flat metal cladding arranged in circumferential bands with the edge of the sheets with the longer dimension applied around the circumference of the equipment insulation.
- 18.1.8** The panels shall have a minimum of 75mm overlap on both longitudinal and circumferential edges, both overlaps being finished with a simple ball swage and rendered water tight with a metal seam sealer applied between overlapping metal edges.

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- 18.1.9** Horizontal overlaps shall be secured with No. 8 x 15mm long, self tapping screws set in the overlap at 75mm intervals, and shall be so arranged that staggered bands of panelling encircle the equipment. Vertical overlaps shall not be screwed.
- 18.1.10** The metal protective finish shall be banded and sealed at 450mm centres ensuring that one band is set over each vertical overlap.
- 18.1.11** The insulated heads of vertical and horizontal equipment shall be fabricated from flat metal in an "orange peel" construction with all radial seams overlapping a minimum of 50mm and secured with self tapping screws at 75mm centres. All overlaps shall be ball swaged and be rendered water tight by the use of metal seam sealer between metal overlaps.
- 18.1.12** Projections from the heads shall be sealed using metal flashings neatly cut to fit around the projections and extending over the cladding for a minimum of 75mm. The seal between flashing and cladding shall be weatherproofed with self tapping screws and seam sealing mastics.
- 18.1.13** Insulation on bottom heads of fully skirted equipment does not require weatherproofing. (See para.16.1.10 re-temporary shop insulated covering).
- 18.1.14** Heads of equipment 550mm OD and smaller shall be finished and waterproofed with square ended fabricated covers.
- 18.1.15** On shop insulated items at temporary shop supports, the insulating system shall be terminated and sealed, and closure pieces shall be designed and fabricated to fit the open positions. Designs of closure pieces shall take into account the insulating requirements together with support and securement and the necessity of maintaining waterproofing and weatherproofing after closures are in place. Closure pieces shall be fitted at site by the site appointed Insulation Applicator.
- 19.0 ACOUSTIC INSULATION AND CLADDING**
- 19.1 General**
- 19.1.1** Acoustic Insulation (noise control) requirements and thicknesses shall be as indicated by classification symbols A, B or C shown in Table 1 and Table 6 of this specification.
- 19.1.2** Application methods and materials shall be as described for thermal insulation with the following additions and exceptions.
- 19.1.3** For Class 'B' and 'C' acoustic insulation all flanges, valves, man ways, fittings supports etc. shall be fully insulated.
- 19.1.4** The extent of acoustic insulation of shop insulated piping and equipment shall be identified to the APPLICATOR by the item Fabricator prior to the commencement of insulation.
- 19.1.5** At positions where metal-to-metal contact would normally occur, anti vibration seals shall be applied. Seals shall have a minimum thickness of 3mm and a minimum width of 50mm. The edges of the cladding or end cap shall be folded where resting on the anti-vibration seals.

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19.1.6 Gaps between the outer metallic insulation cladding and unavoidable projections shall be sealed with flexible, non-setting, impervious seals (i.e. mastic or rubber) where operating temperatures allow; otherwise metal projections shall be insulated for a minimum length of 300mm from the heat source allowing lower operating temperature seals to be used.

19.1.7 Shop fabricators shall inform the APPLICATOR of all operating temperatures where Acoustic insulation is required.

19.1.8 Complete cover of the system with insulating material shall be achieved and special attention shall be paid to ensure the prevention of noise leakage through gaps and voids in the insulating porous layer.

19.1.9 Removable acoustic enclosures (e.g. for valves, flanged joints, etc.) shall have an outer surface of cladding with a mass per unit area at least equal to that of the cladding of adjacent pipes and equipment. The lining of porous layer material shall be similar to that used on the piping and equipment and shall be retained by an inner surface layer of perforated metal sheeting with an open area of about 30%. It shall be at least 10mm away from the surfaces of flanges or valves.

19.1.10 Where acoustic enclosures are installed they shall be of sufficient length to overlap the ends of the pipe and equipment cladding by at least 200mm.

20.0 FIRE HAZARD PROTECTION – INSULATION – EQUIPMENT

20.1 General

20.1.1 The method of application shall be in accordance with Sections 17 and 18 unless modified by specific requirements in the following paragraphs.

20.1.2 The insulation thickness shown in Table 5 shall be regarded as the minimum and shall be increased where necessary as in the case of elevated temperatures where there is an overriding requirement for thickness to suit heat conservation, tracing or other requirements.

20.1.3 The insulation cladding shall be secured with 25mm wide stainless steel bands and screws.

20.1.4 The bands shall be positioned on horizontal overlaps for vertical items or vertical overlaps for horizontal equipment and at 150mm centres.

20.1.5 Bands on all equipment shall be held in their relative positions with 'J' clips which shall be riveted into permanent position.

20.1.6 Insulation applied to bottom heads of vertical vessels in an enclosed skirt shall be fully clad with stainless steel cladding.

21.0 REMOVABLE INSPECTION PORTS (WINDOWS)

21.1 General

21.1.1 Removable insulated inspection ports/windows will be required at strategic points on various piping arrangements and equipment/vessels throughout the plant.

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21.1.2 Inspection ports shall be of a proprietary type and approved by JPEC/OIL prior to purchase.

21.1.3 Locations of any such removable inspection port/window will be initially indicated on (isometric) drawings, and subsequently physically marked with indelible ink/paint on piping or equipment prior to release by CONTRACTOR for insulation.

21.1.4 All inspection ports shall be rendered water tight using correct tooling and seating seals.

22.0 DOCUMENTATION

22.1 General

22.1.1 The APPLICATOR shall ensure that detailed method statements and quality plans are submitted for JPEC/OIL review and agreement, covering all insulation activities and shall include, but not be limited to, the following:

- Programme of work schedules in sufficient detail to allow inspection planning
- Safe storage and handling of materials, safe disposal of unwanted materials.
- Insulation system to be used
- Written information identifying selected materials and manufacturers. (see note 1)
- Copies of manufacturer's current data sheets for all materials
- Material delivery dates
- Documented experience list using the selected insulation system and materials (see note 1)
- Proposed insulation, cladding and fixing expansion details
- Stood off personnel protection guard details. (see note 1)
- Removable flange and valve cover details for both metal box and flexible types. (see note 1)
- QA/QC procedures for the work to be carried out.
- Test and Inspection procedures and plans. (see note 1)
- Copy of proposed Inspection/Record Sheets.
- Written information regarding temporary protection arrangements in the event of
 1. Outdoor or partial outdoor application
 2. Application in the presence of other trades
 3. Site storage

Note 1: - This information shall also be submitted by the APPLICATOR for JPEC/OIL review and agreement prior to contract award

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23.0 INSPECTION

23.1 General

23.1.1 CONTRACTOR/APPLICATOR is fully responsible for all quality assurance tasks related to the materials and application of the insulation systems and proper performance of the installed systems. Such tasks shall also include initiating, organising and maintaining full documentation to verify compliance with this specification. The inspection requirements shall include, but not be limited to the tasks detailed below.

23.2 Inspection Tasks:-

23.2.1 The insulation shall be inspected during the following stages:

- At the time of material receipt
- Before applying the insulation
- During insulation application
- Before and during application of weatherproofing

23.2.2 Inspection activities shall include at least the following activities at the time of receipt of the materials:

- Appropriate checks shall be made to verify materials received at the site are the same as the specified or approved materials. Such checks shall include verification of labels, material safety data sheets, delivery receipts, and thicknesses. Damaged, unspecified, or unapproved insulation materials shall be removed from the site.
- Ensure materials are protected from being damaged by moisture, temperature, wind or any other atmospheric factors.

23.2.3 Inspection activities shall include at least the following prior to insulation application:

- Verify that surfaces to be insulated are clean, dry, and coated as required by Specification for painting FGGS-BJN-PIP-SPC-5004.
- Verify that painting of protrusions through insulation has been carried out.
- Ensure that aluminium foil has been applied over insulated stainless steel surfaces.

23.2.4 Inspection activities shall include at least the following during insulation application

- Make sufficient checks to verify that the materials applied are the same as the specified or approved materials.
- Verify the insulated item and insulation code are the same as marked on the P&IDs and related drawings.
- Inspect the insulation supports for correct location, type, width, and length. Verify that the insulation surface is uniform without gaps and voids.
- Inspect for tightness of joints and fasteners.
- Verify that the joints of the insulation segments are properly staggered and tightly installed.

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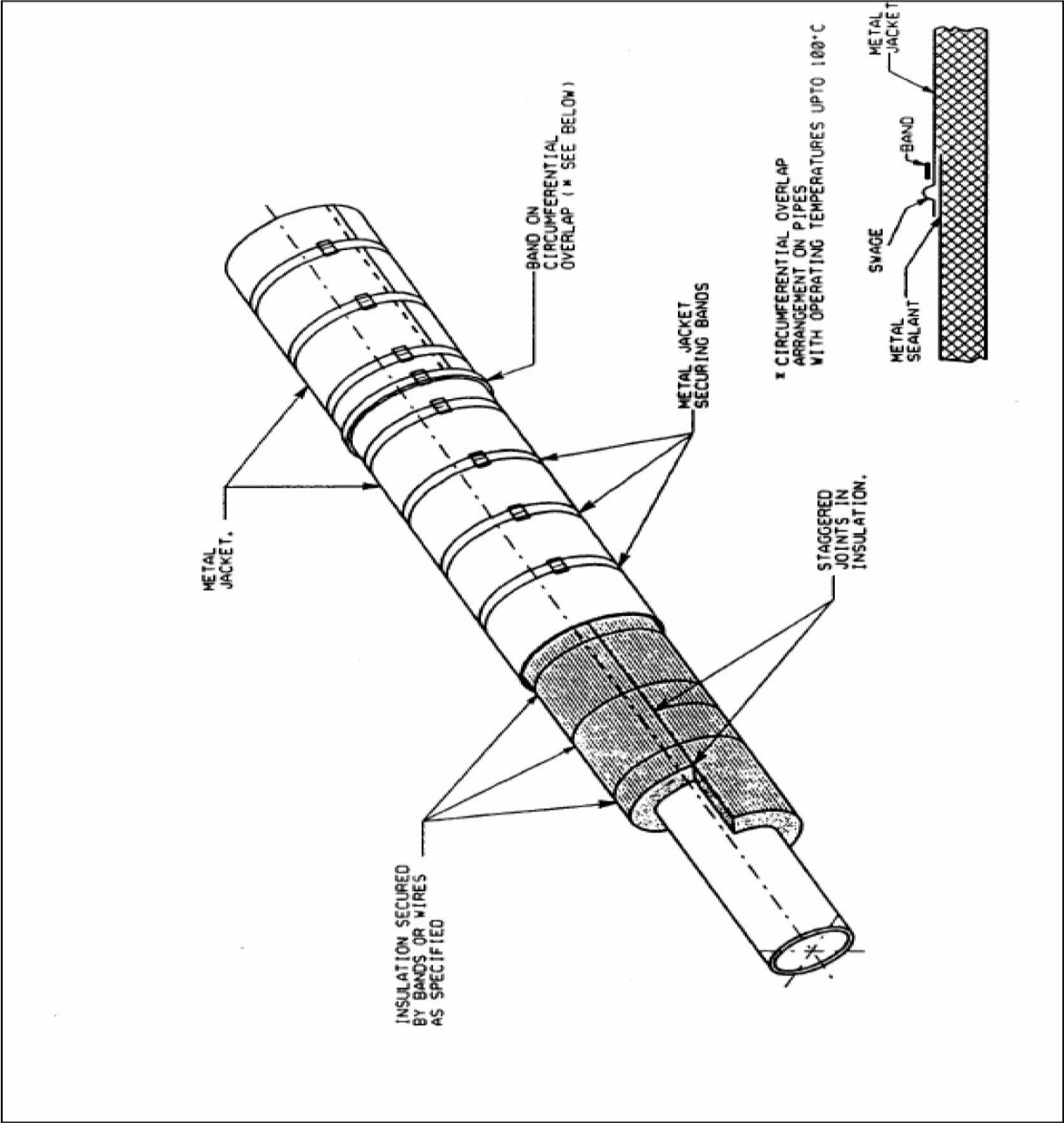
- Verify the location, width, and installation of insulation expansion joints.

23.2.5 Inspection activities shall include at least the following prior to and during weatherproofing:

- Ensure that the insulation is clean, dry, and fit for its intended purpose before weatherproofing is applied.
- Inspect size and direction of metal cladding overlaps.
- Ensure cladding is properly fabricated and installed.
- Verify that the location of bands, screws, S-clips, and J-clips.
- Ensure that moisture protection and weatherproofing at cut outs, protrusions, and locations where moisture could enter the insulation has been appropriately installed.

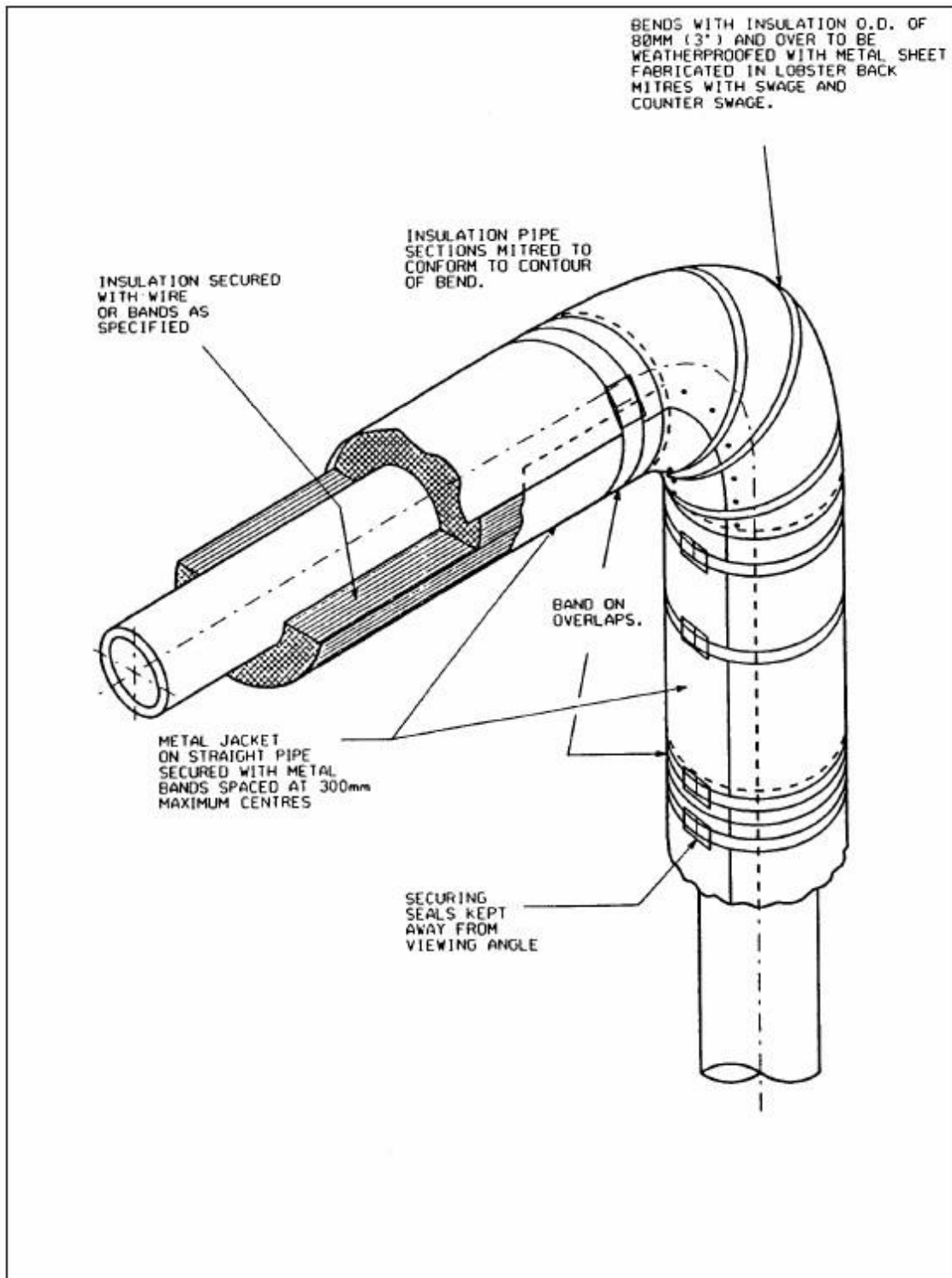
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Figure 1: PIPE INSULATION DETAILS (1 OF 4)



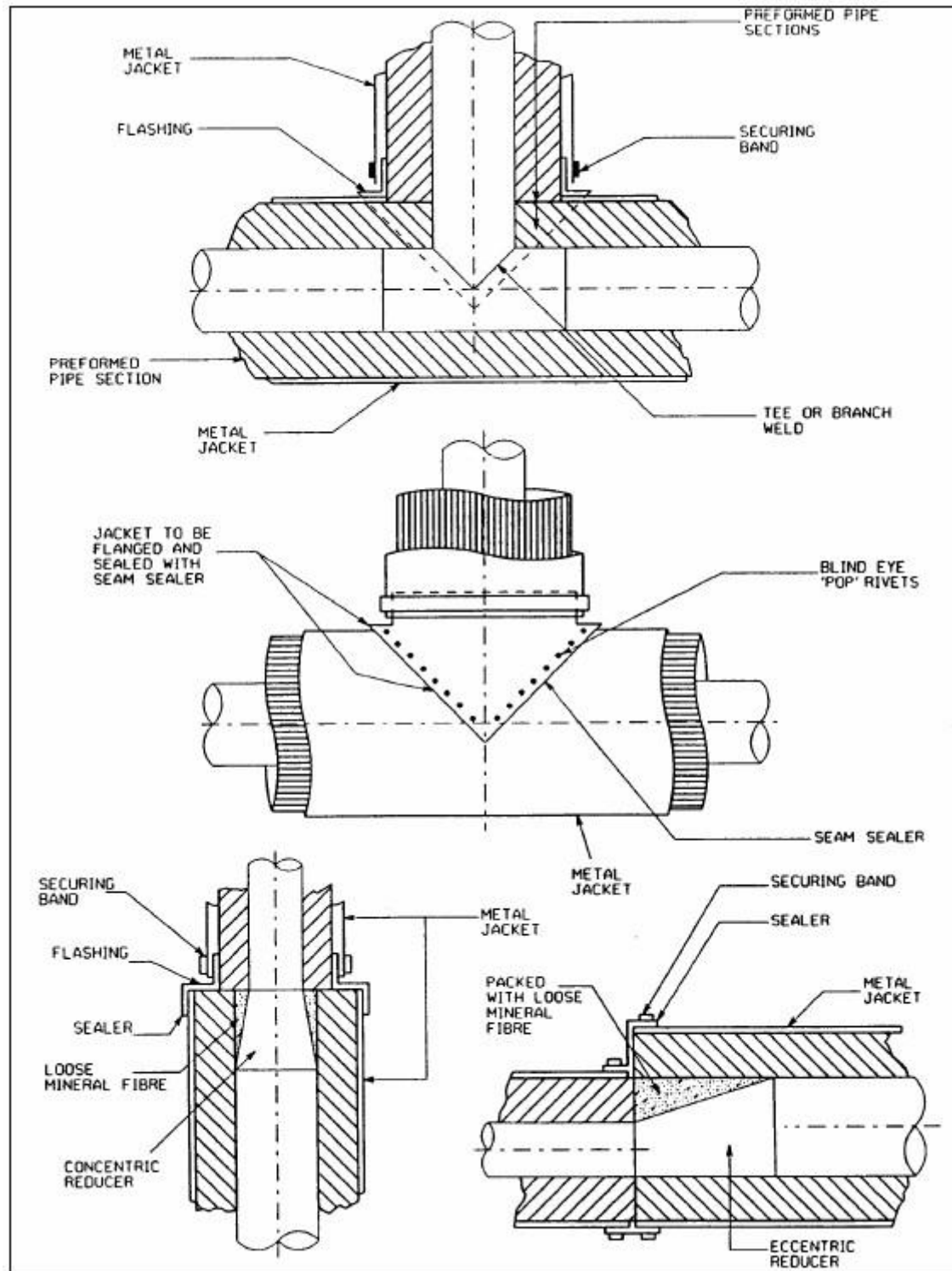
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Figure 1: PIPING – INSULATION DETAILS FOR ELBOWS (2 OF 4)



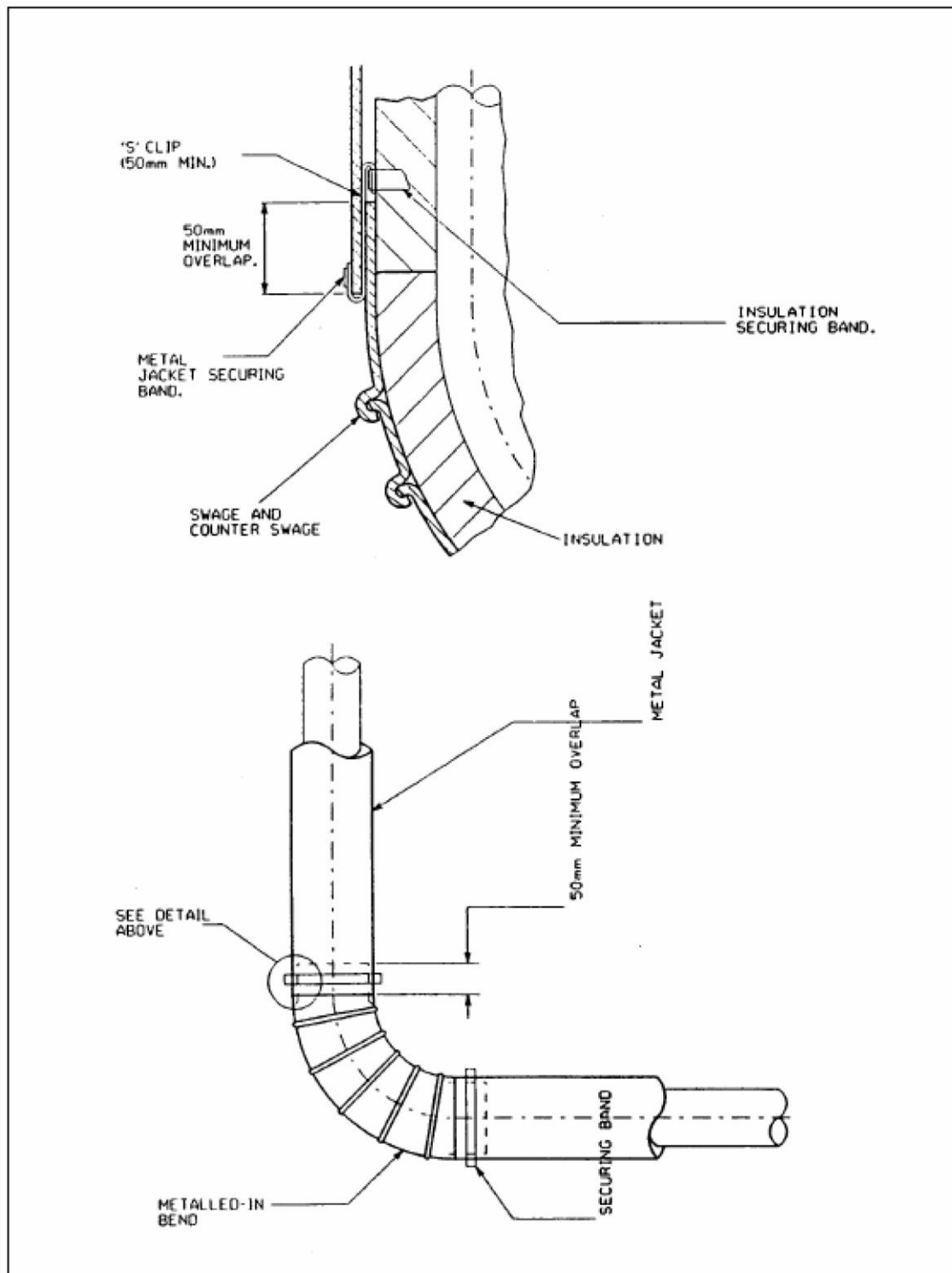
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Figure 1: PIPING – PIPE BRANCH & REDUCER (3 OF 4)



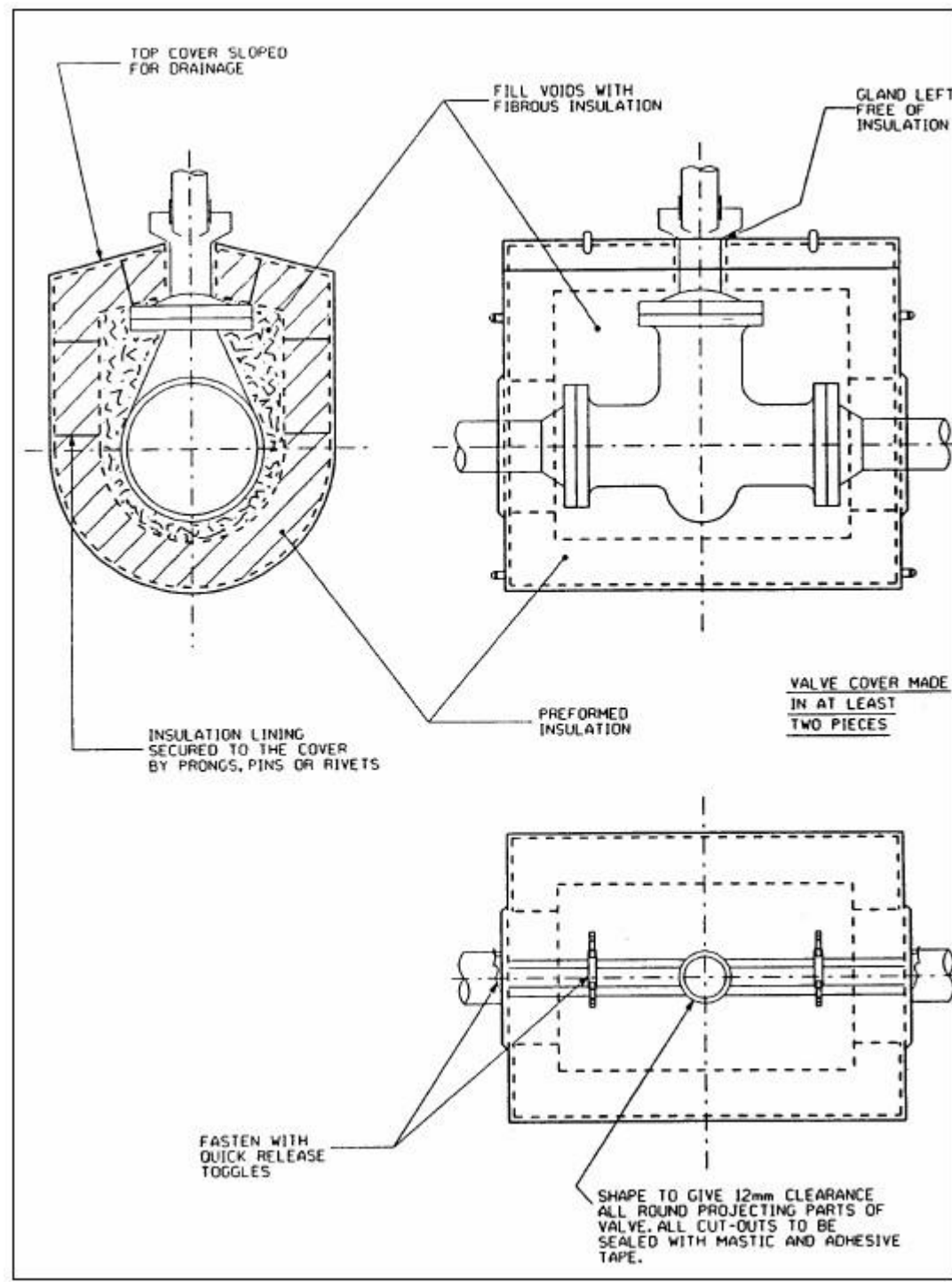
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Figure 1: PIPING – BENDS & ELBOWS (4 OF 4)



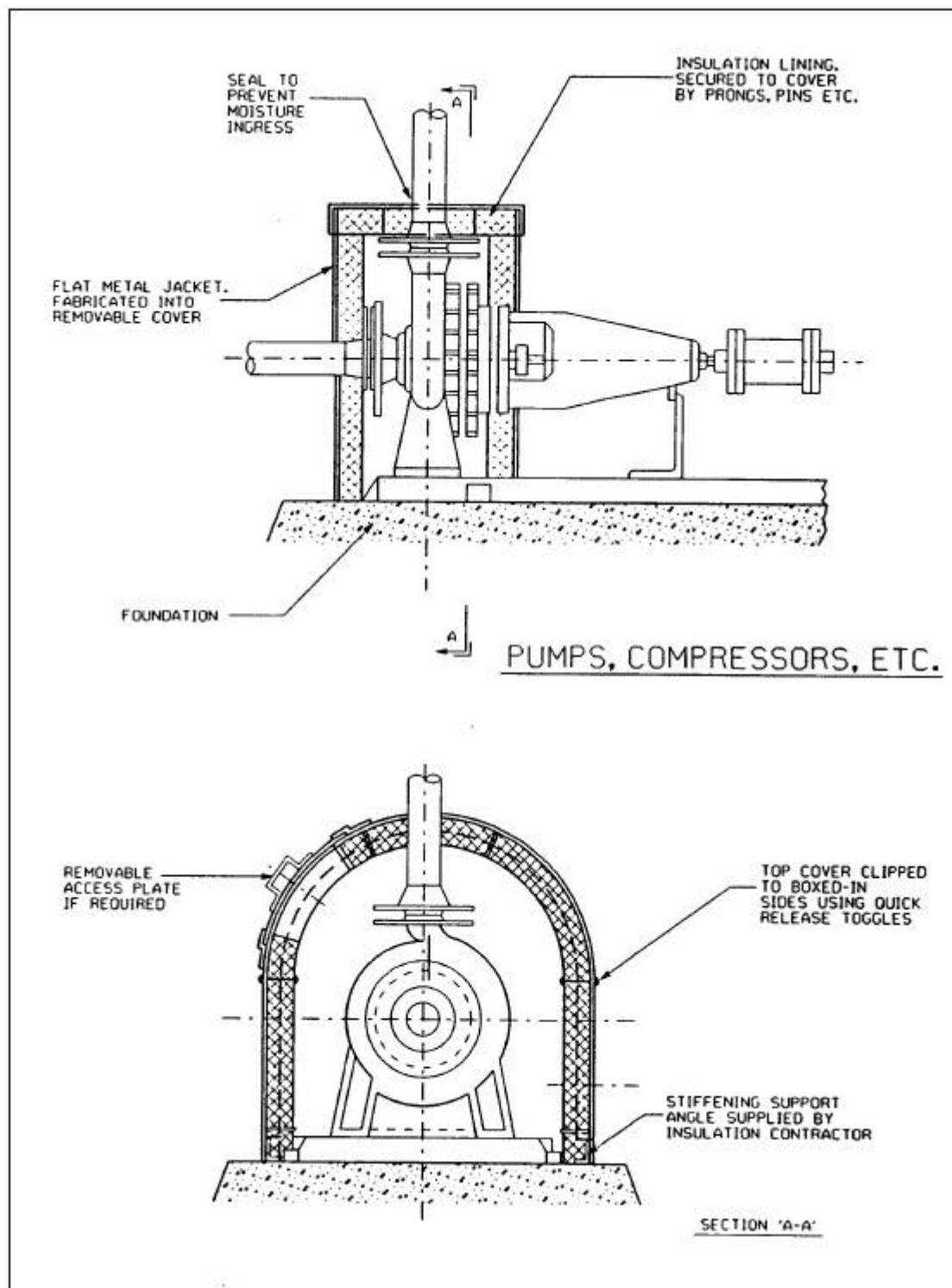
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Figure 2: REMOVABLE COVERS – VALVES (1 OF 4)



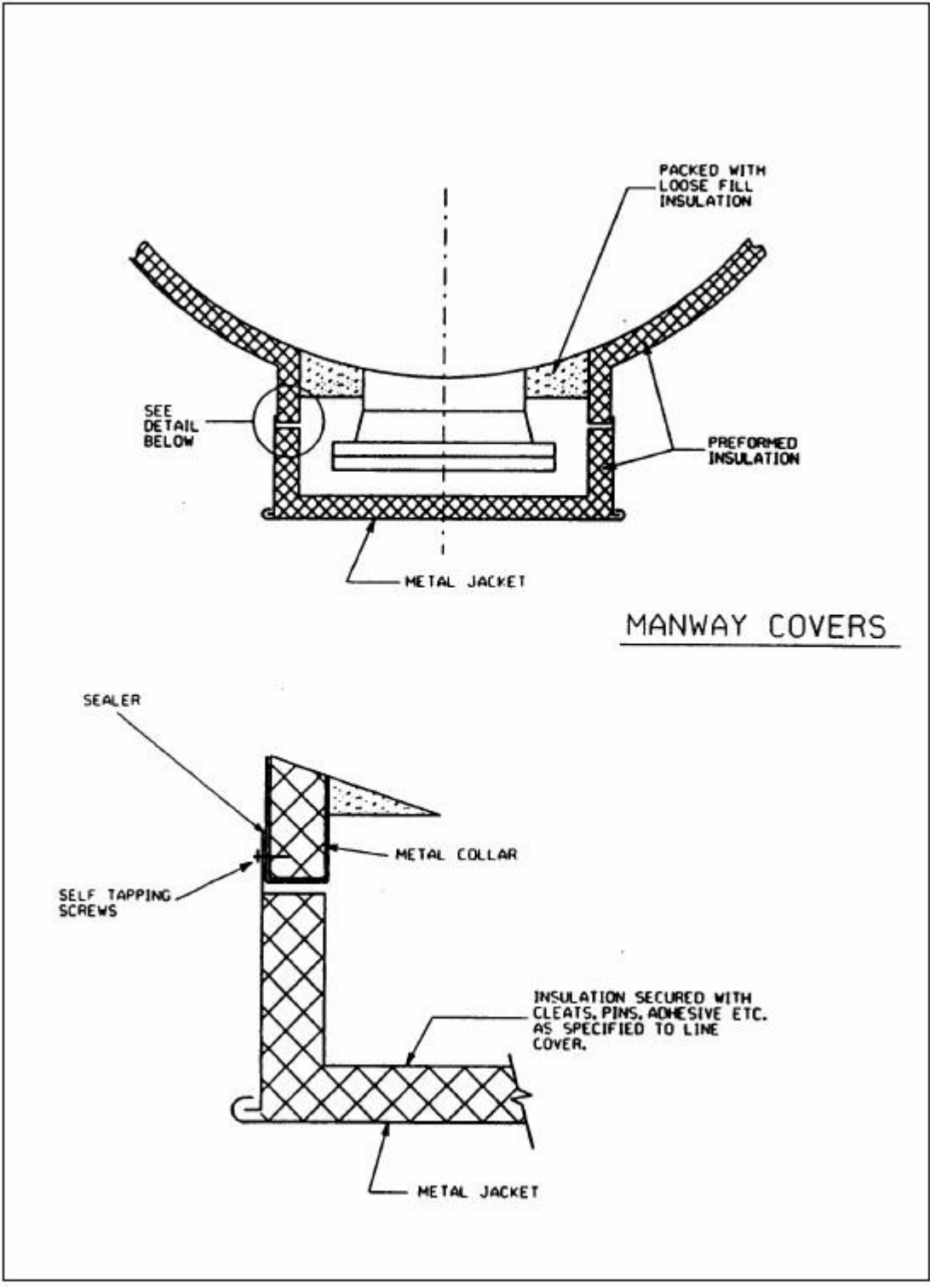
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Figure 2: REMOVABLE COVERS – PUMPS & COMPRESSORS (2 OF 4)



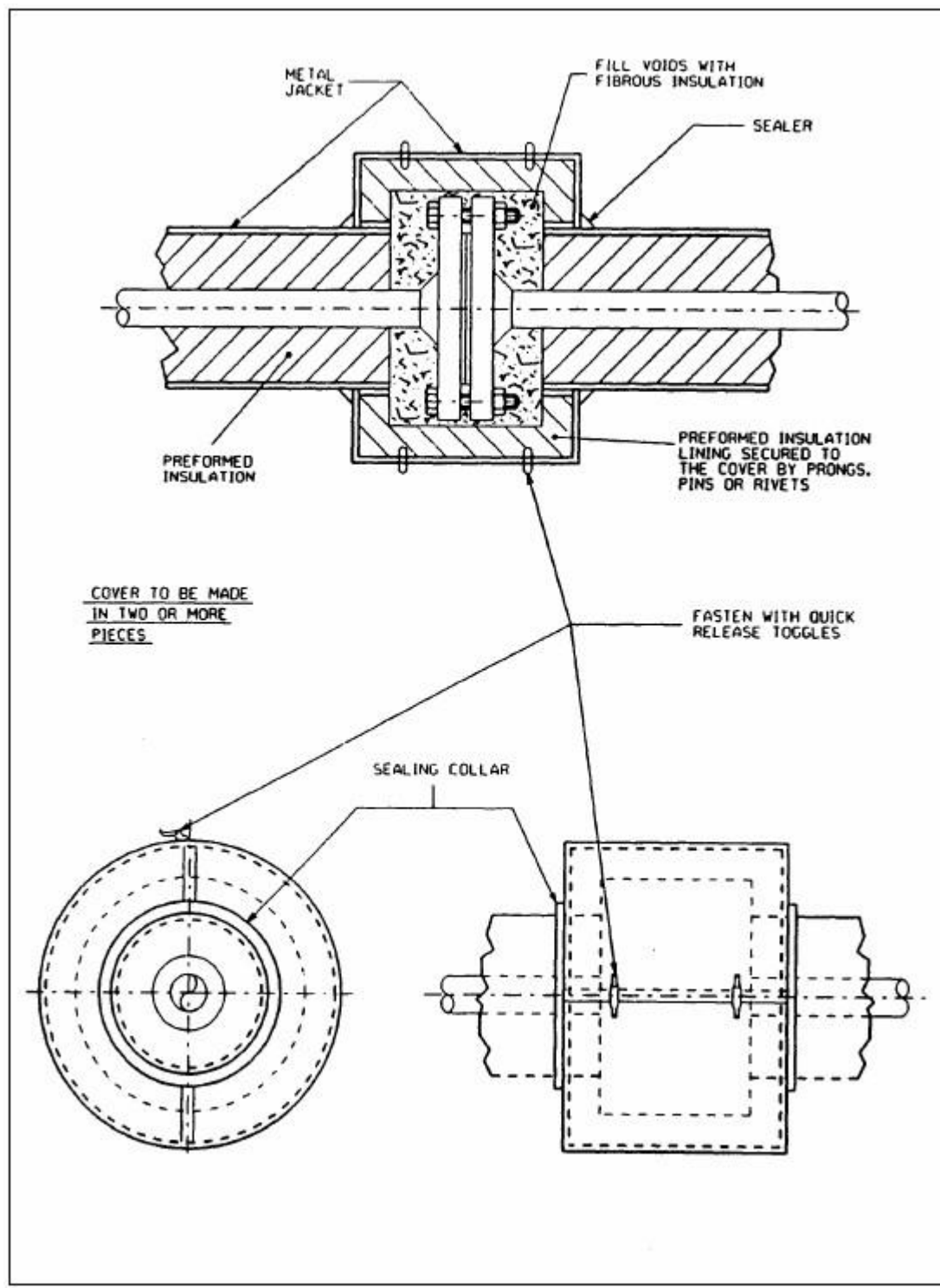
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Figure 2: REMOVABLE COVERS (3 OF 4)



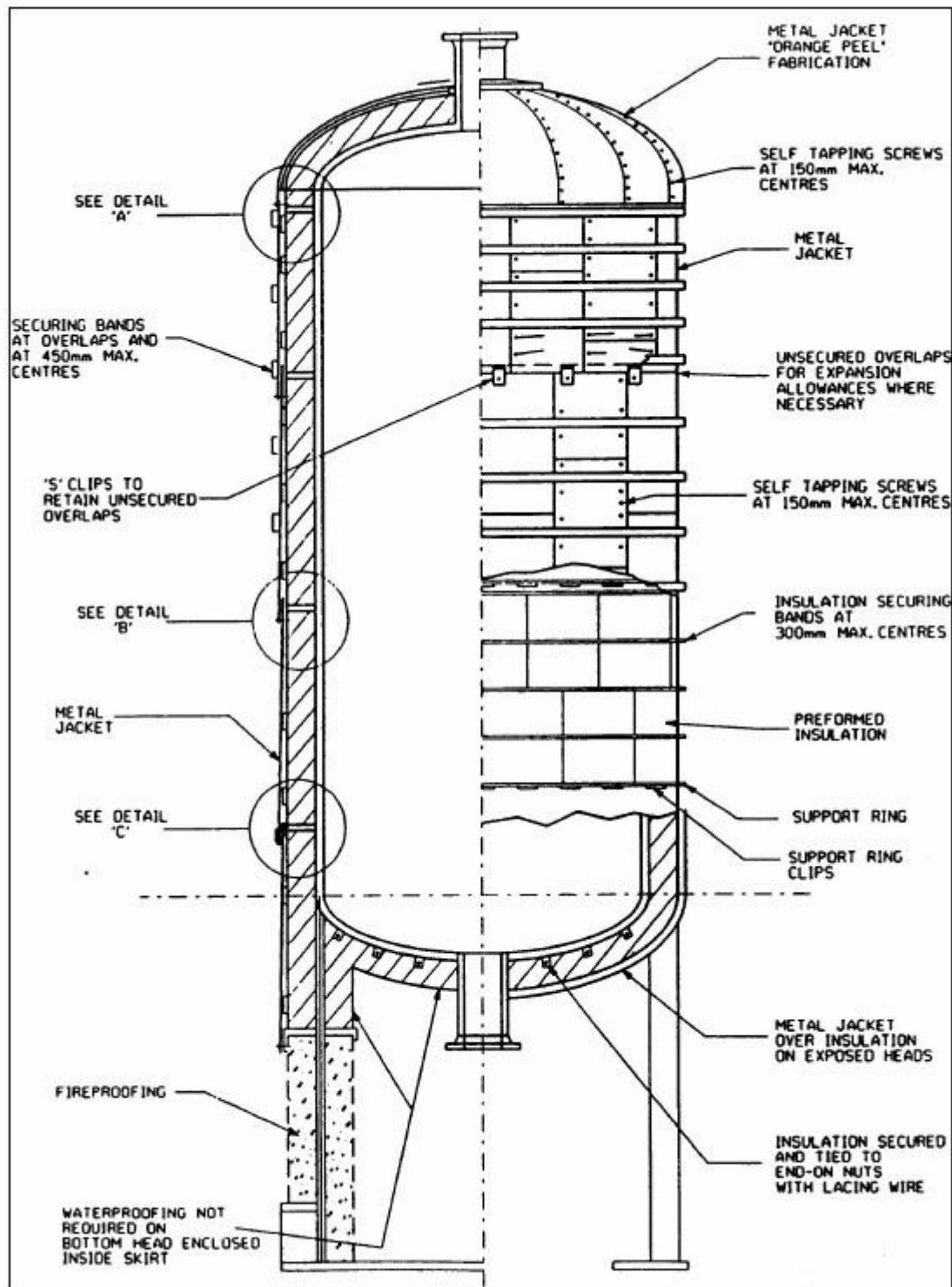
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Figure 2: REMOVABLE COVERS – FLANGED JOINTS (4 OF 4)



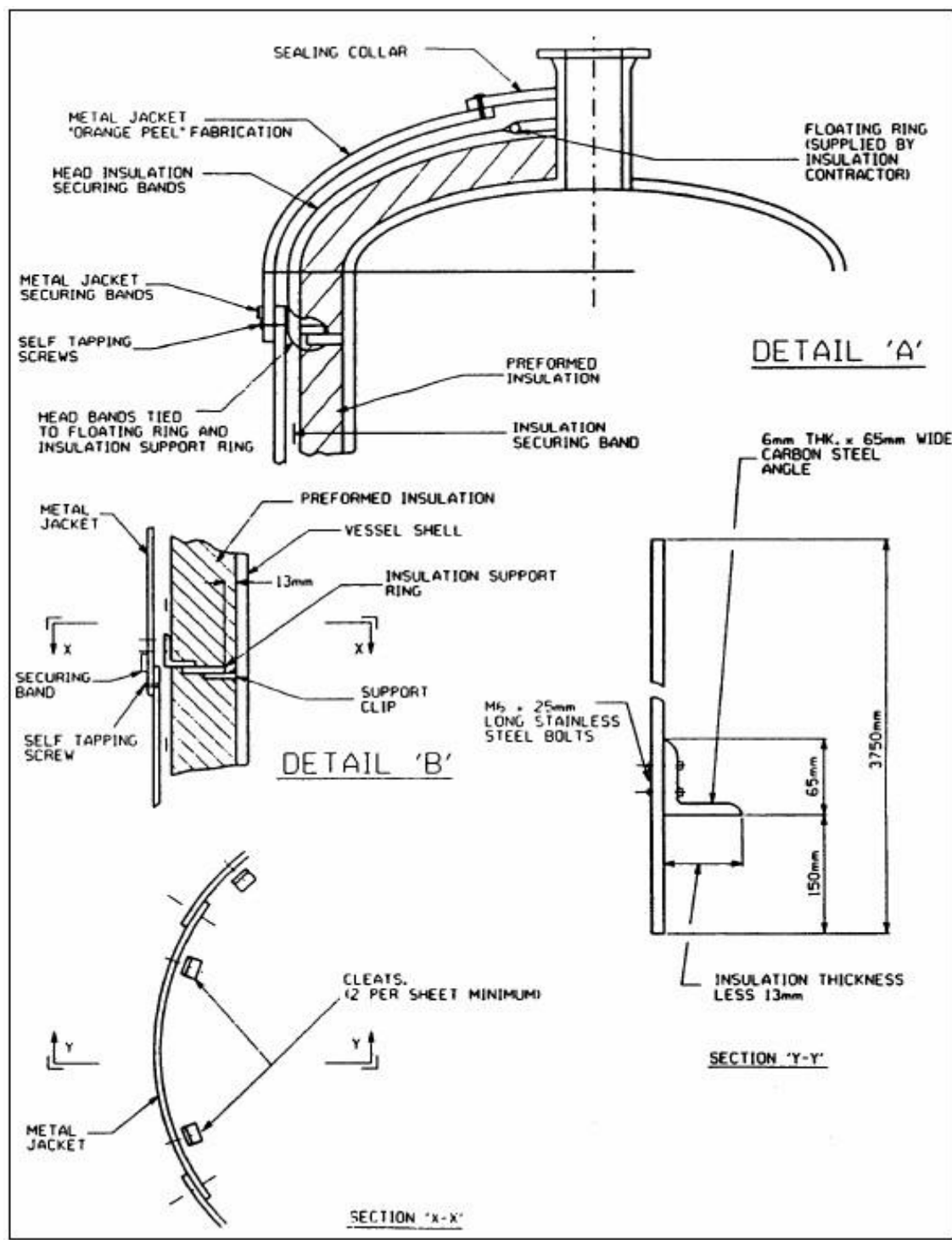
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Figure 3: VERTICAL EQUIPMENT (1 OF 3)



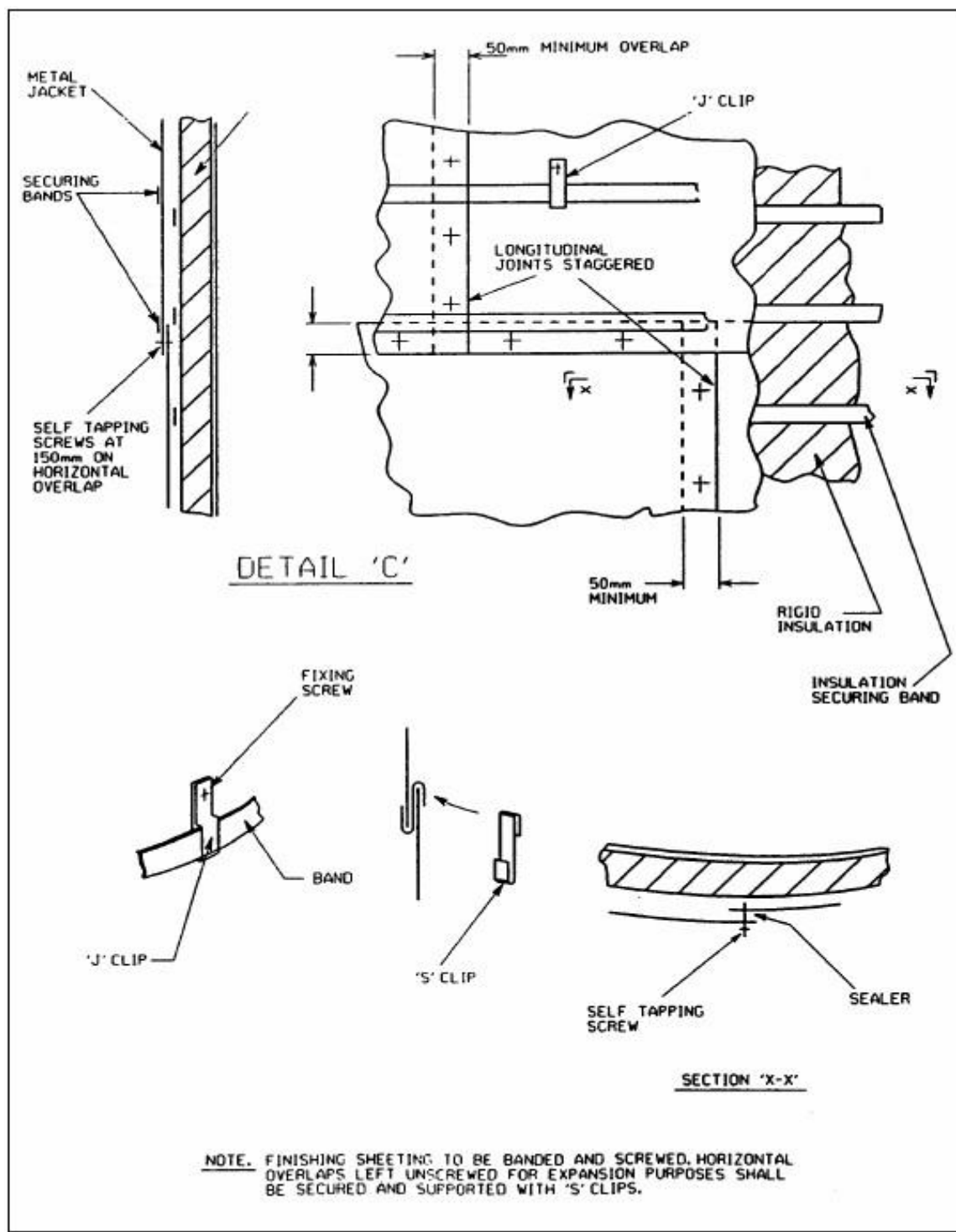
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Figure 3: VERTICAL EQUIPMENT (2 OF 3)



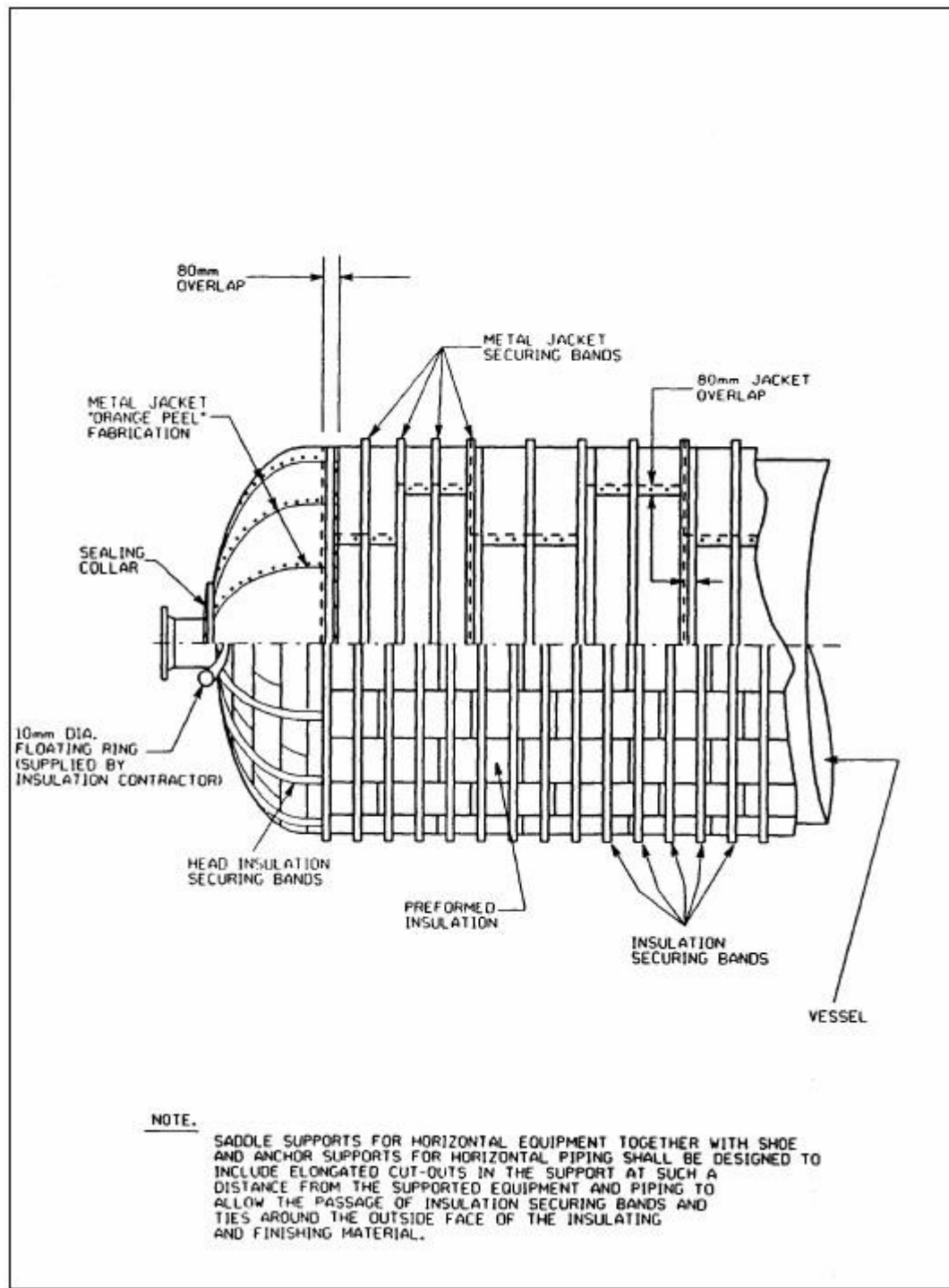
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Figure 3: VERTICAL EQUIPMENT (3 OF 3)



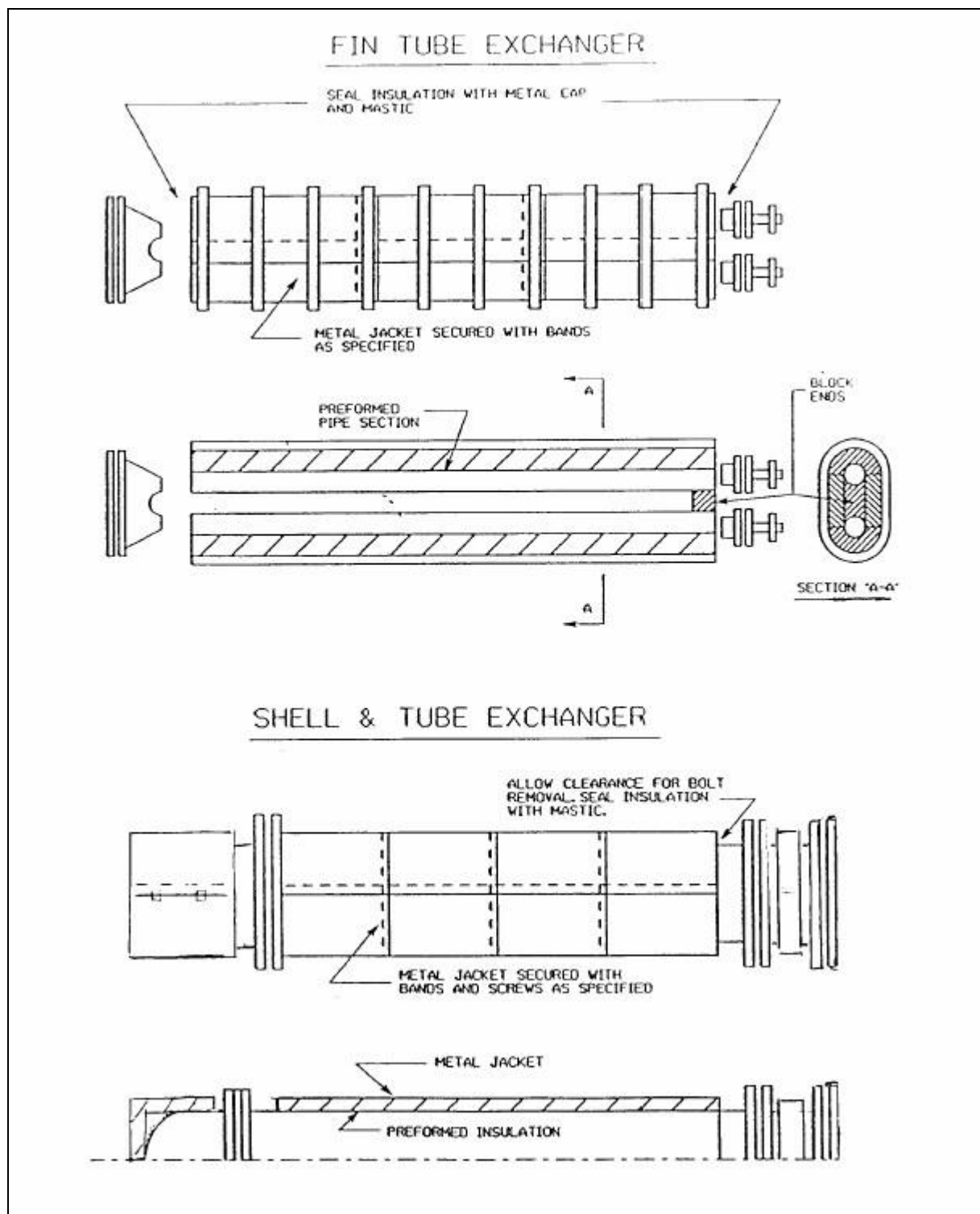
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Figure 4: HORIZONTAL EQUIPMENT (1 OF 3)



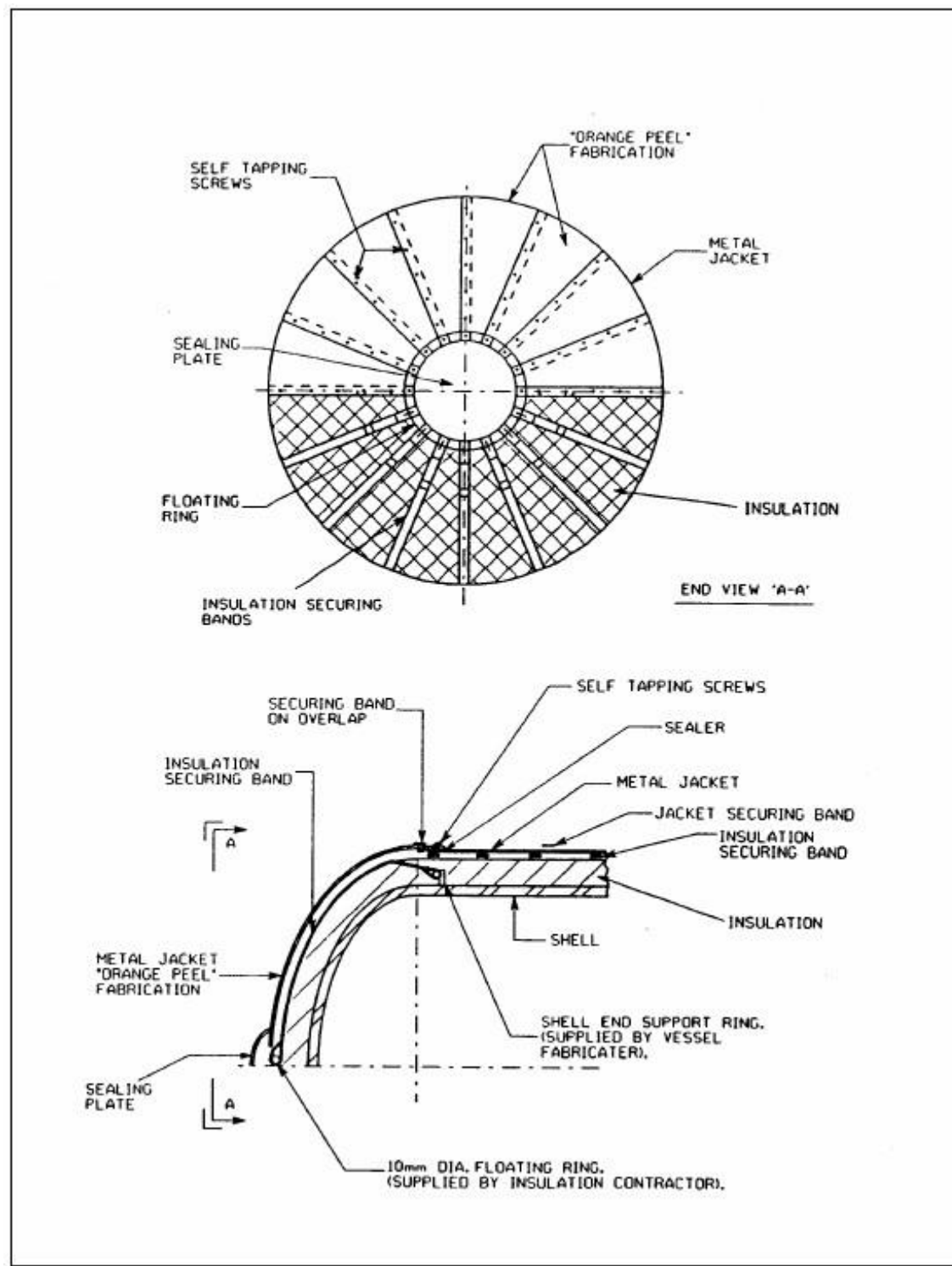
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Figure 4: HORIZONTAL EQUIPMENT (2 OF 3)



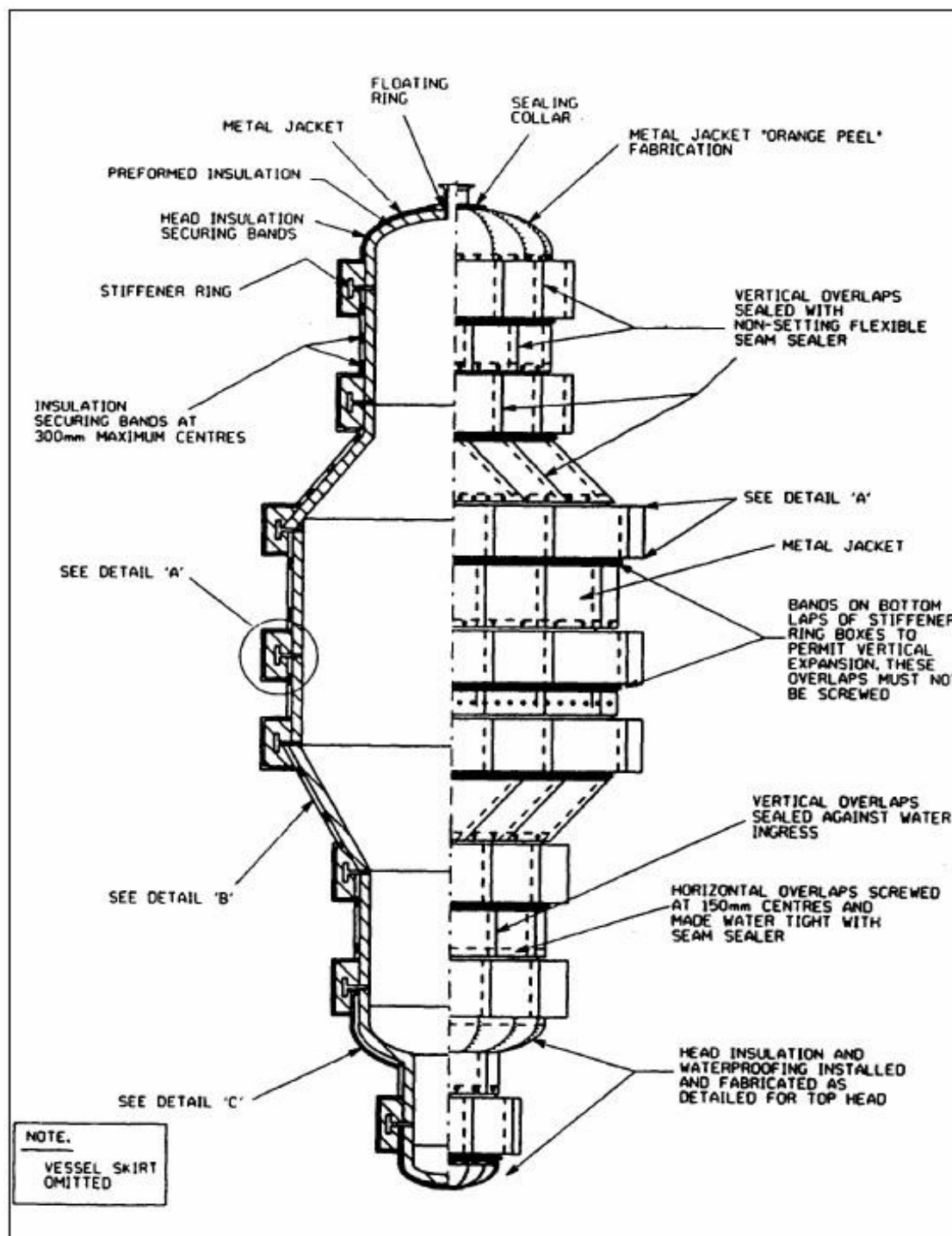
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Figure 4: HORIZONTAL EQUIPMENT (3 OF 3)



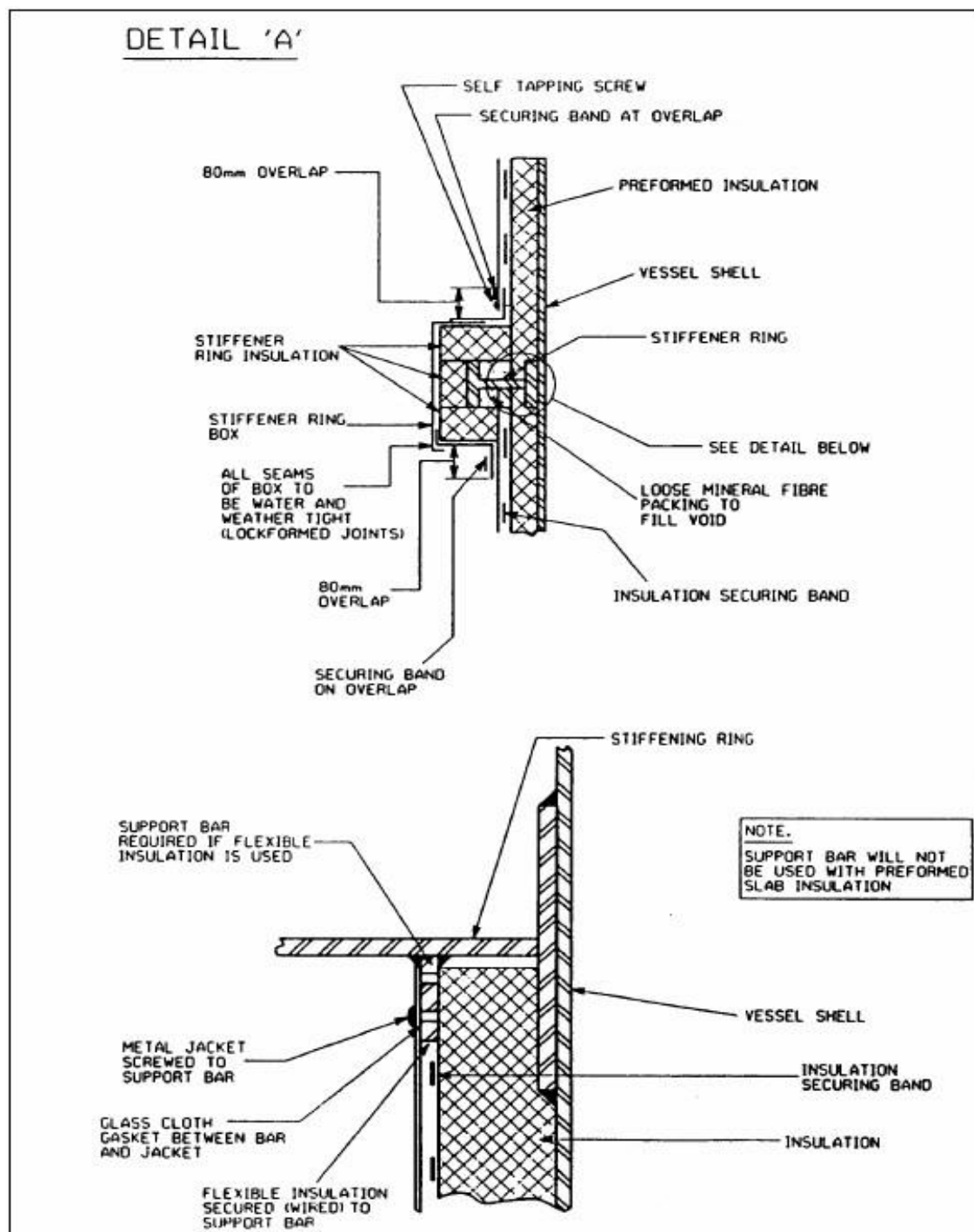
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Figure 5: STIFFENER RINGS AND CONICAL SHAPES (1 OF 3)



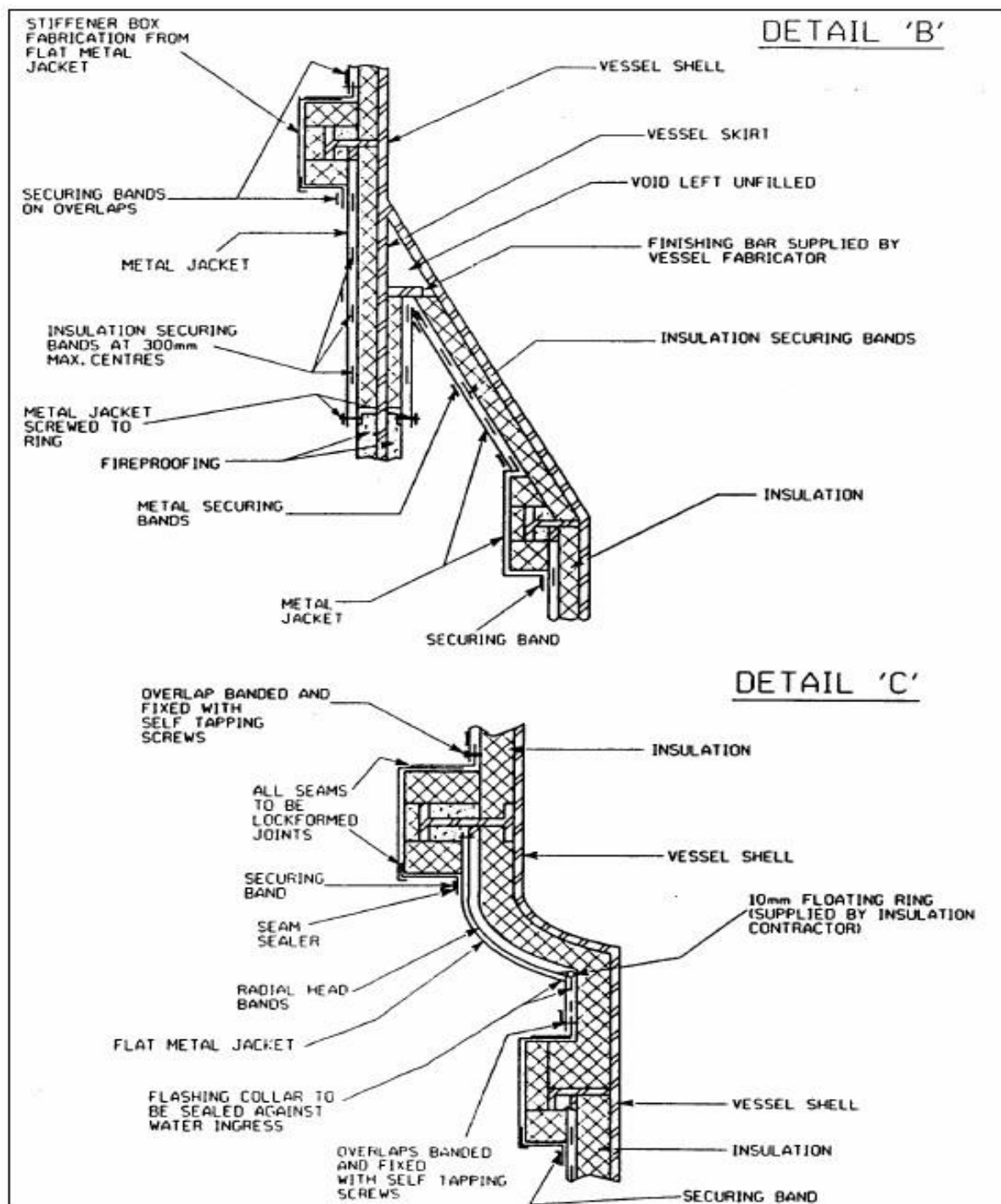
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Figure 5: STIFFENER RINGS AND CONICAL SHAPES (2 OF 3)



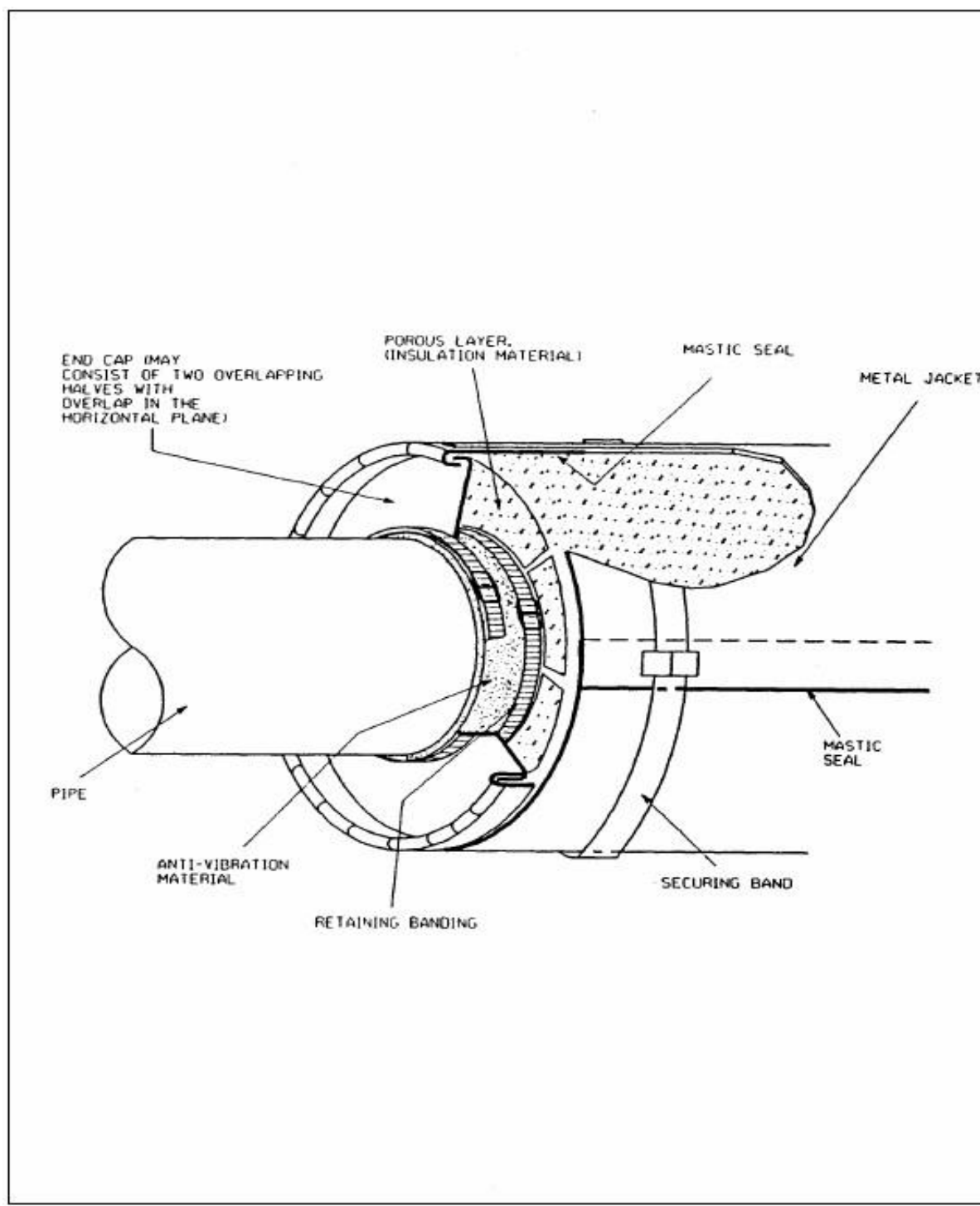
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Figure 5: STIFFENER RINGS AND CONICAL SHAPES (3 OF 3)



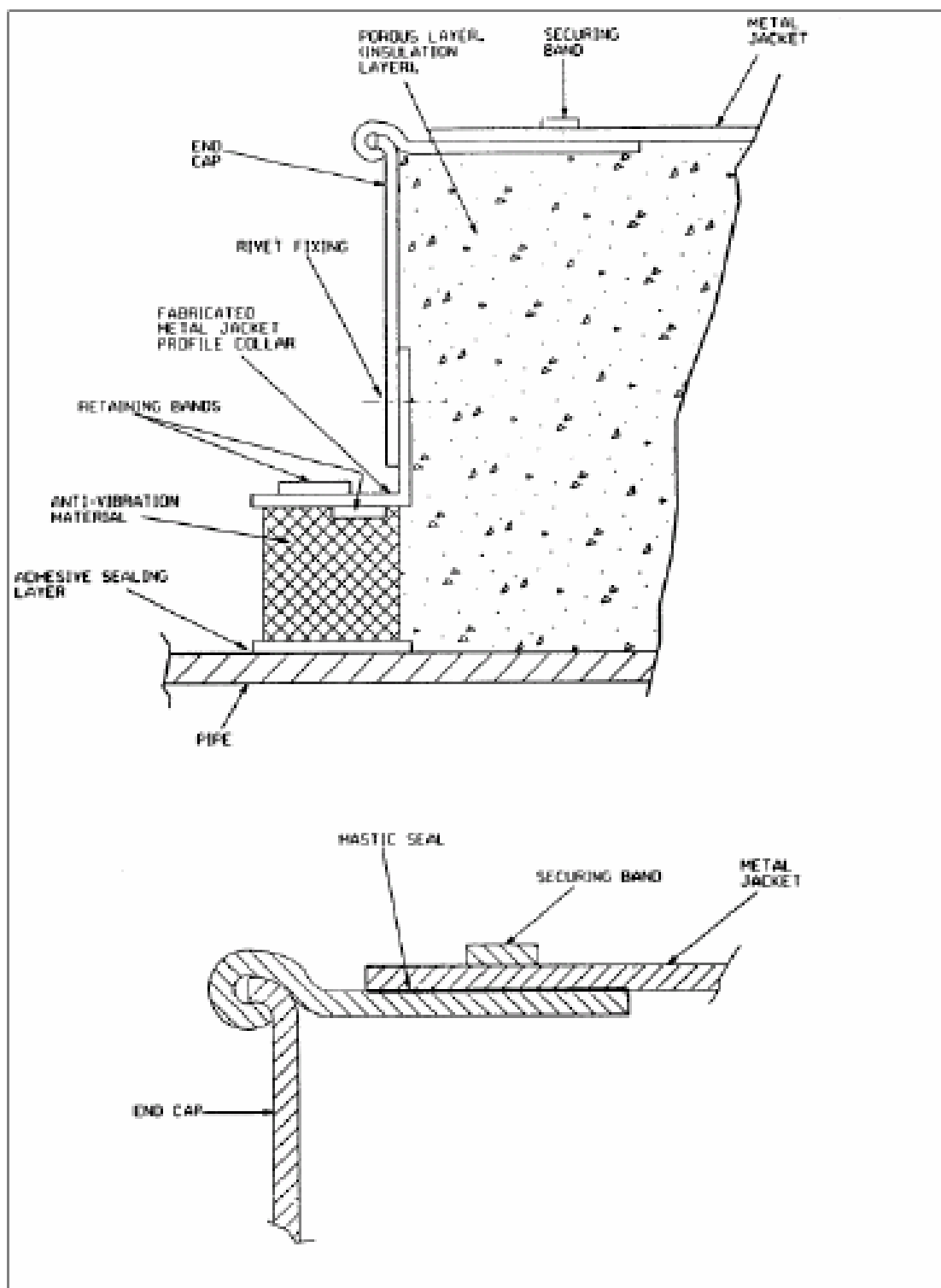
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Figure 6: ACOUSTIC INSULATION (1 OF 4)



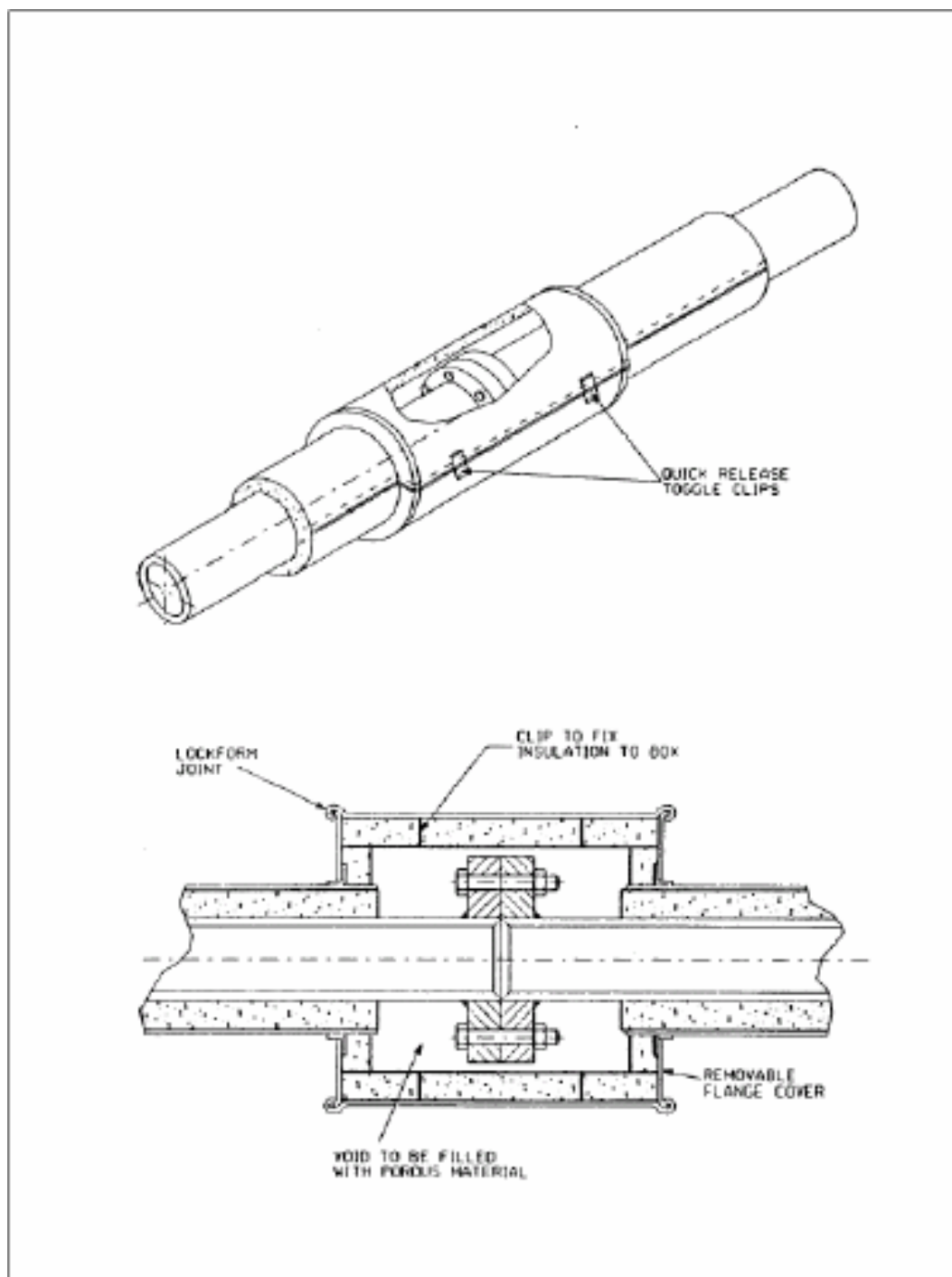
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Figure 6 ACOUSTIC INSULATION (2 OF 4)



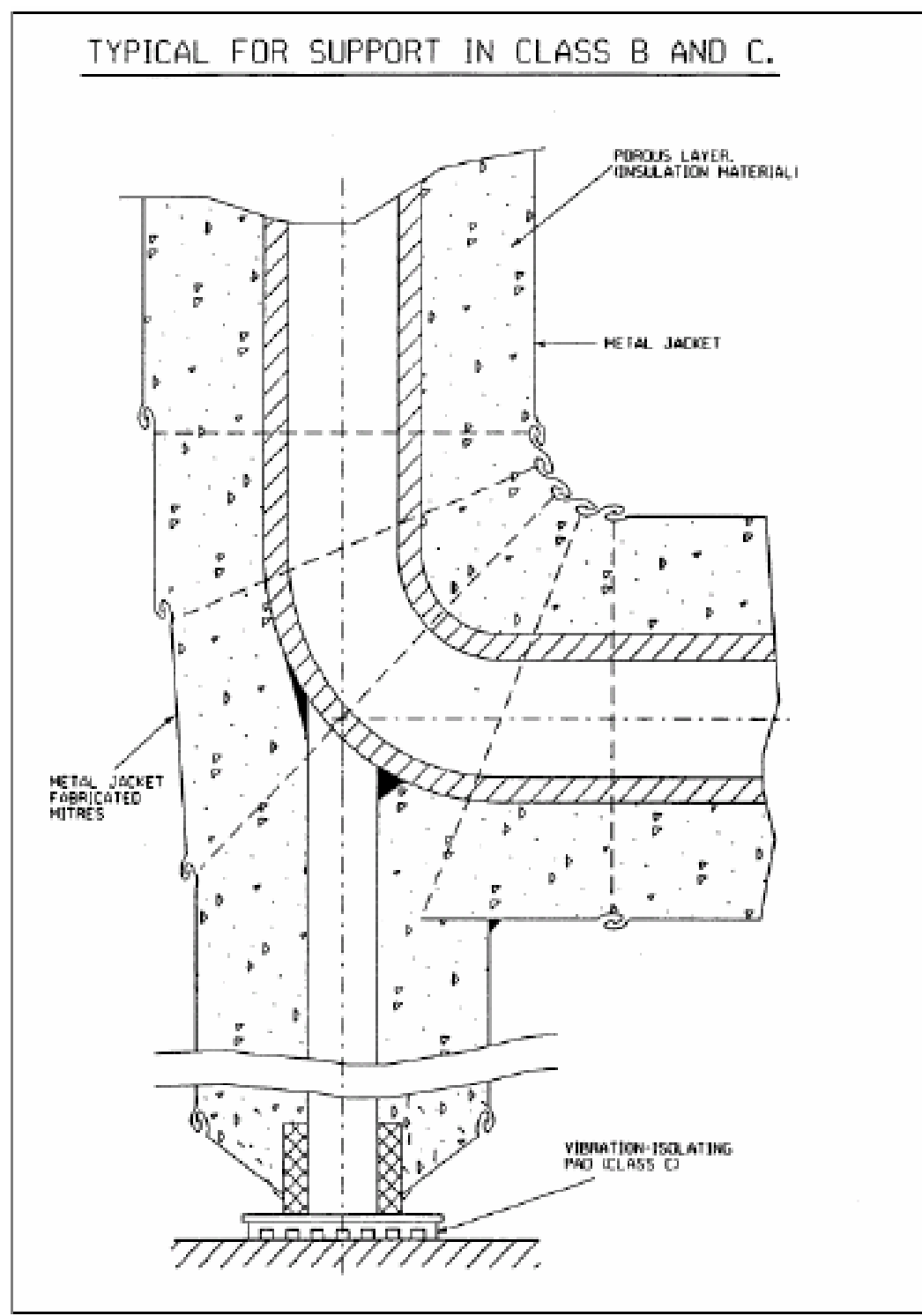
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Figure 6: ACOUSTIC INSULATION (3 OF 4)



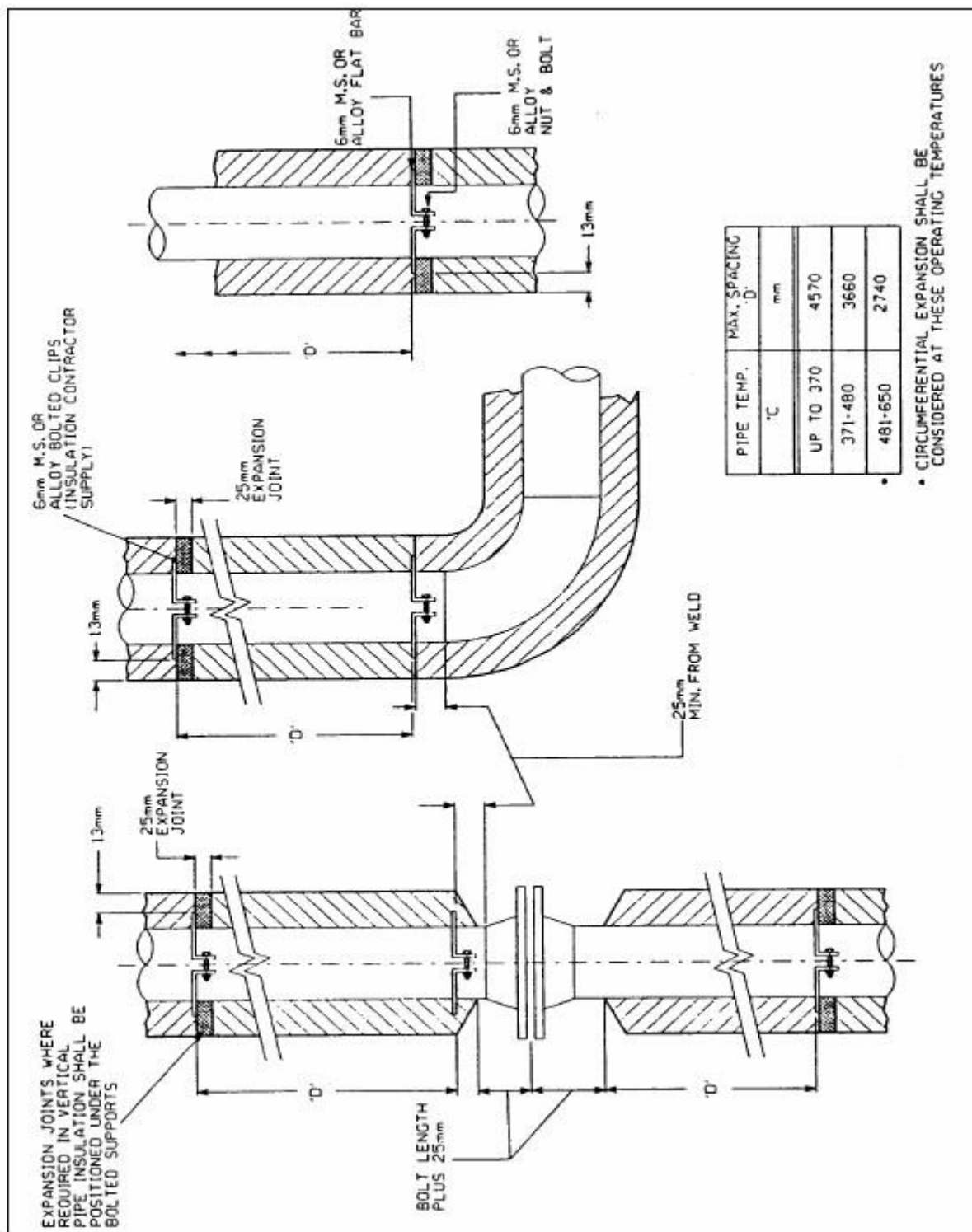
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Figure 6: ACOUSTIC INSULATION (4 OF 4)



	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD SPECIFICATION FOR INSULATION				
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Figure 7: BOLTED ON INSULATION SUPPORT COLLARS



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SPECIFICATION FOR PAINTING

						
0	Issued for ITB	20-06-19	AF	RD	KPM	
A	Issued for Review/Approval	10-04-19	AF	RD	KPM	
REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD SPECIFICATION FOR PAINTING				
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1.0 GENERAL

- 1.1** This technical specification shall be applicable for the work covered by the contract and without prejudice to the provisions of various international codes of practice, standard specifications etc. It is understood that the CONTRACTOR shall carry out the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of Engineer in charge.
- 1.2** Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done, it shall be deemed that the same shall be supplied or carried out by the CONTRACTOR.

Any deviation from this standard without written deviation permit from appropriate authority will result in rejection of the job.

- 1.3** This specification covers the requirement for protective coating for new construction.

2.0 SCOPE

- 2.1** Scope of work covered in the specification shall include, without being limited to, the following:

This specification defines the requirements for surface preparation, selection and application of primers and paints on external surfaces of equipment, vessels, machinery, piping, ducts, steel structures, external & internal protection of storage tanks for all services and chimneys, if any. The items listed in the heading of tables of paint systems are indicative only. However, the CONTRACTOR is fully responsible for carrying out all the necessary painting, coating and lining job on external and internal surfaces as per the tender requirement.

2.2 EXTENT OF WORK

2.2.1 The following surfaces and materials shall require shop, pre-erection and field painting:

- All un-insulated carbon steel & alloy steel equipment like vessels, columns, storage tanks, exchangers, parts of boilers etc.
- All un-insulated carbon steel and low alloy plant and related piping, fittings and valves (including painting of identification marks), furnace ducts and stacks.
- All insulated parts of vessels, boilers, chimneys, stacks, piping and steam piping and other insulated items present, if any.
- All items contained in a package unit.
- All structural steel work, pipes, structural steel supports, walkways, handrails, ladders, platforms etc.
- Flare lines, external surfaces of MS chimney with or without refractory lining and internal surfaces of MS chimney without refractory lining.
- Identification of colour bands on all piping, as required, including insulated Aluminium clad, galvanized, SS and nonferrous piping.

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- Identification lettering/ numbering on all painted surfaces of equipment/piping insulated Aluminium clad, galvanized, SS and non-ferrous piping.
- Marking / identification signs on painted surfaces of equipment and piping including hazardous service.
- Supply of all primers, paints and all other materials required for painting (other than OWNER supplied materials)
- Application of pre-erection/fabrication and shop primer.
- Repair work of damaged pre-erection/ fabrication and shop primer and weld joints in the field/site before and after erection.
- All CS piping, equipment, storage tanks and internal surfaces of RCC tanks in ETP plant.
- Quality control, testing and inspection during all stages of work (surface preparation, application of coating and testing of furnished coating).

2.2.2 The following surfaces and materials shall not require painting in general. However, if there is any specific requirement by the OWNER, the same shall be painted as per the relevant specifications:

- Un-insulated austenitic stainless steel.
- Plastic and/or plastic-coated materials.
- Non-ferrous materials like aluminum, Cu-Ni alloys, galvanized steel.

In general, Galvanized steel doesn't require painting. However, if painting is required due to OWNERs instructions, contractual or for colour coding requirement then coating system in Table 4.0 shall be followed.

2.3 DOCUMENTS

2.3.1 The CONTRACTOR shall perform the work in accordance with the following documents issued to him for execution of the work.

- Bill of quantities for piping, equipment, machinery and structures etc.
- Piping line list.
- Painting specifications including special civil defense requirements.

2.4 Unless otherwise instructed, final paint coating (i.e. application of field primer, intermediate and top coats) on pre-erection/ shop primed equipment shall be applied at site, only after all welding, testing on systems are completed as well as after completion of steam purging.

2.5 Changes and deviations required for any specific job due to OWNERs requirement or otherwise shall be referred to JPEC/OIL for deviation permit.

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3.0 REFERENCE CODES & STANDARDS

3.1 Without prejudice to the provision of clause 1.1 above and the detailed specifications of the contract, latest editions of the following codes and standards are applicable for the work covered by this contract:

ISO-12944-5	Corrosion protection of steel structures by protective paint system.
ASTM-Vol. 6.01&6.03	American standard test methods for paints and coatings.
IS-101	Methods of sampling and test for paints, varnishes and related products.
IS-5	Colours for ready mixed paints and enamels.
RAL DUTCH	International standard for colour shade (Dutch standard).
IS-2379	Indian standard for pipe line identification-colour code

3.2 SURFACE PREPARATION STANDARDS

The latest editions of any of the following standards shall be followed for surface preparation:

3.2.1 ISO 8501-1 / SIS-05 5900: ISO standard for preparation of steel substrates before application of paints and related products. This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the Engineer-In-Charge.

3.2.2 Steel Structures Painting Council, U.S.A. (surface preparation specifications SSPC-SP).

3.2.3 National Association of Corrosion Engineers (NACE), U.S.A.

3.2.4 Various international standards equivalent to Swedish standard for surface preparations are given in Table-1.

3.3 The CONTRACTOR shall arrange, at his own cost, to keep a set of latest editions of above-mentioned standards and codes at site.

3.4 The paint manufacturers' instructions shall be followed as far as practicable at all times for the best results. Particular attention shall be paid to the following:

- Instructions for storage to avoid exposure as well as extremes of temperature.
- Surface preparation prior to painting shall be followed as per Table-4 to 13 of this standards.
- Mixing and thinning.
- Application, recommended limit on time intervals in between coats & DFT.

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4.0 EQUIPMENT

- 4.1** All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning, all equipment, scaffolding materials, shot & grit blasting equipment, air compressors etc. required shall be suitable for the work and shall be arranged by the CONTRACTOR in sufficient quantity at the site. The manufacturers test certificates / data sheets for all the above-mentioned items shall be reviewed by Engineer-In-Charge at site before start of the work.
- 4.2** Mechanical mixer shall be used for paint mixing operations in case of two pack systems except in case of specific requirement; the Engineer-In-Charge may allow the hand mixing of small quantities at his discretion for touch up work only.

5.0 SURFACE PREPARATION, SHOP PRIMER / COATING APPLICATION, REPAIR AND DOCUMENTATION

5.1 General

- 5.1.1** Adhesion of the paint film to the surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system. In order to achieve the maximum durability, one or more of the following methods of surface preparation shall be followed, depending on condition of surface to be painted and as instructed by the Engineer-In-Charge.
- Abrasive blast cleaning
 - Mechanical or power tool cleaning

- 5.1.2** Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. Unless otherwise specified, surface preparation shall be done as per provisions of relevant tables given elsewhere in this specification. The minimum acceptable standard, in case of thermally sprayed metal coatings, in case of mechanical or power tool cleaning shall be St. 3 or equivalent. In case of blast cleaning, it shall be Sa 2-1/2 as per Swedish standard SIS-055900 (latest edition) or SSPC-SP or ISO 8501-01. Blast cleaning shall be Sa 3 as per Swedish standard in case of thermally sprayed metal coatings.

Before surface preparation by blast cleaning, the surface shall be degreased by aromatic solvent to remove all grease, oil etc as per SSPC-SP-1.

- 5.1.3** Irrespective of whether external or internal surface to be coated, blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity >85%. In case of internal coating of storage tanks, dehumidifier shall be used to control humidity level below 60%. Dehumidifier should depress the dew point of air in the enclosed space, sufficient enough so as to maintain it 3°C below the metal substrate temperature during entire period of blasting and coating application. During the interval time between application of primer coat and subsequent intermediate and top coats or between blast cleaning completion and start of application of primer coat, dehumidifier unit should be in continuous operation to ensure that no condensation occurs on the substrate.

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Dehumidifier should be able to maintain grain drop (moisture removal) at the rate of 25 grains per pound of air per hour. Dehumidifier should have capacity of at least 2 air changes per hour of the enclosed space. All necessary psychometric data should be collected by the CONTRACTOR for the given site conditions, before starting operation of dehumidifier, to ensure that desired values of dew point and moisture content in enclosed space is achieved.

Dehumidification to be maintained round the clock for surface preparation and painting till the total coating application is over.

Dehumidifier shall not be stopped under any condition till the entire blasted surface is primed to the satisfaction of the technical representative of the paint manufacturer. In case the dehumidifier breaks down in middle of the job, the same shall be replaced at the risk and cost of the CONTRACTOR.

- 5.1.4 The Engineer in-Charge shall have the right to disallow usage of dehumidifier if the performance is not meeting the specified requirements. Under such circumstances, the CONTRACTOR shall remove the equipment and replace the same with another equipment to provide satisfactory results without any additional cost to the OWNER.
- 5.1.5 Irrespective of the method of surface preparation, the first coat of primer must be applied by airless spray/ air assisted conventional spray, if recommended by the paint manufacturer, on dry surface. This should be done immediately and in any case within 4 hours of cleaning of the surface. However, at times of unfavorable weather conditions, the Engineer-In-Charge shall have the liberty to control the time period, at his sole discretion and/or to insist on re-cleaning before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable.
- 5.1.6 The external surface of R.C.C. chimney to be painted shall be dry and clean. Any loose particle of sand, cement, aggregate etc. shall be removed by scrubbing with soft wire brush. Acid etching with 10-15% HCl solution for about 15 minutes shall be carried out. The surface must be thoroughly washed with water to remove acid and loose particles and then dried completely before application of paint.

5.2 PROCEDURE FOR SURFACE PREPARATION

5.2.1 Air blast cleaning with abrasives

The surfaces shall be blast cleaned using one of the abrasives such as Al_2O_3 particles, chilled cast iron or steel grit, copper slag or nickel slag at a pressure of 7.0 kg/cm^2 and at an appropriate distance & angle depending on nozzle size maintaining constant velocity and pressure. Chilled cast iron or steel shall be in the form of shot or grit of size in the range of G16 – G42 conforming to SSPC AB1 and S250 grade size of steel shots (maximum) to obtain a desired surface profile of 35-50 microns trough to peak. For all other abrasives, size shall be in the range of G16 – G24. The combination of steel grits and shots shall be normally in the ratio of 3:1. The quality of abrasives shall be free from contaminants and impurities and shall meet the requirements of SSPC AB1. The compressed air shall be free from moisture and oil. The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the material for liners. Nozzle orifice may vary from 3/16" to 3/4". On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey-white

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metallic luster. Primer or first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection. If there is dew on the metal surface, it shall be cleaned. The surface profile shall be uniform to provide good adhesion (i.e. 35 to 50 microns) to the paint. If possible, a vacuum collector shall be installed to collect and recycle the abrasives.

5.2.2 Mechanical or power tool cleaning

Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire- brushes. Excessive burnish of the surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust, mill scale etc. shall be removed by clean rags and /or washed by water/steam and thoroughly dried with compressed air jet before application of paint.

5.3 NON-COMPATIBLE SHOP COAT PRIMER

For equipment on which application of total protective coating (primer + intermediate + top coat) is carried out at shop, compatibility of finish coat with primer should be checked with the paint manufacturer. If the shop coat is in satisfactory condition showing no major defect upon arrival at site, the shop coat shall not be removed.

5.4 Shop coated equipment (coated with primer & finishing coat) should not be repainted unless paint is damaged. Repair shall be carried out as per Table-3 of paint systems depending upon the compatibility of paint.

5.5 Shop primed equipment and surfaces will 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 should be completely removed before application of selected paint system for a particular environment.

5.6 For package units/equipment, shop primer should be as per the paint system given in this specification. However, manufacturers" standard can be followed after review. As mentioned in section 2.4, all coating application at field (field primer, intermediate and top coat) on equipment, structures, piping, etc, shall be carried out only after its erection and all welding, testing, steam purging (wherever carried out) have been completed.

5.7 COATING PROCEDURE AND APPLICATION

All coatings shall be applied by airless spray except for the following special cases, where application can be carried out by brush subject to suitability of the application of the paint product by brush.

- Spot repair
- Stripe coating on edges
- Small bore parts not suitable for spray application

Irregular surfaces such as sharp edges, welds, small brackets, and interstices may stripe coated to ensure specified DFT is achieved. Paint manufacturer recommendation should be followed before deciding for brush application.

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5.7.1 Surface shall not be coated in rain, wind or in an environment where injurious airborne elements exist, when the steel surface temperature is less than 5 °F above dew point, when the relative humidity is greater than 85%, when the temperature is below 40°F and when the ambient/substrate temperature is below the paint manufacturers recommended temperature of application and curing. Dehumidifier equipment shall be used to control RH and Dew point. The paint application shall not be done when the wind speed exceeds 20 km per hour.

5.7.2 Blast cleaned surface shall be coated with complete application of primer as soon as practicable but in no case later than 4 hours the same day.

5.7.3 To the maximum extent practicable, each coat of paint shall be applied as a continuous film with uniform thickness and free of probes. Any spots or areas missed in application shall be re-coated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.

5.7.4 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for re-coating when an additional coat can be applied without the development of any detrimental film irregularities such as lifting or loss of adhesion of the under coat. Manufacturer's instructions shall be followed for intercoat interval.

5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate the complete coverage of the surface. The tinting material shall be compatible with the material underneath and shall not be detrimental to its service life and shall be recommended by the original paint manufacturer.

5.7.6 Airless spray application shall be in accordance with the following procedure: As per steel structure paint manual Vol.1 & Vol.2 by SSPC, USA. Airless spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor, issued to operate a pump to produce pressures of 1000 to 6000 psi paint, is delivered to the spray gun at this pressure through a single hose within the gun. A single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This results in more rapid coverage with less over spray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional air spray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have in-built agitator that keeps the paint uniformly mixed during the spraying. The unit shall consist of in-built strainer. Usually, a very small quantity of thinning is required before spray. In case of high build epoxy coating (two packs), 45:1 pump ratio and 0.020-0.023" tip size will provide a good spray pattern. Ideally, fluid hoses should not have ID less than 3/8" and not longer than 50 ft. to obtain optimum results.

In case of gun choking, de-choking steps shall be followed immediately.

5.7.7 Brush application of paint shall be in accordance with the following:

Brushes shall be of a style and quality that will enable proper application of paint.

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- a. Round or oval brushes are most suitable for rivets, bolts, irregular surfaces, and rough/ pitted steel. Wide flat brushes are suitable for large flat areas but they shall not have width over 5 inches.
- b. Paint shall be applied into all corners.
- c. Any runs or sags shall be brushed out.
- d. There shall be a minimum of brush marks left in the applied paint.
- e. Surfaces not accessible to brushes shall be painted by spray, daubers, or sheepskin.

5.7.8 For each coat, the painter should know the WFT corresponding to the specified DFT and standardize the paint application technique to achieve the desired WFT. This has to be ensured in the qualification trial.

5.8 DRYING OF COATED SURFACES

- 5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat. If this exceeds, the paint material has possibly deteriorated or mixing is faulty.
- 5.8.2 No paint shall be force dried under conditions which will cause chalking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint.
- 5.8.3 No drier shall be added to paint on the job unless specifically called for in the manufacturer's "specification for the paint.
- 5.8.4 Paint shall be protected from rain, condensation, contamination, snow and freezing until dried to the fullest extent practicable.

5.9 SPOT REPAIR OF DAMAGED PRIMER

- 5.9.1 Where pre-erection/shop primer has been damaged at isolated localized spots during handling and transportation or after erection / welding, its repair shall be done as given below and as per the Table-3 of this specification.
- 5.9.2 Repair of damaged inorganic zinc silicate pre-erection/pre-fabrication/shop primer (F9) after erection / welding in the design temperature of -90°C to 400°C and damaged silicone Aluminium (F-12) pre-erection/pre-fabrication/shop primer after erection/welding for design temperature range of 401 – 550 °C.

Surface preparation: Quickly remove the primer from damaged area by mechanical scraping and emery paper conforming to SSPC-SP-3 to expose the white metal. Blast clean the surface, if possible. Feather the primed surface, over the intact adjacent surface surrounding the damaged area, by emery paper.

Primer coating: One coat of F-9 shall be applied wherever damage was observed on pre-erection / pre-fabrication or shop primer of inorganic zinc silicate coating (F9). Similarly, one coat of F-12 shall be applied wherever damage observed on pre-erection / pre-fabrication/shop primer of silicone Aluminium (F-12).

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5.9.3 If damaged areas are found to be extensive and spread over large areas, then entire pre-erection/pre-fabrication/shop primer shall be removed by blasting to achieve SSPC-SP-10 and entire blasted surface shall be primed again with F-9 or F-12, as applicable, for the intended design temperature. (See note of Table-3).

5.10 PAINT APPLICATION

5.10.1 Shop priming/pre-erection priming with F9 or F12 shall be done only on blasted surface (SSPC- SP-10).

5.10.2 Shop priming / pre-erection priming with F9 or F12 shall be done only with airless spray or Air assisted pressure pot.

5.10.3 Assessment of painting requirement

The paint system to be applied for a specific job shall be arrived at sequentially as given below:-

- Identify the environment from area classification details and choose the appropriate table.
- Identify the design temperature from the technical documents.
- Identify the specific field paint system and surface preparation requirement from the above identified table and temperature range.
- Identify the shop priming requirement from based on compatibility of the above paint system. - Identify the need of repair of shop primer and execute as per Table-3.

5.11 DOCUMENTATION / RECORDS

5.11.1 A written quality plan with procedure for qualification trials and for the actual work including test and inspection plan & procedure for approval before start of work.

5.11.2 Daily progress report with details of weather conditions, particular of applications, no. of coats and type of materials applied, anomalies, progress of work versus program.

5.11.3 Results of measurement of temperatures, relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.

5.11.4 Particulars of surface preparation and paint application during trials and during the work.

5.11.5 Details of non-compliance, rejects and repairs.

5.11.6 Type of testing equipment and calibration.

5.11.7 Code and batch numbers of paint materials used.

The coating applicator must maintain a job record consisting of all the information as per 5.11.2 -5.11.7 above as well as the approved procedure of work (5.11.1 above). The job record consisting of information in accordance to 5.11.2 – 5.11.7 shall be entered on daily basis and should be daily signed by Engineer-in-charge.

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After completion of the job, along with the final documentation, contractor shall submit the document for the total quantum of job carried out, quantity of paint used area wise / equipment wise. Test certificates, stage wise inspection reports, manufacturer's guarantee certificate, stage wise inspection / witness certificate from paint manufacturer.

TABLE-1
SURFACE PREPARATION STANDARDS

Sl. No.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)		REMARKS
		ISO 8501-1/ SIS-05 59 00	SSPC-SP	
1	<u>Manual or hand tool cleaning</u> Removal of loose rust, loose mill scale and loose paint, chipping, scrapping, standing and wire brushing. Surface should have a faint metallic sheen.	St 2	SSPC-SP-2	This method is applied when the surface is exposed to normal atmospheric conditions when other methods cannot be adopted and also for spot cleaning during maintenance painting.
2	<u>Mechanical or power tool cleaning</u> Removal of loose rust loose mill scale and loose paint to degree specified by power tool chipping, de-scaling, sanding, wire brushing and grinding, after removal of dust, surface should have a pronounced metallic sheen.	St 3	SSPC-SP-3	
3	<u>Dry abrasive Blast cleaning</u> There are four common grades of blast cleaning:			

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Sl. No.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)		REMARKS
		ISO 8501-1/ SIS- 05 59 00	SSPC-SP	
3.1	<u>White metal</u> Blast cleaning to white metal cleanliness. Removal of all visible rust. Mill scale, paint & foreign matter 100% cleanliness with desired surface profile.	Sa 3	SSPC-SP-5	Extremely clean surface can be expected to have prolonged life of paint system.
3.2	<u>Near white metal</u> Blast cleaning to near white metal cleanliness, until at least 95% of each element of surface area is free of all visible residues with desired surface profile.	Sa 2½	SSPC-SP-10	The minimum requirement for chemically resistant paint systems such as epoxy, vinyl, polyurethane based and inorganic zinc silicate paints. Also, for conventional paint systems used under fairly corrosive conditions to obtain desired life of paint system.
3.3	<u>Commercial Blast</u> Blast cleaning until at least two-third of each element of surface area is free of all visible residues with desired surface profile.	Sa 2	SSPC-SP-6	For steel required to be painted with conventional paints, for exposure to mildly corrosive atmosphere and for longer life of the paint systems.
3.4	<u>Brush-off Blast</u> Blast cleaning to white metal cleanliness, removal of all visible rust, mill scale, paint & foreign matter. Surface profile is not so important.	Sa 1	SSPC-SP-7	-

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6.0 PAINT MATERIALS

Typical characteristics and codes of various paint materials used in this specification are as follows.

TABLE-2
PAINT MATERIALS

(Refer to general notes at the end of this section)

DESCRIPTION	P-6	P-7	P-4
Technical name	Epoxy Zinc Phosphate Primer	Cold Galvanizing product `	Etch Primer/Wash Primer
Type and composition	Two component polyamine cured epoxy resin medium, pigmented with zinc phosphate.	One pack synthetic resin-based zinc galvanizing containing min 92% of electrolytic zinc dust of 99.95% purity.	Two pack polyvin butyral resin medium cured with phosphoric acid solution pigmented with zinc tetroxy chromate.
Volume solids % Minimum	49	37	9
DFT per coat, μ	40-50	40-50	8-10
Theoretical covering capacity in m ² /coat/ litre	8-10	4m ² /kg	8-10
Weight per litre in Kg/litre	1.4±0.05	2.67 kg at 15 °C	1.2±0.05
Touch dry at 30°C (max.)	30 min	10 min.	2 hrs.
Hard dry at 30°C (max.), hrs	8	24	24
Over-coating interval, hrs	Min. 8	Min. 4	Min. 4-6
Pot life at 30°C for two component paints, hrs	6 - 8	NA	NA
Adhesion (ASTM D 4541)	>7	NA	NA
Temperature resistance (min) ° C (ASTM D 2485 method B)	80 Dry service	50 Dry service	NA

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TABLE-2: PAINT MATERIAL (Contd.)

DESCRIPTION	F-2	F-3	F-6A/B	F-6C
Technical name	Acrylic Polyurethane finish paint	Chlorinated rubber based finish paint	Epoxy-High Build coating	Solvent less epoxy coating
Type and composition	Two-pack aliphatic isocyanate cured acrylic finish paint (free of alkyd/polyester resins).	Single pack plasticized chlorinated rubber based medium with chemical and weather resistant pigments.	F-6A Two- Pack Aromatic polyamine cured epoxy resin medium suitably pigmented. F-6B: polyamide cured epoxy resin medium suitably pigmented	Two pack, cured with Amine Adduct; catalyzed epoxy resin suitably pigmented
Volume Solids % Minimum.	40	36	57	98
DFT per coat, μ	30-40	30-40	100-125	250-500
Theoretical covering capacity in m ² /coat/litre	10-15	11-15	5-6	2-3
Weight per liter in Kg/litre	1.15±0.03	1.15±0.03	1.42±0.03	1.40±0.03
Touch dry at 30°C (max)	30 min.	30 min.	3 hrs	3 hrs
Hard dry at 30°C (max.), hrs	8	8	16	16
Full cure at 30°C (for immersion/ high temperature service)	NA	NA	5 days	5 days
Over-coating Interval, hrs	Min.12.	Min. Overnight	Min. Overnight Max. 5 days	Min. 8. Max. 48
Pot life (approx.) at 30°C for two component paints, hrs	5-8	NA	3-6	0.5
Adhesion (ASTM D 4541)	>5	>4	>7	>8
Abrasion Resistance (ASTM D4060) For 1000 g load	<300 mg /1000 cycles/CS17 OR <100 mg /1000	NA	NA	NA

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	cycles/CS10			
Temperature resistance (min.) ° C (ASTM D 2485 method B)	80Dry service	60 Dry service	80Dry service	120, dry service 50, immersion

TABLE- 2: PAINT MATERIALS (Contd.)

DESCRIPTION	F-7	F-8	F-9 (primer)	F-11	F-12
Technical name	High build coal tar epoxy coating.	Self priming type surface tolerant high build epoxy coating (complete rust control Coating)	Inorganic zinc silicate Coating	Heat resistant synthetic medium based two pack Aluminium Paint suitable up to 250°C dry temp.	Heat resistant silicone Aluminium Paint suitable up to 540°C dry temp.
Type & composition	Two pack polyamide cured epoxy resin blended with coal tar medium, suitably pigmented	Two pack epoxy resin based suitable pigmented and capable of adhering to manually prepared surface and old coating.	A two-pack air drying self-curing solvent based inorganic zinc silicate coating with minimum 80% zinc content on dry film. The final cure of the dry film shall pass the MEK rub test as per ASTM D4752.	Heat resistant synthetic medium based two pack Aluminium paint suitable up to 250°C.	Single pack silicone resin based medium with Aluminium flakes.
Volume Solids % Minimum.	62	75	57	35	18
DFT per coat in μ	100-125	100-125	65-75	15-20	15-20
Theoretical covering capacity in M ² /coat/ litre	5.2-6.5	6.0-7.2	8-9	10-12	8-10
Weight per liter in Kg/litre	1.40±0.03	1.41±0.03	2.3±0.03	0.95±0.03	1.00±0.03

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DESCRIPTION	F-7	F-8	F-9 (primer)	F-11	F-12
Touch dry at 30°C (maximum), hrs	4	3	0.5	3	0.5
Hard dry at 30°C (maximum), hrs	48	24	12	12	24
Full cure 30°C (for immersion /high temperature service)	5 days	5 days	NA	NA	NA
Over-coating interval, hrs	Min. 24 hrs max.5days	Min. 10	Min. 12 hrs at 20° C & 50% RH	Min. 24	Min. 24
Pot life at 30 C for two component Paints, hrs	4-6	1.5	4-6	NA	NA
Adhesion MPa (ASTM D 4541)	>5	>5	>5	NA	NA
Temperature resistance° C (min) (ASTM D 2485 method B)	80 Dry service	80 Dry service	400 Dry service	250 Dry service	540 Dry service

TABLE- 2: PAINT MATERIALS (Contd.)

DESCRIPTION	F-14	F-15	F-16	F-17	F-20
Technical name	Polyamine cured coal tar epoxy	Two-component Epoxy phenolic coating cured with Polyamine adducts hardener	Ambient temperature curing Poly Siloxane/ inert polymeric coating suitable for under insulation for CS and SS.	Novolac epoxy phenolic coating cured with Polyamine adduct hardener	Glass flake reinforced vinyl ester coating.

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DESCRIPTION	F-14	F-15	F-16	F-17	F-20
Type & composition	Specially formulated polyamine cured coal tar epoxy suitable for application under insulation	Two pack ambient temperature curing epoxy phenolic coating system suitable for application under insulation	Suitable for high temperature service and under insulation coating for CS, alloy steel and SS	Novolac epoxy phenolic coating cured with Polyamine adduct hardener	Two components glass flake filled vinyl ester lining for under immersion services up to 90 deg. C.
Volume Solids % Minimum.	67	67	58	98	98
DFT per coat in microns	100-125	75-100	75-100	300-450	500-600
Theoretical covering capacity in M ² /coat/ litre	5-8	4-5	7.0- 9.0	6.5 – 8	1.6 minimum
Weight per liter in Kg/litre (mix paint)	1.45±0.03	1.65±0.03	1.3	1.7	>1.2
Touch dry at 30°C (max), hrs	4	3	1	2	2
Hard dry at 30°C (max), hrs	24	24	16	24	4
Full cure 30°C (for immersion / high temp service)	168 hrs (7 days)	168 hrs (7 days)	NA	168 hrs (7 days)	96 hrs (4 days)
Over-coating interval	Min. 6 hrs Max.5 days	Min. 36 hrs Max.21 days	Min.16 hrs Max. Not applicable	Min. 16 hrs Max.21 days	Min. 4 hrs Max.3 days
Pot life at 30°C, hrs (for two component paints)	4	4-6	1	1	50 min-1 hr

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DESCRIPTION	F-14	F-15	F-16	F-17	F-20
Adhesion, MPa (ASTM D 4541)	>6	>7	>8: siloxane NA: for inert polymeric matrix	>8	>7, T ensile strength >20N/mm ² (ASTM D 638)
Temperature resistance (min) ° C (ASTM D 2485 method B)	-45 to 125 Under insulation & immersion	-45 to 150 Under insulation & immersion	550 Under insulation	-45 to 150 Immersion service	90 immersion service

GENERAL NOTES FOR TABLE-2: -

1. Covering capacity and DFT achieved per coat depends on method of application. Covering capacity specified above is theoretical. For estimation of actual quantity of paints required, include the losses during application. Minimum specified DFT should be maintained in any case.
2. All primers and finish coats should be ambient temperature curing and air drying unless otherwise specified.
3. All paints shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured. Wherever a deviation is noticed from the specification in manufacturer data sheet, more stringent one between the data sheet and the specification shall prevail e.g. if this specification recommends Sa 2 ½ and the manufacturer data sheet requires Sa3, the surface preparation shall be done as per Sa 3. However, in another case if this specification requires the surface preparation of Sa 2 ½ and the manufacturer data sheet recommends only Sa 2 as minimum, the surface preparation shall be done as per Sa 2 ½.
4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.
5. Higher specific gravity of F-9 is also acceptable.
6. Internationally recognized & acceptable testing method shall be used for lab testing (for clause – 15.1) wherever testing standard is not mentioned.
7. Theoretical covering capacity, hard dry, full cure period & over coating interval shall be as per manufacturer's data sheets and no testing is required. Slight variation in the values of these parameters may be permissible with the discretion of engineer-in-charge.

7.0 COATING SYSTEMS

The coating system should be selected based on the plant location as given below:

Classification based on plant location:

Plant located in inland area (more than 50 km from coast).

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Environment classification – Industrial

- For offsite areas: Table-5 to be followed.
 - For all unit areas including DM, CPP and cooling tower: Table-6 to be followed.
- b) Plant located on sea coast or within 50 km from sea coast.
Environment classification- Industrial marine
- For offsite area, unit areas including DM, CPP, cooling tower etc.: Table-6 to be followed.
- c) For external surface of above ground tanks, Table-8 to be followed for all locations (inland or coastal)

GENERAL NOTES FOR CLAUSE 7.0:

- Coating systems (primers, finish, paints etc.) based on area classification/environments/applications are tabulated in Table-4 to Table-13
- Repair of pre-erection/pre-fabrication & shop priming after erection/ welding shall be done as per Table-3.

TABLE-3

REPAIR OF PRE-ERECTION/PRE-FABRICATION OR SHOP PRIMER AFTER ERECTION/WELDING

(For all un-insulated CS, LTCS & low allow steel items in all environments)

Sl. No.	Design Temp. in °C	Surface Preparation	Coating System	Total DFT in Microns (min.)	Remarks
3.1	-90 to 400	SSPC-SP-3	1 coat of F-9	65-75	See Note-1 below and clause 5.9.3
3.2	401 to 550	SSPC-SP-3	1 coat of F-12	20	

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NOTES FOR TABLE-3

- The application and repair of pre-erection/pre-fabrication or shop primer given in above tables shall be done for all the items to be painted. In case the damages of primer are severe and spread over large area, entire primer shall be removed by blasting to achieve SSPC-SP-10 and surfaces to be primed again with F-9 or F-12 as applicable.

TABLE-4

COATING SYSTEM FOR GI HAND RAILS & GI ITEMS (Refer clause 2.2.2)

Sl. No.	Design Temp. in °C	Coating System	Total DFT in Microns (min.)	Remarks
4.1	Up to 60	Hot Dip Galvanizing to 80-85 microns (600-610 gm/m ²) as per IS 4759, 2629, 4736, 2633 + 1 coat of P-6 @ 40μ DFT/coat + 1 coat of F-2 @ 40 microns DFT/coat	80 of finish coat (excluding the thickness of galvanizing)	-

GENERAL NOTES FOR TABLE-4

- No galvanized specimen shall have thickness less than 80 microns.
- Repair of the damaged areas of galvanized coatings due to welding during erection shall be carried out as per recommended practice IS: 11759, using cold galvanizing spray process. Organic paint systems are not acceptable for the repair.
- After repair of damaged galvanized coating by cold galvanization (P-7), the repaired area shall be top coated with paint system as given in table-4 above (i.e. 1 coat of P-6 @ 40μ DFT/coat + 1 coat of F-2 @ 40μ DFT/coat).
- Suggested cold galvanizing manufacturers are ZINGA, LOCTITE or Z.R.C.
- Galvanized gratings don't require painting in general until otherwise specified elsewhere or as per the requirement of the OWNER. Ladders, stairways & hand rails require painting to meet the colour coding requirement of the OWNER. Contractor has to ensure the applicable colour coding prior to application of coating as per this clause.

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TABLE-5

COATING SYSTEM FOR NORMAL CORROSIVE AREAS (OFFSITES)

(For all un-insulated above ground CS, LTCS & low allow steel piping, equipment, valves, vessels & columns etc.)

Sl.No.	Design Temp. ^o C	Surface preparation & pre-erection/Shop primer	Coating System		Total DFT Microns (min.)	Remarks
			Primer	Finish Paint		
5.1	-45 to -15	SSPC-SP-10; 1coat of F-9 @ 65-75μ DFT/coat	-	None	65-75	No overcoating shall be done on F-9
5.2	-16 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75μ DFT/coat	1 coat of P-6 @ 40 μ DFT/coat	1coat of F-6B @ 100 μ DFT/coat+ 1 coat of F-2 @ 40μ DFT/coat	245-255	
5.3	81 to 250	SSPC-SP-10; 1coat of F-9 @ 65-75μ DFT/coat	-	2 coats of F11 @ 20μ DFT/coat (2x20=40)	105	
5.4	251 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75μ DFT/coat	-	2 coats of F12 @ 20μ DFT/coat (2x20=40)	105-115	F-12 shall be ambient temperature curing type
5.5	>400	SSPC-SP-10; 1coat of F-12 @ 20μ DFT/coat	-	2 coats of F-12 @20μ DFT/coat (2x20=40)	60	This system is suitable up to 540 ^o C

GENERAL NOTES FOR TABLE-5

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The CONTRACTOR is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated through his scope of work as per tender document.
2. Flare line within unit or offsite areas shall be coated as per clause 6.3 of Table-6.
3. If the application of pre-erection/pre-fabrication/shop primer has already been completed, the same shall not be repeated in the field. In case the damages to the primer coat are severe and are spread over large areas, the Engineer-In-Charge may decide & advise re-blasting

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and re-application of the primer coat. Repair of prefabrication/pre-erection primer, if required, shall be done as per Table-3.

4. In case of paint systems as per sl. nos. 5.4 and 5.5, the colour bands shall be applied over the aluminum paint as per the colour coding requirement for specific service of the piping.
5. All coating system including surface preparation, primer, intermediate and finish coat for piping is recommended to be done at field only until otherwise specified.
6. For equipment, vessels, columns & valves etc scope of surface preparation, application of primers to finish coat including repair shall be as per applicable contractual documents like SOR, MR and PR etc.

TABLE-6

(COATING SYSTEM FOR CORROSIVE AREAS (PROCESS UNITS, COOLING TOWER, DM AND CPP)

(For all un-insulated above ground CS, LTCS & low allow steel piping, equipment, valves, vessels & columns etc.)

Sl.No.	Design Temp. ^o C	Surface preparation & pre-erection/Shop primer	Coating System		Total DFT Microns (min.)	Remarks
			Primer	Finish Paint		
6.1	-45 to -15	SSPC-SP-10; 1coat of F-9 @ 65-75μ DFT/ coat	-	-	65-75	a) No over coating on F-9 is allowed b) F-12 shall be ambient temperature curing type
6.2	-16 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75μ DFT/ coat	1 coat of P-6 @ 40 μ DFT/ coat	2 coats of F- 6B @ 100 μ DFT/coat + 1 coat of F-2 @ 40μ DFT/coat (2x100 + 40= 240)	345-355	
6.3	81 to 400	SSPC-SP-10; 1coat of F-9 @ 65-75μ DFT/ coat	-	2 coats of F- 12 @ 20μ DFT/coat 2x20=40	105-115	

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6.4	>400	SSPC-SP-10; 1coat of F-12 @ 20-25μ DFT/coat	-	2 coats of F- 12 @ 20- 25μ DFT/coat (2x20=40)	60	This system is suitable up to 540° C

General notes for TABLE-6

1. The list of items given in the heading of the above table is not exhaustive. There may be more items for a particular contract where these specifications are used. The CONTRACTOR is fully responsible for completing painting including prefabrication primer for all the items supplied and fabricated as per tender document and scope of work.
2. If the application of pre-erection/pre-fabrication/shop primer has already been completed, the same shall not be repeated in the field. In case the damages to the primer coat are severe and spread over large areas, the Engineer-In-Charge may decide & advise re-blasting and re-application of the primer coat. Repair of prefabrication/pre-erection primer, if required, shall be done as per Table-3.
3. For external surface of MS chimney with or without refractory lining and for internal surface without refractory lining, paint system as per 6.3 above shall be followed.
4. For external surface of RCC Chimney, 2 coats of F-6 B@ 100μ DFT/coat to obtain a total DFT of 200 μ shall be applied after proper surface preparation as per guidelines in 5.1.6.
5. In case of paint systems as per sl. nos. 6.3 and 6.4, the colour bands shall be applied over the aluminum paint as per the colour coding requirement for specific service of piping given in clause 9.0.
6. For piping, equipment, vessels, columns & valves etc, scope of surface preparation, application of primers to finish coat including repair shall be as per applicable contractual documents like SOR, MR, and PR etc.

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TABLE-7

COATING SYSTEMS FOR EFFLUENT TREATMENT PLANT

Sl. No.	Design Temp. in °C	Surface Preparation	Coating system		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
7.1			For external surfaces of C.S./M.S. it ems: screens, walk way bridges, baffles, dual media filters, vertical pumps, piping in treated effluent sump, bio sludge pump, screw pump and pump house, CS tanks, sumps and vessels.			
	-14 to 80	SSPS-SP-10	1 coat of F-9 @ 65-75µ DFT/coat	2 coats of F-6A @100µ DFT/coat +1 coat of F-2 @ 40µ DFT/coat (2x100+40=240)	305-315	-
7.2			For internal surfaces of CS/MS Item s: bio-sludge sump, filter feed sump, process sump, sanitary sump, transfer sump, sludge, slop oil tank, scrapping mechanism in clarifier.			
	-14 to 80	SSPS-SP-10	1 coat of F-6A @ 65-100µ DFT/coat.	3 coats of F-6A @100µ DFT/coat (3x100=300)	300	Note-1
7.3			All R.C.C./concrete surfaces exposed to effluent water / liquid such as tanks, structures, drains etc. in process sump, TPI separator (process and oil), aeration tank and transfer sump etc.			
	-14 to 80	Blast cleaning to SSPC-SP guide lines and acid etching with 10-15% HCl acid followed by thorough water washing.	Epoxy screed lining		3000	Epoxy screed lining shall be applied as per manufacturer and Engineer-In-Charge instructions
7.4			C.S/M. S du al media filters (intern al), chemical dosing tanks(internal) such as diammonium phosphate (DAP) and urea			

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	Up to 60	SSPC-SP-10	1 coat of clear two component solvent free vinyl ester primer @ 100μ DFT/ Coat + 2 coats of F-20 @ 500μ DFT/ Coat	1100	-

NOTE:

- The paint /coating manufacturers shall provide their quality control test certificate of coating materials (F-6A) for immersion service of the exposed effluent.

TABLE-8

EXTERNAL COATING SYSTEMS FOR UN-INSULATED CARBON STEEL AND LOW ALLOY STEEL STORAGE TANKS

Sl. No.	Design Temp. in °C	Surface Preparation	Coating system (Note-1)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
8.1	All external surfaces of shell, wind girders, appurtenances, roof tops of all above ground tank including top side of external and internal floating roof and associated external structural works.					
8.1.1	-14 to 80	SSPC-SP-10	1coat of F-9 @ 65-75μ DFT/coat + 1coat of P-6 @ 40μ DFT/ coat	2 coats of F-6B @ 100μ DFT /coat + 1 coat of F-2 @ 40μ DFT/ coat	345-355	F-6 should be suitable for occasional water immersion
8.1.2	81 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80μ DFT/ coat + 1 coat of F-15 intermediate coat @ 80μ DFT/coat	1 coat of F-15 finish coat @80μ DFT/ coat + 1coat of F-2 @ 40μ DFT/ coat	240	-

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Sl. No.	Design Temp. in °C	Surface Preparation	Coating system (Note-1)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
8.1.3	151 to 400	SSPC-SP-10	1coat of F-9 @ 65-75µ DFT/coat	2 coats of F-12 @20 µ DFT/ coat or 1 coat of F-16 @ 125 µ DFT / coat	105-115 or 190-200	For higher design temperatures, system as per 8.2.3 of this table is applicable
8.2	External surf aces of bottom plate (soil side) for all storage tanks.					
8.2.1	-14 to 80	SSPC-SP-10	1 coat of F-9 @ 65-75µ DFT/ coat	3 coats of F-7@ 100µ DFT/coat (3x100=300)	365-375	F-7 should be suitable for immersion service of the products given
8.2.2	81 to 150	SSPC-SP-10	1 coat of F-15 primer @ 80µ DFT/ coat + 1 coat of F-15 intermediate coat @ 80µ DFT/coat (80+80=160)	1 coat of F-15 finish coat @ 80µ DFT/ coat	240	-
8.2.3	151 to 450	SSPC-SP-10	1 coat of F-16 @ 125 µ DFT/coat	1 coat of F-16 @ 125 µ DFT/coat	250	This system is suitable for design temperatures up to 550°C
8.3	For undersid e of the bottom plate (in case tank is not lifted during PWHT) (Note- 2)					
8.3.1	-180 to 650 (Note-3)	For CS SSPC SP-10	1 coat of inert polymeric matrix coating @ 125 µ	1 coats of inert polymeric matrix coating @ 125 µ	250-300	-

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Sl. No.	Design Temp. in °C	Surface Preparation	Coating system (Note-1)		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
		For SS SSPC-SP-7 (15-25μ surface profile)				

NOTES FOR TABLE-8

1. All paint coating application including primer for tanks shall be carried out at field after erection and completion of entire welding.
2. For underside of bottom plate:
 - a) Painting shall be carried out before laying the bottom plate for tanks with non-Post Weld Heat Treatment (PWHT).
 - b) For tanks with PWHT, painting shall be carried out after PWHT.
 - c) In case tank is not lifted during PWHT then painting shall be applied before laying the bottom plate, clause no.8.3.1 shall be followed.
3. The temperature range indicated (-180 to 650 deg C) corresponds to the temperature resistance of coating material i.e. inert polymeric matrix coating.

Caution: PWHT temperature shall not exceed 650°C

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TABLE-9

INTERNAL COATING SYSTEMS FOR CARBON STEEL AND LOW ALLOY STORAGE TANKS

Sl. No.	Design Temp. in °C	Surface Preparation	Coating system		Total DFT in Microns (min.)	Remarks
			Primer	Finish Coat		
9.1	Crude oil, ATF, turpentine oil, lubricating oil: Underside of floating roof, internal surface of cone roof, inside of bottom plate, internal surfaces of shell - including wetted and free board height, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structures, structural steel, ladders and other CS internals.					
9.1.1	-14 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80μ DFT/ coat	1 coat of F-15 intermediate coat @ 80μ DFT/coat + 1 coat of F-15 finish coat @ 80μ DFT/ coat	240	-
9.2	Petroleum products & intermediates like LD O, HSD, gas oil, feeds of FCC -PC, FCCLCO, VG O-HDT, ISOM, D HDT, reformat, DCU, NHT & gasoline, naphtha, isomerase and kerosene: Underside of floating roofs, internal surface of cone roof, inside of bottom plate, internal surfaces of bare shell for full height, underside of floating roof, oil side surfaces of deck plates, oil side surfaces of pontoons, support structures and ladders etc.					
9.2.1	-14 to 45	SSPC-SP-10	1 coat of F-9 @ 65-75 μ DFT/coat	-	65-75	-
9.2.2	46 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80μ DFT/ coat	1 coat of F-15 intermediate coat @ 80μ DFT/coat + 1 coat of F-15 finish coat @ 80μ DFT/ coat	240	-
9.3	Potable, Raw & Fire water All internal surfaces, accessories and roof structures of cone and dome roof tanks					
9.3.1	-14 to 60	SSPC-SP-10	1 Coat of F-6A @ 100 μ DFT/coat	2 Coats of F-6A @ 100μ DFT/ Coat (2x100=200)	300	Note-1
9.4	De-mineralized (DM) water & Condensates etc.: All internal surfaces, accessories and roof structures of cone and dome roof tanks.					

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9.4.1	-14 to 60	SSPC-SP-10	1 Coat of F-6A @ 100μ DFT/coat	2 coats of F-6C @ 200μ DFT/ coat (2x200=400)	500	Single coat of F-6C @ 400 μ is also acceptable
9.4.2	61 to150	SSPC-SP-10	1 coat of F-15 primer @ 80μ DFT/ coat	1 coat of F-15 intermediate coat @ 80μ DFT/coat + 1 coat of F-15 finish coat @ 80μ DFT/ coat (80+80=160)	240	-
9.5	Hydrochloric acid (HCl) 10 %: All internal surfaces, accessories and roof structures of cone and dome roof tanks					
9.5.1	-14 to 60	SSPC-SP-10	1 Coat of clear two component solvent free vinyl ester primer @ 100μ DFT/ Coat	2 Coats of F-20 @ 500μ DFT/ Coat	1100	-
9.6	Aggressive solvents like hexane, hexene, benzene, xylene and toluene: All internal surfaces, accessories and roof structures of cone and dome roof tanks					
9.6.1	-14 to 65	SSPC-SP-10	1 coat of F-9 @ 65-75μ DFT/ coat	-	65-75	-
9.7	Ethylene glycol tanks: Internal s hell-full height, bottom plate, underside of roof and all accessories					
9.7.1	All	SSPC-SP-10	-	3 coats of vinyl chloride copolymer @ 75μ /Coat; (3x75=225)	225	-
9.8	Inside pontoon and inside of double deck of all floating roofs					
9.8.1	-14 to 80	SSPC-SP-3	1 coat of F-8 @ 100μ DFT/coat	1 coat of F-8 @ 100μ DFT/coat	200	-
9.9	Wet slops, amine solutions, sour water, water draw off: All internal surfaces, accessories and roof structures of cone and dome roof tanks					
9.9.1	-14 to 90	SSPC-SP-10	1 coat of F-15 primer @ 80μ DFT/ coat	1 coat of F-15 intermediate coat @ 80μ DFT/coat + 1 coat of F-15 finish coat @ 80μ DFT/ coat (80+80=160)	240	-

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9.10	Vacuum residue, fuel oil, dry slop, bitumen and other high temperature hydrocarbon liquids: Underside of floating roof, internal surface of cone roof, bottom plate, inside of bare shell- including wetted and nonwetted surfaces, oil side surfaces of deck plates, oil side surfaces of pontoons, roof structure s, structural steel and ladders					
9.10.1	Up to 150°C	SSPC-SP-10		1 coat of F-17 @ 375μ DFT/coat	375-425	-
9.11	Alkalis up to 50 % concentration: All internal surfaces, accessories and roof structures of cone and dome roof tanks					
9.11.1	Up to 60°C	SSPC-SP-10	1 coat of F-15 primer @ 80μ DFT/ coat	2 Coats of F-6 A @ 100μ DFT/coat (2x100=200)	280	-

NOTES FOR TABLE-9

1. F-6 A shall be suitable for drinking water service and should have competent authority certification.

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TABLE-10

**COATING SYSTEMS FOR EXTERNAL SIDE OF UNDERGROUND CARBON STEEL PLANT
PIPING AND VESSELS**

Sl. No.	Design Temp. in °C	Surface Preparation & Shop Primer	Coating system		Total DFT in Microns (min.)	Remarks
			Surface Preparation & Primer	Finish Coat		
10.1	Underground carbon steel plant piping					
10.1.1	25 to 65	-	SSPC-SP-10; 1 coat of synthetic fast drying primer 25 @μ DFT/ coat	1 layer of coal tar tape coating @ 2mm +1 coat of synthetic fast drying primer 25 @μ DFT/ coat + 1 layer of coal tar tape coating @ 2mm /layer as per EIL Standard Specification. No 6-79-0011 (latest edition)	--	--
10.1.2	66 to 150	-	SSPC-SP-10; 1 coat of F-17 primer @400 μ DFT/ coat	1 coat of F-17 @ 400 DFT/coat	800	-
10.1.3	151 to 450	-	SSPC-SP-10; 1 coat of F-16 primer @ 125μ DFT/ coat	1 coat of F-16 @125μ DFT/ coat	250	This system is suitable up to 550°C
10.2	External side of un-insulated underground storage vessels					
10.2.1	-40 to 80	SSPC-SP -10; 1 coat of F-9 @ 65-75μ DFT/ coat	-	3 coats of F-7 @ 100μ DFT/coat	365-375	-
10.2.2	81 to 150	SSPC-SP -10	1 coat of F-17 primer @400 μ DFT/ coat	1 coat of F-17 @400μ DFT/ coat	800	-

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10.2.3	151 to 450	SSPC-SP -10; 1 coat of F-16 @ 125μ DFT/ coat	-	1 coat of F-16 finish coat @125μ DFT/ coat	250	This system is suitable up to 550° C

NOTES FOR TABLE-10:

1. For underground vessels, scope of surface preparation, application of primers to finish coating including repair shall be as per applicable contractual documents like SOR, MR, PR etc.

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TABLE-11

COATING SYSTEMS FOR UNDER INSULATION (ALL UNIT AREAS & OFFSITES)

(For all insulated piping, equipment, storage vessels, tanks, columns etc. of carbon steel,
LTCS, alloy steel & stainless steels in all environments.)

Sl. No.	Design Temp. °C	Surface Preparation & Pre-erection/Shop Primer	Coating system		Total DFT Microns (min.)	Remarks
			Primer	Finish paint		
11.1	Carbon steel, LTCS and Low alloy steel Piping, Storage tanks, Vessels, Equipments etc					
11.1.1	-45 to 125	SSPC-SP-10; 1coat of F-15 @ 75µ DFT/coat	None	2 coats of F-15 @75µ DFT/coat	225	
11.1.2	126 to 450 (CS)	SSPC-SP-10; 1 coat of F-12 @20µ DFT/coat	None	2 coats of F-12 @20µ DFT/coat	60	This system is suitable up to 540 °C for low alloy steels
11.2	Stainless Steel, Alloy Steel, Alloy-20 Piping, Vessels & Equipments					
11.2.1	-45 to 125	SSPC-SP-7; (15-25µ surface profile) 1 coat of F-15 @75 µ DFT/coat	None	2 coats of F-15 @75µ DFT/coat	225	
11.2.2	126 to 550	SSPC-SP-7; (15-25µ surface profile) 1 coat of F-16 @125µ DFT/coat	None	1 coat of F-16 @125µ DFT/coat	250	
11.3	Cyclic service of CS, LTCS, SS, & Alloy Steels					

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11.3.1	-45 to 150 (Note-1)	SSPC-SP-10 For CS, LTCS & low Alloy steel. SSPC-SP-7 for SS; (15-25μ surface profile) 1 coat of F-15 @75 μ DFT/coat	None	2 coats of F-15 @75μ DFT/coat	225	
11.3.2	-180 to 650 (Note-2)	SSPC-SP-10 for CS, LTCS & Alloy steel. SSPC-SP-7 for SS (15-25μ surface profile) 1 coat of Inert polymeric matrix coating @ 125μ DFT/coat	None	1 coat of Inert polymer matrix coating @ 125μ DFT/coat	250	(Note-3 & 4)

NOTES

1. In case of overlapping of cyclic temperature ranges as mentioned in 11.3.1 and 11.3.2 then clause 11.3.1 shall be followed.
2. The temperature range indicated (-180 to 650 deg C) corresponds to the applicability of the coating material i.e. inert polymeric matrix coating.
3. Alternatively, thermally sprayed aluminium (TSA) coating @ 500μ as per Annexure-1 of 6-79-0020 Rev.0 is acceptable.
4. This coating system is applicable for any other temperature range (-180 to 650 o C) of CS, SS etc. which are not covered in clauses 11.1 or 11.2.

GENERAL NOTES FOR TABLE-11:

1. "Cyclic Service" is characterized by rapid or periodical temperature fluctuation or temperature cycles.
2. The blasting abrasives for SS and alloy steels shall be aluminum oxide or garnet only.
3. For insulated vessels & equipment scope of surface preparation, application of primers to finish coat including repair shall be as per applicable contractual documents like SOR, MR, PR etc.

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TABLE-12

**COATING SYSTEM (INTERNAL PROTECTION) FOR CARBON STEEL
COMPONENTS OF COOLERS/CONDENSERS FOR FRESH WATER SERVICE**

Sl. No.	Design Temp. in °C	Surface Preparation & Pre-erection/Shop Primer	Coating System		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
12.1	Up to 80	SSPC-SP-10	1 coat of F15 @ 80 μ DFT/coat	2 coats of F-15 @ 80 80 μ DFT/coat	240	-
12.2	81 to 140	SSPC-SP-10	---	1 coat of novolac epoxy	1500	-

TABLE-13

**COATING SYSTEM (INTERNAL PROTECTION) FOR GALVANIZED OR NONFERROUS /
STAINLESS STEEL/ DUPLEX STAINLESS STEEL COMPONENTS OF COOLERS/
CONDENSERS FOR FRESH WATER SERVICE.**

Sl. No.	Design Temp. in °C	Surface Preparation & Preerection/Shop Primer	Coating System		Total Final DFT in Microns (min.)	Remarks
			Primer	Finish paint		
13.1	Up to 80	Sweep Blasting	1 coat of F-15 @ 80μ DFT/coat;	1 coat of F-15 @ 80μ DFT/coat;	160	-
13.2	81 to 140	Sweep Blasting	-	1 coat of novolac epoxy	1500	-

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8.0 STORAGE

- 8.1** All paints and painting materials shall be stored in rooms only which are to be arranged by CONTRACTOR and approved by Engineer-In-Charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the word "PAINT STORAGE- NO NAKED LIGHT-HIGHLY INFLAMMABLE" shall be clearly displayed outside. Manufacturers' recommendation shall be followed for storage of paint materials.

9.0 COLOUR CODE

The colour coding system as per Table-14 shall be followed.

TABLE-14
COLOUR CODING

COLOUR CODING SR. No.	SERVICE	RECOMMENDED COLOUR FOR PAINT SYSTEM	RAL COLOUR CODE			
			BASE COLOUR		BAND COLOUR	
HYDROCARBON LINES (UNINSULATED)						
1	CRUDE SOUR	Dark Admiralty grey with 1 orange band	7012		2011	
2	CRUDE SWEET	Dark Admiralty grey with 1 red band	7012		3001	
3	LUBE OILS	Dark Admiralty grey with 1 green band	7012		6010	
4	FLARE LINES	Heat Resistant Aluminium	9006			
5	LPG	Orange with 1 oxide red band	2011		3009	
6	PROPYLENE	Orange with 2 blue bands	2011		5013	
7	NAPTHA	Orange with 1 green band	2011		6010	
8	M.S.	Orange with 1 dark admiralty grey band	2011		7012	
9	AV. GASOLINE (96 RON)	Orange with 1 band each of green, white and red bands	2011	6010	9010	3001
10	GASOLINE (regular, leaded)	Orange with 1 black band	2011		9005	
11	GASOLINE (premium, leaded)	Orange with 1 blue band	2011		5013	
12	GASOLINE (white)	Orange with 1 white band	2011		9010	

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COLOUR CODING SR. No.	SERVICE	RECOMMENDED COLOUR FOR PAINT SYSTEM	RAL COLOUR CODE	
			BASE COLOUR	BAND COLOUR
13	GASOLINE (Aviation 100/130)	Orange with 1 red band	2011	3001
14	GASOLINE (Aviation 115/145)	Orange with 1 purple band	2011	4006
15	N-PENTANE	Orange with 2 blue bands	2011	5013
16	DIESEL OIL (White)	Oxide red with 1 white band	3009	9010
17	DIESEL OIL (Black)	Oxide red with 1 yellow band	3009	1023
18	KEROSENE	Oxide red with 1 green band	3009	6010
19	HY. KEROSENE	Oxide red with 2 green bands	3009	6010
20	DISULFIDE OIL (EXMEROX)	Oxide red with 1 black band	3009	9005
21	M.T.O	Oxide red with 3 green bands	3009	6010
22	DHPPA	Oxide red with 2 white bands	3009	9010
23	FLUSHING OIL	Oxide red with 2 black bands	3009	9005
24	LAB FS	Oxide red with 2 dark admiralty grey bands	3009	7012
25	LAB RS	Oxide red with 3 dark admiralty grey bands	3009	7012
26	LAB (Off. Spec)	Oxide red with 1 light grey band	3009	7035
27	N-PARAFFIN	Oxide red with 1-blue band	3009	5013
28	HEAVY ALKYLATE	Oxide red with red band	3009	3001
29	BLOW DOWN, VAPOR LINE	Off white / Aluminum with 1Brown band	9006	8004
30	BLOWDOWN	Off white / Aluminum with 2 brown bands	9006	8004
31	A.T.F.	Leaf brown with 1 white band	8003	9010
32	TOULENE	Leaf brown with 1 yellow band	8003	1023
33	BENZENE	Leaf brown with 1 green band	8003	6010
34	LAB PRODUCT	Leaf brown with 1 blue band	8003	5013
35	FUEL OIL	Black with 1 yellow band	9005	1023
36	FULE OIL (Aromatic rich)	Black with 2 yellow bands	9005	1023
37	ASPHALT	Black with 1 white band	9005	9010
38	SLOP AND WASTE OILS	Black with 1 orange band	9005	2011
39	SLOP AROMATICS	Black with 2 orange bands	9005	2011

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COLOUR CODING SR. No.	SERVICE	RECOMMENDED COLOUR FOR PAINT SYSTEM	RAL COLOUR CODE	
			BASE COLOUR	BAND COLOUR
CHEMICAL LINES				
40	TRI-SODIUM PHOSPHATE	Canary yellow with 1 violet band	1012	5000
41	CAUSTIC SODA	Canary yellow with 1 black band	1012	9005
42	SODIUM CHLORIDE	Canary yellow with 1 white band	1012	9010
43	AMMONIA	Canary yellow with 1 blue band	1012	5013
44	CORROSION INHIBITOR	Canary yellow with 1 Aluminum band	1012	9006
45	HEXAMETA PHOSPHATE	Canary yellow with 2 black bands	1012	9005
46	ACID LINES	Golden Yellow with 1 red band	1004	3001
47	RICH AMINE	Canary yellow with 2 blue bands	1012	5013
48	LEAN AMINE	Canary yellow with 3 blue bands	1012	5013
49	SOLVENT	Canary yellow with 1 green band	1012	6010
50	LCS	Canary yellow with 1 smoke grey	1012	7031
WATER LINES				
51	RAW WATER	Sky blue with 1 black band	5015	9005
52	INDUSTRIAL WATER	Sky blue with 2 signal red band	5015	3001
53	TREATED WATER	Sky blue with 1 oxide red band	5015	3009
54	DRINKING WATER	Sky blue with 1 green band	5015	6010
55	COOLING WATER	Sky blue with 1 light brown band	5015	1011
56	SERVICE WATER	Sky blue with 1 signal red brown	5015	3001

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COLOUR CODING SR. No.	SERVICE	RECOMMENDED COLOUR FOR PAINT SYSTEM	RAL COLOUR CODE	
			BASE COLOUR	BAND COLOUR
57	TEMPERED WATER	Sky blue with 2 green bands	5015	6010
58	DM WATER	Sky blue with 1 aluminum band	5015	9006
59	DM WATER ABOVE 150°F	Sky blue with 2 black bands	5015	9005
60	SOUR WATER	Sky blue with 2 yellow bands	5015	1013
61	STRIPPED WATER	Sky blue with 2 blue bands	5015	5013
62	ETP TREATED WATER	Sky blue with 2 oxide red bands	5015	3009
FIRE PROTECTION SYSTEM (ABOVE GROUND)				
63	FIRE WATER FOAM & EXTINGUISHERS	Post office red	30 02	
AIR & OTHER GAS LINES (UNINSULATED)				
64	SERVICE AIR	Sea green with 1 signal red band	6018	3001
65	INSTRUMENT AIR	Sea green with 1 black band	6018	9005
66	NITROGEN	Sea green with 1 orange band	6018	2011
67	FREON	Sea green with 1 yellow band	6018	1023
68	CHLORINE	Canary yellow with 1 oxide band	1012	3009
69	SO ₂	Canary yellow with 2 white bands	1012	9010
70	H ₂ S	Orange with 2 red oxide bands	2011	3009
71	GAS (Fuel)	Orange with 1 aluminum band	2011	9006
72	GAS (Sour)	Orange with 2 aluminum bands	2011	9006
73	GAS (Sweet)	Orange with 2 signal red band	2011	3001
74	HYDROGEN	Orange with 1 light green band	2011	6021
STEAM AND CONDENSATE LINES (UNINSULATED)				
75	HP STEAM	Off white / Aluminum with 1 yellow band	9006	1023

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COLOUR CODING SR. No.	SERVICE	RECOMMENDED COLOUR FOR PAINT SYSTEM	RAL COLOUR CODE	
			BASE COLOUR	BAND COLOUR
76	MP STEAM	Off white / Aluminum with 1 red band	9006	3001
77	MLP STEAM	Off white / Aluminum with 1 orange band	9006	2011
78	LP STEAM	Off white / Aluminum with 1 light green band	9006	6021
79	CONDENSATE	Sky blue with 1 white band	5015	9010
80	CONDENSATE ABOVE 150°F	Sky blue with 3 oxide red band	5015	3009
81	BFW	Sky blue with 2 red bands	5015	3001
Note: For all insulated steam lines, the colour coding shall be followed as given for un-insulated lines with the specified length of colour bands.				
INSULATED HYDROCARBON PIPING				
82	IFO SUPPLY	1 Black ground colour with 1 yellow band in centre	9005	1023
83	IFO RETURN	Black ground colour with 1 green band in centre	9005	6010
84	HPS	Black ground colour with 1 red band in centre	9005	3001
85	BITUMEN	Black ground colour with 2 red bands in centre	9005	3001
86	CLO	Black ground colour with 1 brown band in centre	9005	8004
87	VB TAR	Black ground colour with 2 brown bands in centre	9005	8004
88	VR AM (BITUMEN / VBU FEED)	1 Black ground colour with 1 blue band in centre	9005	5013
89	VR BH	1 Black ground colour with 2 blue bands in centre	9005	5013
90	VAC. SLOP	1 Black ground colour with 1 white band in centre	9005	9010
91	SLOP	1 Black ground colour with 1 orange band in centre	9005	2011
92	CRUDE SWEET	1 Dark admiralty grey ground colour with 1 red band in centre	7012	3001
93	CRUDE OIL	1 Dark admiralty grey ground colour with 1 orange band in centre	7012	2011

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COLOUR CODING SR. No.	SERVICE	RECOMMENDED COLOUR FOR PAINT SYSTEM	RAL COLOUR CODE	
			BASE COLOUR	BAND COLOUR
94	VGO / HCU	1 Oxide red ground colour with 2 steel grey bands in centre	3009	7011
95	OHCU BOTOM / FCCU FEED	1 Oxide red ground colour with 2 steel grey bands in centre	3009	7011
UNINSULATED EQUIPMENT, TANKS AND STRUCTURES				
96	HEATER STRUCTURE	Steel grey	7011	
97	HEATER CASING	Heat resistant aluminium	9006	
98	VESSELS & COLUMNS	Aluminium	9006	
99	HYDROGEN BULLETS	Pink	3014	
100	LPG VESSELS	Oxide red	3009	
101	SO ₂ VESSEL	Canary yellow	1012	
102	HEAT EXCHANGER	Heat resistant aluminium	9006	
103	FO TANK AND HOT TANKS	Black	9005	
104	ALL OTHER TANKS	Aluminum / Off white	9006	
105	CAUSTIC / AMINE / ACID TANKS	Golden yellow	1004	
106	SOUR WATER	Sky Blue	5015	
107	OUTER SURFACE IN BOILER HOUSE	Heat resistant aluminum	9006	
108	COMPRESSORS AND BLOWERS	Dark admiralty grey	7012	
109	PUMPS	Navy blue	5014	
110	MOTORS & SWITCH GEAR	Bluish green	5024	
111	HAND RAILING	Signal red	3001	
112	STAIRCASE, LADDER AND WALKWAYS	Black	9005	
113	LOAD LIFTING EQUIPMENT AND	Leaf brown	8003	
	MONORAILS ETC			
114	GENERAL STRUCTURE	Black	9005	
PIPES AND FITTINGS OF ALLOY STEEL AND SS MATERIAL IN STORE				
115	IBR	Signal red	3001	
116	9Cr-1Mo	Verdigris green	6021	
117	5Cr-0.5Mo	Satin blue	5012	

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COLOUR CODING SR. No.	SERVICE	RECOMMENDED COLOUR FOR PAINT SYSTEM	RAL COLOUR CODE	
			BASE COLOUR	BAND COLOUR
118	2 _{1/4} Cr-1 Mo	Aircraft yellow	1026	
119	11/4Cr- ½ Mo	Traffic Yellow	1023	
120	SS-304	Dark blue grey	5008	
121	SS-316	Dark violet	4005	
122	SS-321	Navy blue	5014	
SAFETY COLOUR SCHEMES				
123	DANGEROUS OBSTRUCTION	Black and alert orange band	9005	2008
124	DANGEROUS OR EXPOSED PARTS OF MACHINERY	Alert orange	2008	

GENERAL NOTES FOR TABLE-14:

1. All LPG service PSVs shall be painted deep blue.
2. All drains & vents shall be painted in main line colour.
3. The colour code scheme is for identification of piping service group. It consists of a ground colour and 1 / 2 colour bands.

9.1 IDENTIFICATION

The system of colour coding consists of a ground colour and secondary colour bands superimposed over the ground colour. The ground colour identifies the basic nature of the service and secondary colour band over the ground colour distinguishes the particular service. The ground colour shall be applied over the entire length of the un-insulated pipes. For insulated lines, ground colour shall be provided as per specified length and interval to identify the basic nature of service and secondary colour bands to be painted on these specified lengths to identify the particular service. Above colour code is applicable for both unit and offsite pipelines.

9.2 GROUND COLOUR

On un-insulated pipes, the entire pipe has to be painted in ground colour. On metal clad insulated lines, minimum 2 m long portion should be painted.

9.3 COLOUR BANDS

9.3.1 Location of colour bands:

- a. At battery limits.
- b. Intersection points & change of direction points in piping.
- c. Midway of piping section, near valves, across culverts.

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- d. At 50 m interval on long stretch pipes.
- e. At starting and termination points.

9.3.2 Minimum width:

NB	Width
3" and below	75 mm
Above 3" to 6"	NB X 25 mm
Above 6" to 12"	NB X 18 mm
Above 12"	NB X 15 mm

Note: For insulated pipes, NB indicates OD of the insulation.

Sequence: Colour bands shall be arranged in sequence as shown above and the sequence follows the direction of flow. The width of the 1st Band to 2nd band is 4:1. Wherever deemed required by process department or safety, pipes handling hazardous substances will be given hazard marking of 30 mm wide diagonal stripes of black and golden yellow as per IS: 2379.

9.4 SPECIAL CAMOUFLAGE PAINTING FOR UN-INSULATED CRUDE AND PRODUCT STORAGE TANKS

Coating system shall be as per this standard.

Camouflage painting scheme for defense requirement in irregular patches will be applied with 3 colours.

Dark green : Light green : Medium brown

5 : 3 : 2

- a. The patches shall be irregular and asymmetrical and inclined at 30 to 60 degrees.
- b. Patches should be continuous at surface meeting lines / points.
- c. Slits / holes shall be painted in dark green shade.
- d. Width of patches shall be 1 to 2 m.

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9.5 IDENTIFICATION MARKINGS ON EQUIPMENT/PIPING

Equipment tag numbers shall be stenciled /neatly painted using normal “Arial” lettering style on all equipment and piping (both insulated & un-insulated) after completion of all paint works. Lettering colour shall be either black or white, depending upon the background, so as to obtain good contrast.

Operations group shall specify the location of the marking.

Size of the making shall be as follows:

Columns, vessels, heaters	150 mm
Pumps and other machinery	50 mm
Piping	OD / 2 with maximum 100 mm
Storage tanks	(as per drawings)

9.6 COLOUR CODING FOR CONTROL VALVE

Carbon steel body	Light grey
Alloy steel body	Canary yellow
Stainless steel body	Natural
The actuator of the control valve shall be painted as:	
Direct action (open on-air failure) valves	Green
Reverse acting (close on-air failure) valves	Red

The painting status shall be comprehensively updated every 6 months for compliance.

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9.7 Colour Coding for Structural & Others

Sl. No	Item	Color	Indicative
1	Pipe rack structurals	Dark Admiralty Grey	
2	Chequered Plate (Both faces)	Black	
3	Grating	Black	
4	Ladder Rungs & Railing Vertical Posts	Black	
5	Hand Rail, Middle rail, Toe Plate	Signal Red	
6	Ladder Vertical Posts	Signal Red	
7	Building Structurals, Steel Columns, brackets, beams, bracings, roof trusses, purlings, side girts, louvers, stringers	Dark Admiralty Grey	
8	OverHead Monorail	Signal Red	
9	Gantry Girder & Monorail	Dark Green	
10	Monorail Stopper Plates	Signal Red	
11	Coke Cutting System	Signal Red	
12	EOT/HOT Cranes	Canary Yellow	
13	Transformers & Battery room structurals	Dark Admiralty Grey	
14	Electrical Motors	Dark Blue	

10.0 IDENTIFICATION OF VESSELS, PIPING ETC.

- 10.1** Equipment number shall be stenciled in black or white on each vessel, column, equipment & machinery (insulated or un-insulated) after painting. Line number in black or white shall be stenciled on all the piping of more than one location as directed by Engineer-In-Charge. Size of letter printed shall be as below:

Column & vessels	150 mm (high)
Pump, compressor & other machinery	50 mm (high)
Piping	40-150 mm

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10.2 Identification of storage tanks

The storage tanks shall be marked as detailed in the drawing.

11.0 PAINTING FOR CIVIL DEFENCE REQUIREMENTS

11.1 The following items shall be painted for camouflaging, if required by the client:

- a. All columns
- b. All tanks in offsite
- c. Large vessels
- d. Spheres

11.2 Two coats of selected finishing paint as per defence requirement shall be applied in a particular pattern as per clause 11.3 and as per the instructions of Engineer-InCharge.

11.3 Method of camouflaging

11.3.1 Disruptive painting for camouflaging shall be done in three colours in the ratio of 5:3:2 (all matte finish).

Dark Green	Light Green	Dark Medium Brown
5	:	3
	:	2

11.3.2 The patches should be asymmetrical and irregular.

11.3.3 The patches should be inclined at 30° to 60° to the horizontal.

11.3.4 The patches should be continuous where two surfaces meet at an angle.

11.3.5 The patches should not coincide with the corners.

11.3.6 Slits and holes shall be painted in dark shades.

11.3.7 Width of patches should be 1 to 2 m.

12.0 QUALITY CONTROL, INSPECTION AND TESTING

12.1 All painting materials including primers and thinners brought to site by CONTRACTOR for application shall be procured directly from manufactures as per specifications and shall be accompanied by manufacturers' test certificates. Paint formulations without certificates are not acceptable (see section 14.0 & 15.0).

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12.2 The CONTRACTOR must produce test certificate from pre qualified paint manufacturer for various tests as detailed out in section 15.0 of this document. The Engineer-In-Charge shall have the right to test wet samples of paint at random for verifying quality of paint supplied. CONTRACTOR shall arrange to have such tests, when required by Engineer-in-Charge, performed at his cost at any one of the NABL accredited laboratories.

Samples for the test will be drawn at random in presence Engineer-In-Charge or his representations. Following tests to be carried out if called for by Engineer-in-Charge:

- Specific Gravity
- % solids by weight (% zinc content in case of inorganic or organic zinc primer)
- Drying time (touch dry & full curing)
- Adhesion
- Storage stability (pot life)

Test methods for above tests shall be as per relevant ASTM or ISO Standard.

12.3 The painting work shall be subject to inspection by Engineer-In-Charge at all times. In particular, following stage-wise inspection will 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

Following tests are to be carried out during surface preparation:

- Test for presence of oil/grease and contamination

The steel substrate after degreasing as per SSPC-SP-1 shall be tested as per following procedure to validate absence of oil and grease contamination:

- a) Visual inspection - continue degreasing until all visible signs of contamination are removed.
- b) Conduct a solvent evaporation test by applying several drops or a small splash of residue-free tri-chloromethane on the suspect area especially pitting, crevice corrosion areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination. Continue degreasing and inspection till test is passed.
 - Tests for surface finish of blasted surface shall be done by visual inspection using SSPC-VIS1. Clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on blasted surface. Checks shall be done on each component at least once per 200 m² of blasted surface and a minimum of 3 checks per shift.
 - Test for presence of soluble salt as per method ISO 8502-9. Maximum allowable salt content shall be considered 20 mg/m². Checks shall be done on

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each component at least once per 200 m² of blasted surface and minimum of 3 checks per shift. In case salt exceeds specified limit, the contaminated surface shall be cleaned by method as per Annexure-C of IS 12944-4 (water cleaning). After cleaning, surface shall be retested for salt after drying.

- Blast profile measurement – This shall be done as described in sec 6.2 of **Annexure-I** of 6-79-0020 Rev 0 (Specification for thermally sprayed Aluminium).
- Test for blasting Media and Blasting air- this shall be done as described in sec 6.6 of **Annexure-I** of 6-79-0020 Rev 0 (Specification for thermally sprayed Aluminium).

In addition to above, record should include type of shop primer already applied on equipment e.g. zinc silicate or zinc rich epoxy or zinc phosphate. Any defect noticed during the various stages of inspection shall be rectified by the CONTRACTOR to the entire satisfaction of Engineer-In-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, CONTRACTOR shall be responsible for rectifying any defects found during final inspection/guarantee period/defect liability period as defined in general conditions of the 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 cost to OWNER, the extra coat should have prior approval of Engineer-in-charge.

12.4 Primer Application

After surface preparation, the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-In-Charge. 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-In-Charge before application of successive coats.

The CONTRACTOR shall provide standard thickness measurement instrument with appropriate range(s) for measuring dry film thickness of each coat, surface profile gauge for checking of surface profile in case of sand blasting, holiday detectors and pinhole detector and protector whenever required for checking in case of immersion conditions.

Prior to application of paints on surfaces of chimneys, the thickness of the individual coat shall be checked by application of each coat of same paint on MS test panel. The thickness of paint on test panels shall be determined by using gauge such as 'Elko meter'. The thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-In-Charge before application of paints on surface of chimney.

At the discretion of Engineer-In-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the OWNER, as it would be in the interest of the manufacturer to

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ensure that both surface preparation and application are carried out as per their recommendations. The CONTRACTOR is responsible to arrange the same.

12.9 Final inspection of finished coating shall consist of the following:

- 1) **Coating dry film thickness check:** DFT measurement shall be as per ISO 2808. Type II electromagnetic gauges should be used for ferrous substrates. DFT gauge calibration, number of measurements shall be as per SSPC-DA-2. Measured DFT shall be within + 10% of the dry film thickness, specified in the specifications.
- 2) **Adhesion testing:** Adhesion of the primer to the steel substrate and inter-coat adhesion of the subsequent coat(s) after curing for at least a week after application of the topcoat shall be examined by a knife test in accordance with ASTM D6677. For the knife test, if the rating is better than 8, the adhesion is considered acceptable. The adhesion is destructive and tested areas shall be repaired afterward using the spot repair procedure. Alternatively, the applicator may perform the adhesion test on a steel panel coated using the same surface preparation and coating application procedure as the work piece. Adhesion testing shall be carried out for each component at least once per 200 m2 of coated surface.
- 3) **Holiday detection check:** Holiday testing shall be conducted in accordance with NACE SP0188. For immersion services, 100% of coated area shall be inspected for holidays. For atmospheric exposure, 10% of coated area which must include weld seams, corners and edges to be holiday tested. Voltage at which test is to be carried out will depend upon DFT of coating being tested and shall be as per NACE SP0188. Any holiday is unacceptable and should be marked and repaired immediately.

The CONTRACTOR shall arrange for spot checking of paint materials for specific gravity, glow time (ford cup) and spreading rate.

12.11 Final Inspection of coating system

A final inspection shall be conducted prior to the acceptance of the work. The coating CONTRACTOR and the facility OWNER shall both be present and they shall sign an agreed inspection report. Such reports shall include:

General

- Names of the coating CONTRACTOR and the responsible personnel
- Dates when work was performed

Coating Materials

- Information on coating materials being applied
- Condition of coating materials received

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Environmental conditions

- Weather and ambient conditions
- Coating periods

Surface preparation

- Condition of surface before preparation
- Tools and methods used to prepare surface
- Condition of surface after preparation

Coating application

- Equipment used
- Mixing procedure prior to application
- Coating application techniques used

Testing

- Type and calibration of inspection instruments used
- Type of quality control tests performed, and results

13.0 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.

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SPECIFICATION FOR GENERAL INSTRUMENTATION

						
0	Issued for ITB	17-07-19	SRS	ST	CK	
A	Issued for Review	20-03-19	SRS	ST	CK	
REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

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1.0 INTRODUCTION:

M/S Oil India Ltd (OIL), is a pioneer oil company to explore and exploit crude oil and natural gas with its headquarter at Duliajan, Assam. The development of non-associated gas fields in OIL's Upper Assam operational area is underway. As part of this development scheme, OIL desires to construct state-of-the-art stations namely, two non-associated gas production setups (Field Gathering Stations: FGS) one each at Baghjan and Chabua and one high volume self-contained Gas Gathering, Custody Transfer and Metering Delivery Terminal (Central Gas Gathering Stations and Offtake Point; CGGS & OTP) at Madhuban in Upper Assam, India.

2.0 PROJECT OBJECTIVE:

OIL is in the process of development of producing field in Baghjan area. As a part of this development scheme, OIL desires to construct FIELD GAS GATHERING STATION (FGGS) setup comprising of crude oil & natural gas production facility at Baghjan field in Upper Assam, India.

The Baghjan oilfield is producing from 6 Nos. of wells through an EPS (Early Production Setup). Associated Gas is expected to be around 0.3 MMSCUMD. The Baghjan field also having huge amount of non-associated gas potential and it is expected to produce about 2.5 MMSCMD of non-associated natural gas from this area. To explore the resources one Field Gas Gathering station having the facilities for production of natural gas are to be created.

OIL INDIA LIMITED has awarded the job of Project management Consultancy services for execution of this project to Jayathe Petrotech Engineers and Consultants Pvt. Ltd. (JPEC) The project envisages design, creation of process facilities, requisite utilities etc. in various modules and other infrastructure for a standalone integrated surface production set up for production natural gas complying with all gas field safety norms (DGMS, OISD etc.) and applicable government laws.

3.0 DOCUMENT PURPOSE:

This document covers the minimum requirements for the design, selection, application and installation of instruments and control system for Engineering and project management Consultancy (EPMC) for the project PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM.

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4.0 DEFINITIONS AND ABBREVIATIONS:

4.1 DEFINITIONS:

Table 4.1.1 Definitions

NOMENCLATURE	DESCRIPTION
Company	Oil India Limited (OIL)
Consultant	Jayathe Petrotech Engineers & Consultants (JPEC)
Project	Field Gas Gathering Station, Baghjan (FGGS-BJN)
Vendor Manufacturer	/ The person, firm, COMPANY or Corporation including their assignees who supplies the equipment/materials required for the project.
SHALL	Indicates a mandatory requirement
SHOULD	Indicates a strong recommendation to comply with the requirements of this document

4.2 ABBREVIATIONS:

Table 4.2.1 Abbreviations

ABBREVIATIONS	DESCRIPTION
AC	Alternating Current
AGA	American gas Association
ANSI	American National Standards Institute
API	American petroleum Institute
ATEX	ATmosphere EXplosibles
BDV	Blow Down valve
BJN	Baghjan
BS	British Standards
BWPD	Barrels of Water per day
CS	Carbon Steel
dBA	Decibels
DP	Differential Pressure
DCS	Distributed Control System

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ABBREVIATIONS	DESCRIPTION
EPCC	Engineering, Procurement , Construction and Commissioning
EPS	Early Production Station
ERA	Environmental Risk Assessment
ESD	Emergency Shutdown
ETP	Effluent Treatment Plant
FFG	Flame Front Generator
FG	Fuel Gas
HART	Highway Addressable Remote Transducer
FGGS	Field Gas Gathering Station
F&G	Fire & Gas
HAZOP	Hazard and Operability Study
HP	High Pressure
IP	Ingress Protection
IEC	International Electro technical Commission
ISA	International Society of Automation
ISO	International Organization for standardization
JPEC	Jayathe Petrotech Engineers and Consultants Pvt Ltd
KCAL	Kilo Calories
LPG	Liquefied Petroleum Gas
MMSCMD	Million Standard Cubic Meter per Day
MOV	Motor Operated Valve
NACE	National Association for Corrosion Engineers
NPSHA	Net Positive Suction Head Available
PFD	Process Flow Diagram
P&ID	Piping and Instrumentation Diagram
PCV	Pressure Control Valve
PIT	Pressure Indicating Transmitter
PMS	Piping Material Specification

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ABBREVIATIONS	DESCRIPTION
ppm	Parts Per Million
PRV	Pressure Relief Valve
PVRV	Pressure Vacuum Relief Valve
PSV	Pressure Safety Valve
QRA	Quantitative Risk Assessment
SCMD	Standard Cubic Meters per Day
SDV	Shutdown Valve
SIL	Safety Integrity Level
TC	Temperature Control
TEG	Tri Ethylene Glycol
TIT	Temperature Indicating Transmitter
UPS	Uninterruptible power supply
WTP	Water Treatment Plant

5.0 UNITS OF MEASUREMENT

Following units of measurement shall be used, unless otherwise specified:

Flow (Liquid)	Kg/hr, m ³ /hr
Flow (Gas)	Sm ³ /hr
Temperature	Deg. Centigrade
Pressure	Kg/cm ² g
Differential Pressure	inch of Water Column

Standard and Normal Conditions are defined as below:

Standard and Normal Conditions pressure	: 1.014 bar(a)
Standard Conditions temperature	: 60°F (15.56 °C)
Normal Conditions temperature	: 32°F (0 °C)

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6.0 ENVIRONMENTAL DATA

Design ambient temperature Maximum, °C	40
Design ambient temperature Minimum, °C	7
Dry bulb temperature Maximum, °C	36
Dry bulb temperature Minimum, °C	8
Average Rainfall (in full monsoon)	194.2 cm
Average Rainfall (in 24 hours)	15.9 cm
Wind velocity at 10m height	50 m/s
Maximum relative humidity	93%

7.0 APPLICABLE CODES & STANDARDS

Unless otherwise specified, the latest editions of the following codes and Standards are applicable. These shall be suitably applied for the design of instruments and control systems. This list does not absolve the Contractor of his responsibility for proper design of instrumentation and controls based any other code that is relevant to the particular application, but not included in the list below. In case of such omissions, the same shall be brought to the immediate notice of the Owner/ Consultant. The referenced standards shall be of the latest edition, including amendments, unless an edition is mentioned.

Note:

For the specifications relating to individual instruments and the applicable codes and standards, refer Technical Specifications attached elsewhere in the bid document.

Indian Standards (IS)

IS - 319	-	Specification for free cutting Brass bars, rods and sections
IS – 1239	-	Mild steel tubes, tubulars and other wrought steel fittings
IS-1271	-	Specification of Thermal Evaluation and Classification of Electrical Insulation
IS – 1554	-	Part-I PVC Insulation (heavy duty) electric cables-working voltage upto and including 1100V

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IS – 3624	-	Specification for pressure and vacuum gauges
IS – 5831	-	PVC insulation and sheath of electric cables
IS – 7358	-	Specifications for Thermocouples
IS2147	-	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS 2148-1981	-	Flameproof enclosures for electrical apparatus Rev. 2 nd and. 5 th
IS 5	-	Indian std. for colours for ready mixed paints and enamels 4 th rev. amd. 1.

American Gas Association (AGA)

Report No 3	-	Gas custody metering based on orifice metering
Report No 7	-	Gas custody metering using turbine meters
Report No 8	-	Compressibility and Super-compressibility for Natural Gas and other Hydrocarbon Gases. Transmission Measurement
Report No 9	-	Gas custody metering using Ultrasonic flow meters

American Petroleum Institute (API)

API-RP-520	-	Sizing, selection & installation of pressure relieving devices-Part II – Installation.
API Std. 520	-	Sizing, selection & Installation of Pressure relieving devices- Part I –Sizing & Selection
API 521	-	Guide for pressure and depressurising system.
API 526	-	Flanged steel safety relief valves. - Design and manufacture as per ASME section VIII and orifice calculation as per API -RP-520 part I and II, appendix C
API 527	-	Commercial seat tightness of safety relief valves with metal-to-metal seat.

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API RP 551	-	Process Measurement Instrumentation
API RP 552	-	Transmission System
API 2000	-	Sizing of pressure / vacuum relief valves on storage tanks.
API 600	-	Steel gate Valves - Flanged & Buttwelding Ends
API 6D	-	Specification for Pipeline Valves (Gate, Plug, Ball and Check Valves)
API 598	-	Valve Inspection & Testing
API 607	-	Fire Test for Soft-Seated Quarter-Turn Valves
API 609	-	Butterfly Valves, Lug-Type and Wafer Type
API 6FA	-	Fire Safe test
API 670	-	Vibration, Axial Position and bearing temperature Monitoring System

American National Standards Institute / American Society of Mechanical Engineers (ANSI/ASME)

ANSI/ ASME	-	Boiler and Pressure Vessel Code, including all mandatory addenda a) ASME Boiler and pressure vessel code section I - Design, manufacture and calculation for steam services in fired pressure vessels. b) ASME Boiler and pressure vessel code section VIII - Design, manufacture and calculation for steam, gas, vapour and liquid services in unfired pressure vessels
ANSI/ ASME B1.20.1	-	Screw Threads - Pipe Threads, General Purpose(Inch)
ANSI/ ASME B16.5	-	Pipe Flanges and Flanged Fittings NPS ½ Through NPS 24
ANSI/ ASME B16.11	-	Forged Steel Fittings, Socket-Welding and Threaded
ANSI/ ASME B16.20	-	Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral-Wound, and Jacketed
ANSI/ ASME B16.25	-	Buttwelding Ends
ANSI/ ASME B16.34	-	Valves – Flanged, Threaded and Welding End

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ANSI/ ASME B16.47	-	Large Diameter Steel Flanges NPS 26 Through NPS 60
ANSI/ ASME MC96.1	-	Thermoelectric properties and limits of error
ANSI/ ASME PTC 19.3	-	Temperature Measurement Part 3

American Society for Testing and Materials (ASTM)

ASTM A193/ A193M	-	Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A194/ A194M	-	Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature A194M Service or Both
ASTM A320/ A320M	-	Alloy-Steel Bolting Materials for Low-Temperature Service
ASTM A350/A350M	-	Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for A350M Piping Components
ASTM A352/ A 352M	-	Steel Castings Ferritic and Martensitic for Pressure-Containing Parts Suitable A352M for Low-Temperature Service

Ethernet Standards

IEEE 802.3	-	Carrier Sense Multiple Access With Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications
IEEE 802.4	-	Token –Passing Bus Access Method and Physical Layer Specifications
IEEE 802.5	-	Token –Passing Ring Access Method and Layer Specifications

Fluid Control Institute (FCI)

FCI 70-2 Control Valve Seat Leakage

Instrumentation Systems and Automation Society (ISA)

ISA S-5 .1	-	Instrumentation Symbols and Identification
ISA S-5.2	-	Binary logic diagrams for process operation

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ISA S-5.3	-	Graphic Symbols for Distributed Control/ Shared Display Instrumentation, Logic and Computer Symbols
ISA 50.1	-	Compatibility of Analog Signals for Electronic Industrial Process Instruments
ISA 75.01	-	Flow Equations for Sizing Control Valves
ISA 75.02	-	Control Valve Capacity Test Procedure
ISA 75.03	-	Face-To-Face Dimensions for Integral Flanged Globe-Style Control Valve Bodies (ANSI Classes 125, 150, 250, 300, and 600)
ISA 75.04	-	Face-To-Face Dimensions for Flangeless Control Valves (ANSI Classes 150, 300, and 600)
ISA 75.16	-	Face-To-Face Dimensions for Flanged Globe-Style Control Valve Bodies (ANSI Classes 900, 1500, and 2500)
ISA 75.19	-	Hydrostatic Testing of Control Valves
ISA 12.01.01	-	Definitions and Information Pertaining to Electrical Apparatus in Hazardous (Classified)
ISA S 18.1	-	Specifications and guides for the use of general Annunciators
ISA S 84.1	-	Reliability calculation
ISA S 75.11	-	Flow characteristics & rangeability
ISA SP 75.17	-	Aerodynamics noise prediction

International Electro Technical Commission (IEC)

IEC 60079	-	Electrical Apparatus For Explosive Atmospheres
IEC61131(Parts1-4)	-	Programmable controller
IEC 61508	-	Functional safety programmable electronic systems
IEC 61511	-	Functional safety – Safety instrumented systems for the process industry sector.

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IEC 801	-	Electromagnetic compatibility for industrial process measurement & control equipment
IEC 68	-	Environmental testing
IEC 584	-	Thermoelectric properties and limits of error
IEC 585	-	Insulation limit of impurities
IEC 1285	-	Design of purged enclosure
IEC534.8.3	-	Aerodynamics noise prediction
EN 60950-1992	-	Power supply
EN 50081/82	-	Electromagnetic compatibility
EN 50-014 / 020	-	Electrical Apparatus for Potentially Explosive Atmosphere.
IEC 534	-	Industrial - Process Control Valves
IEC 654	-	Measurement and Control equipment
IEC 751	-	Industrial Platinum Resistance Thermometer Sensor
IEC 902	-	Industrial Measurement and Control Terms and Definitions
IEC 529	-	Environmental Protection of equipment
IEC 61158	-	Digital Data Communication for Measurement and Control – Fieldbus for use in industrial control Systems
IEC 61158-2	-	Physical Layer specification & service definition

International Organisation for Standardisation (ISO)

ISO 4200	-	Plain End Steel Tubes, Welded and Seamless - General Table of Dimensions and Masses per Unit Length
ISO 5167	-	Calculation & construction standard for Orifice

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ISO 5167.1	-	Calculation & construction standard for Venturi

Manufacturer's Standardisation Society (MSS)

MSS SP 67	-	Butterfly Valves
MSS-SP-61	-	Pressure Testing of Steel Valves
DIN		
DIN 43760	-	Measurement Standard for RTD.
DIN 19243	-	Measurement and Control Electrical Sensors, Electrical Position Sensors and Signal Converters used for Intrinsically safe two-wire DC System

National Association of Corrosion Engineers (NACE)

NACE MR-175 Sulfide stress cracking resistant metallic materials for oil field equipment.

BRITISH STANDARDS

BS – 1042	-	Measurement of fluid flow in closed conduits
BS – 4368	-	Compression couplings for tubes
BS – 5308 Part-2	-	Specification for PVC insulated cables

International Organization for Legal Metrology (OIML) STANDARDS

R 6 - EN	-	General provisions for gas volume meters
R 32 - EN	-	Rotary piston gas meters and turbine gas meters
R 34 – EN	-	Accuracy classes of measuring instruments
R 137-1 – EN	-	Gas Meters. Part 1: Requirements

Fieldbus Foundation Standards

FF-103	-	Common File Format
FF-581	-	System Architecture
FF-586	-	Ethernet Presence

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FF-588	-	Field Device Access Agent
FF-589	-	HSE System Management
FF-593	-	HSE Redundancy
FF-801	-	H1 Network Management
FF-803	-	HSE Network Management
FF-806 H1	-	Data Link Bridge Addendum
FF-816	-	31.25 kbit/s Physical Layer
FF-821	-	H1 Data Link Services
FF-822	-	H1 Data Link Protocol
FF-830	-	31.25kbit/s Physical Layer Conformance Test
FF-831	-	Fieldbus Power Supply Test Specification
FF-870	-	Fieldbus Message Specification
FF-875	-	Fieldbus Access Sublayer
FF-880	-	H1 System Management
FF-883	-	Software Download Addendum
FF-890	-	Function Block AP Part 1
FF-891	-	Function Block AP Part 2
FF-892	-	Function Block AP Part 3
FF-893	-	Function Block AP Part 4
FF-894	-	Function Block AP Part 5
FF-900	-	Device Description Language
FF-902	-	Transducer Block Common Structure
FF-903	-	Pressure Transducer Block
FF-940	-	Communication Profile
FF-941	-	HSE Profile

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National Fire Protection Association

NFPA 70	-	National Electric Code
NFPA 72	-	National Fire Alarm and Signalling Code

National Electrical Manufacturer's Association

NEMA 250	-	Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS-6	-	Industrial Control and Systems: Enclosures

Oil Industry Safety Directorate (OISD)

OISD-RP-147	-	Inspection & Safe Practices during Electrical Installations
OISD-RP-149	-	Design Aspects for Safety in Electrical Systems
OISD-RP-152	-	Safety Instrumentation for Process System in Hydrocarbon Industry

Oil Mines Regulation (OMR) – 1984

8.0 GENERAL REQUIREMENTS:

8.1 Instrument Protection

The minimum degree of protection for junction boxes, electronic instruments and pneumatic instruments shall be IP 65 in accordance with IEC 60529.

Instruments located inside the enclosures shall be weatherproof to IP 55 and instruments inside air conditioned building shall be weather proof to IP 42.

Instruments shall be tropicalized for humidity and fungus.

8.2 Hazardous area Classification:

Instruments/ Equipments located in hazardous area shall be suitable for Installation in the area classified as per the Hazardous area classification drawings.

All instruments, junction boxes and cable glands and Local Control panels shall be certified for use in hazardous area as per area classification drawing. The instrumentation shall be certified intrinsically safe in general, as per IEC-79. However, field switches and Solenoid

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Valves shall be certified flameproof for use in classified area as applicable (IS-2148 / IEC-79).

Moreover all field instruments shall also be Weatherproof to IP 65 as per IS 2147 / IEC 529. All junction boxes, cable glands and local panels etc. shall also be weatherproof to IP 65 as a minimum. Junction boxes, cable glands and accessories shall be weather proof only when connected to intrinsically safe circuit and shall be weather proof and explosion proof / flame proof to IP 65 and NEMA-7 or equivalent IS standard, when connected to explosion proof instruments / circuits.

8.3 Instrument Air:

Pressure : 8.5 kg/cm²a at Baghjan

Dew Point, Oc : (-) 40 at atmospheric pressure

Instrument Air package with Compressor, Dryer and Receivers shall be included as part of the Project to ensure continuous availability of instrument air.

8.4 Electrical Connections:

Minimum two electrical entries shall be provided wherever possible. Electrical entries shall be ISO metric. Size for the signal cable entry shall be M20. Larger size such as M25, M32, M40 shall be provided for the power supply connection based on manufacturer standard.

All electrical entries shall be provided with suitably certified flameproof plug. Sizes other than above shall be provided with flameproof adapters/reducers, as applicable.

9.0 INSTRUMENT IDENTIFICATION NAME PLATES

All field instruments shall be furnished with a Stainless steel corrosion resistant nameplate permanently fastened with screws and stamped as follows:

- Manufacturer's name
- Model number
- Serial number
- PO Number
- Instrument tag number
- Supply voltage
- Operating range

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- Calibrated range
- Output
- Hazardous Area Certification
- Pressure rating

10.0 SELECTION OF INSTRUMENTS:

10.1 General Requirements

1. All the new instruments supplied shall be well proven design. No prototype or otherwise unproven equipment or instruments shall not be considered. Proven equipment or instruments is defined as equipment or instruments that have been used in similar service for minimum of 2 years with no major failure.
2. The instruments shall be selected considering high reliability, repeatability, ease of operation and accessibility for maintenance and inspection.
3. Instruments shall feature low power consumption and short stabilization time when they are powered on. Low maintenance requirements, High Mean Time between Failure (MTBF) and Low Mean Time To Repair (MTTR) shall be considered in selection of instruments.
4. All level instruments shall be suitable for the environmental and weather conditions..
5. The instrument shall be designed to meet the upper and lower design pressure and design temperature of the Equipment in which it is installed.
6. Instrument shall be chosen for minimal maintenance intervention and be rated with a minimum stability period of 5 years.
7. Transmitter shall be used for all measurements including alarm and trip service in general.
8. The design life of new instruments shall be 15 years.
9. Unless otherwise specified, the instrument ranges shall be selected such that the normal value will be between 50% and 75% of the calibrated span for linear scale taking into account the specified minimum and maximum values.

11.0 FLOW INSTRUMENTATION:

11.1 Selection of Flow Instruments:

- 11.1.1 In-line flow meters shall be preferred for flow rate measurements.

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- 11.1.2 In general, differential pressure (D/P) type (orifice or annubar with D/P transmitter) flow measurements are preferred for safety and control/monitoring applications where the line size ranges from 2 inches to 24 inches with a minimum Reynolds number of 20,000.
- 11.1.3 Flow measurement accuracies are reliable over 4-1 rangeability (with orifice plates). For 10:1 rangeability, variable area flow meters (rotameters), turbine meters, and positive displacement meters may be used.
- 11.1.4 For lines less than 2 inches and other special applications, integral orifice meters, rotameters, turbine meters, vortex flow meters, positive displacement meters, and mass flow meters shall be used.
- 11.1.5 Vortex flow meters, ultrasonic flow meters, electromagnetic flow meters, coriolis mass flow meters, and thermal dispersion mass flow meters can be considered and selected based on the particular application requirements. Special requirements such as size, pressure rating, accuracy, turn-down, multi-phase or bi-directional flow, low Reynolds number, avoidance of obstructions in the piping, etc., shall be considered in the selection of the flow metering technique.
- 11.1.6 Multi-path ultrasonic flow meters, coriolis mass flow meters, positive displacement meters, and turbine meters shall be considered based on application requirements.
- 11.1.7 The use of conditioning orifice plates (multiple bore) to reduce straight length requirements shall be considered with COMPANY approval.

11.2 General:

- 11.2.1 Electronic Flow Transmitters shall be of differential pressure type and shall be equipped with an integral output indicator calibrated in engineering units and external zero adjustment. The integral output meter shall be intrinsically safe and weather proof to IP 65 or better.
- 11.2.2 The transmitter shall be mounted local, on a yoke. All mounting accessories required for 2" pipe shall be provided.
- 11.2.3 The transmitter shall be intrinsically safe.
- 11.2.4 Cable entry to the transmitter shall be ½" NPTF.
- 11.2.5 The Electronic Flow transmitter shall operate on 24 V DC negative earthed and shall generate a FF output.
- 11.2.6 The flow transmitter shall be provided with a 5-valve manifold.

11.3 Measuring Unit:

- 11.3.1 The pressure element in the measuring unit shall be Diaphragm.

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11.3.2 The process connection to the measuring unit shall be ½” NPTM.

11.4 Orifice Plate

11.4.1 Orifice plate material shall be SS316 as a minimum.

11.4.2 The orifice plate beta ratio shall be between 0.20 and 0.60 for liquids and between 0.20 and 0.70 for gases and steam. A beta ratio of 0.75 is acceptable for orifice plates in 24 inch and larger pipelines.

11.4.3 Orifice plate thickness shall be between 0.005D and 0.02D as per ISO 5167 Part 2.

11.4.4 ISA standard sharp-edged, concentric orifice plates shall be used in all installations that indicate, record, and transmit process flow measurements unless process conditions require otherwise.

11.4.5 For high accuracy accounting installation, prefabricated meter runs should be purchased.

11.4.6 Orifice plates shall be sized such that the normal flow reading is between 50% and 60% of the full scale flow. Meter maximum flow range shall be a minimum of 1.1 times process maximum flow value.

11.4.7 Orifice plates in 2” NPS lines and above shall be provided with flange taps. Orifice plates in lines below 2” NPS shall consider standard orifice, integral orifice meters, or the use of other flow measurement devices.

11.4.8 Square edge orifice plates shall be supplied with the following information stamped on the upstream side of the plate handle: Orifice size (bore), diameter of the pipe, material of construction, upstream side, and instrument tag number.

11.4.9 To ensure that the orifice is correctly installed, a notch cut at the left hand corner viewed from the upstream side of the orifice plate shall be provided.

11.4.10 Concentric orifice plates can be provided with drain holes to prevent buildup of entrained liquids in gas streams, or with vent holes for venting entrained gases from liquids. The unmeasured flow passing through the vent or drain hole is usually less than 1% of the total flow if the hole diameter is less than 10% of the orifice bore. The effectiveness of vent / drain holes is limited, however, because they often plug up.

11.4.11 The orifice flanges provided shall be ‘weld neck type’ with flange taps in line with ASME B16.36. For the pipe line / size ratings not covered in ASME B16.36, alternative to flange taps or alternative methods of flow measurement shall be considered with COMPANY approval.

11.4.12 All these orifice plates shall be supplied as loose items clearly identifying the tag number along with duration/period during which the orifice is to be used.

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11.5 Restriction Orifice

- 11.5.1 Restriction orifice plates are devices that create process required pressure drops to limit a flow rate. They are not intended for flow measurement, but are similar to orifice plates in construction and sizing method. They are usually placed between normal piping flanges.
- 11.5.2 Restriction orifices shall be calculated (as per ISO 5167) in the same manner as square edge concentric orifice plates with flange taps, considering the relationship between differential pressure and permanent pressure loss.
- 11.5.3 The restriction orifice shall be a single plate or a multistage assembly with end flanges, based on the noise calculation, beta ratio and bore diameter.
- 11.5.4 VENDOR shall perform bore, plate thickness, and noise calculation for the plate or assembly accordingly and submit the same for CONTRACTOR review / approval.
- 11.5.5 Plate thickness should be calculated by considering forward and back flow pressure, whichever is higher.
- 11.5.6 VENDOR shall also perform and submit “stress and deflection” calculations for the restriction orifice plates and either confirm or offer alternative plate thickness.
- 11.5.7 A maximum noise level of 85 dBA measured 1m downstream is permitted within the boundary fence limits of the process units
- 11.5.8 The noise level limit may be as high as but not exceed 90 dBA in areas where presence of personnel is required for only short period of time.
- 11.5.9 Where the noise limit is exceeded, VENDOR shall provide multi-hole and / or multi-plate design. VENDOR shall obtain approval from CONTRACTOR / COMPANY prior to using sound level higher than 85 dBA.
- 11.5.10 The specification of restriction orifices shall take into account the following:
- The nominal size – normally equal to the line size.
 - The pressure rating, the pressure drop and material.
 - For high pressure drops, consideration should be given to hard facing of the plate, or to the selection of a material which can be hardened throughout.
 - The orifice bore diameter resulting from the sizing shall be the calculated with it's dimension rounded off to the nearest 0.1 mm.

11.6 Ultrasonic Flow Meters

- 11.6.1 Unless otherwise stated, the minimum accuracy of ultrasonic flow meters may be $\pm 0.1\%$ to 1% of full scale flow (depending on the number of paths) for inline type and $\pm 5\%$ for clamp on type. Range shall be as specified on the instrument data sheet.

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- 11.6.2 Ultrasonic flow meters are expensive and shall be used only when a non-intrusive, no head loss, and/or high accuracy meter is required. Ultrasonic flow meters shall not be used in fouling services that will block or plug the transducer paths (such as waxing service).
- 11.6.3 Ultrasonic flow meters provide greater than 100:1 rangeability.
- 11.6.4 Ultrasonic flow meters have capability of maintaining constant pressure with no pressure drop.
- 11.6.5 Only ultrasonic flow meters based on the transit-time method shall be used.
- 11.6.6 Ultrasonic flow meters may be used for clean liquids or gases and steam.
- 11.6.7 Ultrasonic flow meters may be considered where pressure drop is not permitted, and shall normally be spool piece inline type with integrally mounted transducers and can be of clamp on type with COMPANY approval.
- 11.6.8 When high accuracy is required, multipath ultrasonic flow meters shall be used.
- 11.6.9 Ultrasonic flow meters can be used for Class 2 measurements when used for Class 2 measurements, the minimum accuracy shall be $\pm 1\%$.
- 11.6.10 Ultrasonic flow meters to be provided with meter verification software from VENDOR to ensure the health and performance of the meter.
- 11.6.11 Ultrasonic flow meters shall be suitable for bi-directional flow.

11.7 Coriolis Mass Flow Meters

- 11.7.1 Unless otherwise stated, the minimum accuracy of coriolis mass flow meters shall be $\pm 0.05-0.5\%$ of full scale flow. Range shall be specified on the instrument data sheet.
- 11.7.2 For 100:1 rangeability, Coriolis mass flow meters may be used.
- 11.7.3 Coriolis meters shall be used where-
- Mass flow or density outputs are required
 - High accuracies are needed
 - When no obstructions to flow are desired (i.e. suspended solids)
 - When a low pressure drop is desirable.
- 11.7.4 Coriolis mass meters are capable of withstanding maximum temperatures up to 200°C and are suitable for low pressure drops.

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11.7.5 Coriolis meters can be used for liquid or gases, avoid using in two-phase flow.

11.7.6 Coriolis flow meters to be provided with meter verification software from VENDOR to ensure the health and performance of the meter.

11.7.7 Coriolis flow meters shall be suitable for bi-directional flow.

11.7.8 Coriolis flow meters shall be in line flanged type.

11.8 Variable Area Flow Meters (Rotameters):

11.8.1 The use of variable area flow meters, often known as rotameters shall be for simple applications such as measurement of purge, bubble-type level measurements, cooling or sealing fluids, or in sample conditioning system for analyzers.

11.8.2 Variable area flow meters shall be of armored all-metal type.

11.8.3 Unless otherwise stated, the minimum accuracy of variable area flow meters shall be $\pm 2-4\%$ of full scale flow. Range shall be specified on the instrument data sheet.

11.8.4 For 10:1 rangeability, variable area flow meters may be used.

11.8.5 Variable area meters are capable of withstanding maximum temperatures up to 300°C and are suitable for medium pressure drops.

11.8.6 Rotameters can be provided with integral transmitters for indication purposes.

11.9 Magnetic Flow Meters

11.9.1 Magnetic flow meters shall be used for volumetric flow of conductive liquids, including slurries and corrosive or abrasive materials. The process fluid must generally have conductivity equal to or greater than 5 microS/cm.

11.9.2 Flow meter electrode material should be selected for compatibility with the process fluid to be measured.

11.9.3 Where process fluids could be abrasive, counter flanges shall be provided with detector body to prevent damage to the internal lining. Construction of coil and internal lining shall be suitable for maximum rated temperature of the fluid.

11.9.4 The pipe should be filled with liquid at all the times and piping layout shall be designed to avoid empty pipe condition.

11.9.5 The detector body shall have flanged connections to ANSI B16.5. Grounding rings or connections should be provided for meters to ensure proper grounding. The grounding ring material shall be compatible with the process fluid.

11.9.6 The accuracy of the meter shall be $\pm 0.5\%$ of full scale and the repeatability shall be 0.25%.

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11.9.7 Flow direction shall be clearly and permanently stamped on the meter body.

12.0 CHOKE VALVES - TECHNICAL REQUIREMENTS

12.1 Valve selection

12.1.1 The choke valves shall be designed and constructed in accordance with the requirements of this specification and with the referenced codes and standards.

12.1.2 The choke valves shall be supplied as fully assembled and tested units, complete with all necessary accessories.

12.1.3 The choke valve selected shall be suitable to use in entire production profile without changing the valve body. However, if the selected valve trim/orifice is not meeting the valve travel requirement for the min/max flow conditions as per specification; the valve trim/orifice shall be selected to cover first 10 years of production profile. Additional trims to cover the rest of the flow conditions beyond 10 years shall be provided by the VENDOR.

12.1.4 Choke valve and electric actuator design, test, material selection, marking, inspection and testing shall conform to ANSI/API 6A, as a minimum. Material of construction shall conform to Product Specification level (PSL2) and Performance Requirement (PR2) of ANSI/API 6A and "Piping Material Specification", FGGS-BJN-PIP-SPC-5000.

12.1.5 The process fluids are corrosive and sour in nature. All wetted parts along with accessories coming in contact with the process fluid shall be suitable for wet H₂S and carbon dioxide.

12.1.6 All items on the valve/electric actuator/accessory assembly that are exposed to the environment shall be of a non-corroding material.

12.1.7 Cadmium plating or galvanizing shall not be used for any component of the choke valve or accessories.

12.1.8 Bolting shall be of like material to the equipment supplied. Body, trim, and all bolting materials shall be in accordance with "Piping Material Specification", FGGS-BJN-PIP-SPC-5000.

12.2 Valve Body

12.2.1 The design of the choke valves shall be angle-body type. The angle type orientation is preferred for severe service applications. This orientation will allow improved fluid management since the fluid exiting the trim will travel directly into the valve outlet. Flow direction shall be with inlet through the side of the valve and outlet through bottom and in line with the valve body.

12.2.2 VENDOR shall ensure that cavitation is eliminated and that the modulated choke valve operation shall be stable and shall minimize repair or replacement of trims and/or bodies.

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- 12.2.3 The modulated choke valves shall have ASME/ANSI flanged end connections in accordance with the requirements of the associated piping classes, as indicated on the data sheets. Flanges shall be integral with modulated choke valves. Welded flanges are not permitted.
- 12.2.4 Ring Type Joint flange (RTJ) shall have smooth finish with a surface roughness between Ra 0.4 µm and 1.6 µm in accordance with ASMB46.1/ASME B16.5 and Piping Material Specification.
- 12.2.5 Valve inspection shall include non-destructive evaluation (NDE), hydrostatic testing in accordance with IEC 60534, material test and traceability report, and positive material identification (PMI) shall be provided for alloy valves as well as valves in sour service (NACE).
- 12.2.6 Fugitive emission type test shall be as per Class “B” of BS EN ISO 15848 Part-1
- 12.2.7 Fugitive emission type acceptance test shall be carried out as per ISO 15848 Part-1 as pre-requisite to carry out Production test required as per ISO 15848 Part-2. Fugitive emission test is not required for valves in non-hazardous / non sour service and nonlethal service
- 12.2.8 Valves shall be provided with corrosion resistant bolting.
- 12.2.9 Repair of valve body castings by welding is not acceptable.
- 12.2.10 Threaded connections / plugs shall be avoided in pressure retaining components in Hydrocarbon sour service.

12.3 Trim and Leakage Class

- 12.3.1 Trim material shall be selected to withstand corrosion, erosion, cavitation, flashing and wear under worst operating conditions.
- 12.3.2 Trim designs may be classified as needle and seat, disk, or cage designs. Important factors to consider in trim selection are controllability defined as the “turn down ratio”; pressure recovery factor defined as the “FL factor”.
- 12.3.3 Design shall incorporate cage type trim. Trim design can be cage with external sleeve or internal plug design. Erosive or high pressure applications shall utilize an external throttling sleeve. Internal plug designs are not recommended for erosive or high pressure drop applications.
- 12.3.4 Valve trim should be designed with linear or equal percent characteristics. Quick opening characteristics shall not be supplied for modulating service.
- 12.3.5 For erosive service the ports should be positioned on the valve axis to reduce turbulence around the cage. For non-erosive service multi-ported cages are acceptable.

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- 12.3.6 Materials used for erosion protection shall be solid tungsten carbide for erosive conditions and hardened stainless steel for non-erosion applications. Stainless steel carriers are acceptable for the flow sleeve; however the entire turbulent area and high velocity zone shall be protected with hardened trim material. The Cage shall be of solid hardened trim material.
- 12.3.7 All Valves shall be hard faced with tungsten carbide. Tungsten carbide hard facing shall be performed by a suitable process avoiding decomposition of tungsten and carbon. The process shall be subject to approval by the COMPANY.
- 12.3.8 Tungsten Carbide trim materials shall utilize composite binders considering both erosion and corrosion properties. Minimum hardness for the tungsten carbide shall be Ra 93. Binder constitutes shall be Nickel, Chromium and Cobalt at a minimum.
- 12.3.9 Multi-Stage trim designs shall utilize a throttling mechanism on each stage. Designs which throttle on the initial or final stage only are not acceptable.
- 12.3.10 Trim design shall consider the potential for plugging and the design shall incorporate suitable means for passing normal sand that may be present within the fluid media.
- 12.3.11 Valve trim design shall be capable of Class IV shutoff as minimum defined by ANSI/FCI 70-2.

12.4 Valve Sizing

- 12.4.1 Valve sizing shall conform to ANSI/ISA 75.01.01. and capacity test shall be per ISA 75.02.01

VENDOR shall provide the following minimum sizing information for each choke valve at minimum, normal, maximum flow, and 120% of maximum flow cases:

- Calculated Cv value
- Rated Cv value
- Valve percentage (%) opening
- Noise prediction (dBA)
- Fluid velocity (m/s for liquid and Mach for gas). This shall be within the recommended limit and

if velocity exceeds the recommended limit, VENDOR to suggest the alternative solution.

- Flashing or cavitation prediction

- 12.4.2 Capacity Cv rating shall be tested per ISA 75.02.01.

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12.4.3 A single sized choke valve to cover all service conditions shall be provided. The choke valve size shall be chosen so that maximum calculated Cv (at all service conditions) shall be no more than 80% for linear or equal percent trim.

12.4.4 The minimum and maximum openings of the choke valves shall usually fall between 15% and 80% of the full stroke.

12.5 Valve Characteristic

12.5.1 The choke valve characteristics shall be obtained by using a characterized trim. Choke valves shall have linear or equal percentage characteristics based on the process data and production profile. The percent (%) opening for “Normal flow condition” shall be approximately 65% for linear or equal percent characteristics.

12.6 Handwheel

12.6.1 Valve shall be provided with handwheel for manual operation. Handwheel shall allow the valve stroking as a back-up mode independent of the control circuit.

12.6.2 Handwheel shall be of declutching type. Direction of rotation for open and close shall clearly be identified on handwheel.

13.0 TEMPERATURE INSTRUMENTATION:

13.1 Temperature Sensing

Temperature transmitters shall be used for all temperature measurements including bearing and winding temperatures. Integral head mounted temperature transmitters are preferred; however, remote mounted transmitters shall be provided the following:

- Skin measurements types
- Multi element types
- High vibration areas
 - Where suitable, temperature detection shall be via PT100 Resistance Temperature Detectors (RTD). Thermocouples may be used where RTDs are not suitable, such as high temperature range, the presence of high frequency vibration etc.
 - Thermocouples and resistance temperature detectors shall be supplied as complete assemblies, comprising thermocouple or RTD element and head converters.
 - Temperature element shall be equipped with an extension nipple and a screwed union.

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13.2 Thermowells

1. Thermowells shall be provided for all process/utility's temperature measurements except for 'skin type'. Minimum line size for thermowell installation shall be 4". When line size less than 4", it should be enlarged to 4" for the installation of temperature instruments.
2. Generally 1½" flanged thermowells shall be provided. Flanges minimum rating shall be ANSI 150 RF.
3. Thermowell type shall be one piece, bored from one-piece solid bar stock or forgings. Flanges / thermowells welding shall be full penetration double weld.
4. Thermowells and associated flanges shall meet the requirements of the ANSI B16.5 and B31.3. Thermowell and flange material of construction shall be AISI 316SS as a minimum, or other materials as required in the applicable piping class. Thermowell Materials and the flange material shall be the same.
5. Screwed type wells may be considered for minor services such as lube oil and seal oil for compressor packages, etc. These shall have external thread size of 1" NPT male with ½"NPT female internal thread and shall withstand a minimum of 20 bar at 200 °C.
6. Natural frequency and wake frequency calculations shall be performed as per ASME PTC 19.3 and submitted for COMPANY review.
7. Insertion length shall be in line with API 551. The tip of the thermowell shall be located within the middle of the flow line diameter. Well material, nominal well length, rating and tag number shall be stamped on the side of the flange or on the hex flat for screwed type wells. Each well shall have 0.5 inch 316SS plug and chain connected to well.
8. Flanged thermowells shall also be certified pressure tested externally, based on the flange rating, under requirements of ASME B31.3 or ASME B31.8 as applicable.
9. The VENDOR shall assemble the thermometer with transmitter and test the same before dispatching.

13.3 Temperature Gauges

1. For local indications Bi-metallic every angle dial thermometer shall be used. Where bimetallic types are not suitable, gas or liquid capillary instruments may be used.
2. Bi-metallic temperature indicators shall be supplied as complete assemblies comprising: every angle rotation hermetically sealed case indicator, extension nipple and thermowell.
3. Weatherproof (IP65) cases shall be used unless otherwise specified.

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4. Accuracy shall be within $\pm 1\%$ of span. The window material shall be shatterproof laminated glass. All gauges shall have external zero adjustment. Over range protections shall be at least 125% of Full Scale.
5. Range of the gage shall be specified in a manner that the pointer operate in the middle third of the scale at normal service condition.
6. Case material shall be 316 SS. Bi-metallic thermometers in service where vibration may be expected shall be either silicone filled or have other internal dampening means.
7. Dial size shall be 100 mm, black figures on white dial. Dial face shall be adjustable to any angle with respect to stem. Stem shall be 6 mm (1/4 in.) diameter SS316.
8. Connection shall be 1/2 "NPT, adjustable compression gland, 316 SST, bottom connection.
9. Temperature Gauge shall have a nameplate with tag number, manufacturer and purchase order number embossed on a 316 SS nameplate and attached with 316 SS wire.

13.4 Resistance Temperature Detectors

1. To eliminate the lead-wire error between resistance temperature detections (RTD) and transmitting or receiving instruments 3-wire or 4-wire shall be used depending on the degree of the required accuracy. Except otherwise specified in the datasheets, 3 wires resistance temperature detectors (RTD) shall be used.
2. Resistance thermometers will be used for the range - 200 to 450°C.
3. Resistance thermometer heads shall have a cable entry of M20 x 1.5.
4. The RTD head assembly shall consist of a spring loaded PT-100, 3-wire, Resistance temperature detector (RTD) encapsulated in a 316SS sheath material. The element and the internal wires shall be firmly secured within the capsule by a high compaction of magnesium oxide (mineral insulated). The head cover shall be of screwed type.
5. Resistance Temperature Detectors shall be Class-A to IEC-60751 and have a resistance of 100 ohms at 0°C (32°F) and a fundamental interval of 38.5 ohms. The RTD and the transmitter shall be matched for calibration accuracy.
6. The temperature element dimensions should comply with BS 2765 with an element diameter of 6 mm nominal. The lead wires shall be Teflon insulated, nickel-coated stranded copper wire. The RTD assembly to have a nipple-union-nipple arrangement for connecting to thermowell. The material of nipple-union-nipple shall be SS 316/316L grade.

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7. RTDs and T/C circuits operating high temperature alarms shall have upscale element burnout. Those on low temperature alarms shall fail to down scale position.

13.5 Thermocouples

1. For temperatures above RTD range 450°C, thermocouples shall be used and manufactured from nickel/chromium nickel aluminum (Type K) wires with reference characteristics in accordance with IEC-60584.
2. Thermocouples shall be mineral insulated, sheathed to 6mm diameter in accordance with IEC 60584 and with hot junction insulated from the sheath. Thermocouple head terminals shall be marked with positive and negative symbols.
3. The thermocouple to 4-20 mA converters shall use a HART communication protocol.
4. All thermocouple actuated control systems shall contain 'burn-out' protection. The design shall enable this feature to be switched in or out.

13.6 Temperature Transmitters

1. Temperature transmitters shall be 2-wire smart type (HART Protocol) with 3 wire RTD input, providing 4 – 20 mA output @ 24 V DC supply. The temperature transmitter shall be integral head mounted type with RTD assembly.
2. The overall accuracy shall be at least equal to + 0.05% of full scale taking into account hysteresis, repeatability, dead band and influence of environmental conditions.
3. Temperature Transmitters shall have input / output isolation, programmable / configurable upscale / downscale protection, and linearizing facilities.

14.0 LEVEL INSTRUMENTATION

14.1 General

1. To measure the level inside equipment over a range, various types of instruments are available.
2. Depending on the process conditions, the following techniques may be applied:
 - Differential pressure type instruments (with or without remote diaphragm seals);
 - Radar (GWR & Non-Contact Radar type) instruments;
3. Level gauges shall be of sufficient length to provide complete coverage of the range of the associated level instrument, including all control, alarm, and protective level functions. When two (2) or more gauge glasses are required to cover the level

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range, they shall be so installed that the visible length overlaps by at least 25mm (1").

4. Each individual instrument shall be supplied with a dedicated process isolation, drain and vent valves. Level connections shall be provided directly on the side or top of the equipment, i.e. bottom connections shall not be used.
5. For non-process package vessels, when the use of stand pipe is mandatory due to the vessels size and / or due to the quantity of level instruments to be connected to the relevant vessel, the use of stand pipes may be considered if there is no risk of nozzle(s) plugging.

14.2 Magnetic Level Gauge

1. Magnetic level gauges shall be used at all process vessels containing crude oil with high pressure and H₂S. Magnetic type Level Gauges in full Stainless Steel shall be used wherever suitable for gas/liquid level and interface level.
2. Attached externally to the level bridle is a graduated scale in millimeters and a series of incremental indicating sections that change color as a magnetic float moves with changing process level.
3. The indicators shall be mounted in a hermetically sealed chamber and selected to display the level in 25 millimeter increments, or less. The visual length of the magnetic level gauge shall be specified on individual instrument data sheets.
4. Separate valving shall be provided for the level instrument and its associated level gauge. The use of a bridle (standpipe) assembly to reduce the number of vessel connections is acceptable. Level gauges shall be hydro tested to 1.5 times the process design pressure by the Manufacturer.
5. For magnetic follower gauges, the float shall be selected so as to withstand the highest expected process and mechanical damage due to rapid level fluctuations.

14.3 Gauge Glasses

1. All gauge glasses shall be 'transparent' or 'reflex' type with chambers and covers made of carbon steel and heat resistant borosilicate glass. Alloy or 316 stainless steel construction shall be used for all wetted parts where process requires it.
2. All gauge glasses shall be equipped with safety balls.
3. Transparent gauges and reflex gauges shall be fitted with toughened glass.
4. Tubular glass type gauges shall not be used, except where specified by a Process Licensor.
5. Reflex gauge glasses shall be used on clean services.

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6. Reflex gauges shall be used for liquid and vapour interface detection except in the following circumstances, where transparent gauges shall be used:
 - Interface between immiscible liquids.
 - Viscous, caustic or acidic service
 - Color or turbidity observation.
7. All gauges shall be supplied with a shut-off valve on the top and bottom mountings and a full bore Ball valve. A vent valve shall be provided on toxic services or on corrosive liquid and liquid interface duties to allow for piping for safe fluid disposal. A vent plug shall be provided where a vent valve is not fitted.
8. Each gauge shall be stamped with the maximum working pressure and temperature that is equal to or higher than the vessel design pressure and temperature ratings.

14.4 Guided Wave Radar Type Level Transmitter

1. Guided Wave Radar (GWR) transmitters are independent of the liquid density and hence can be used on fluids with varying density but shall require accurate specification of the dielectric constant. Use of GWR on viscous coating waxy media should be avoided.
2. Dielectric values of the fluids should be greater than 1.4. In interface level applications, low dielectric fluid must be on top and the two liquids must have a dielectric difference of 10 or greater to avoid measurement errors.
3. GWR probe should be installed directly on top of vessel in a stilling well or in external chambers and must not touch the wall of the chamber or the bottom of the chamber.
4. The GWR transmitter shall be electronic, EEx'd' certified, 24 V DC loop powered, 2-wire SMART type with digital communication signal superimposed (HART) on the standard 4-20 mA DC output.
5. The transmitter shall be provided with integral digital indicator.
6. The GWR transmitter accuracy (as a percentage of the calibrated span) including effect of linearity, hysteresis and repeatability shall be +/- 5mm or better.
7. The principal of operation Guided Wave Radar (GWR) shall be based on the technology of Time Domain Reflectometry (TDR).
8. TDR utilizes pulses of electromagnetic energy, which are transmitted down through a probe. Once the pulses reach liquid surface that has a higher dielectric than the air or vapor in which pulses are travelling, the pulses shall get reflected. An ultra high

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speed timing circuit precisely measure the transit time and provides an accurate measurement of liquid level.

9. The Transmitters shall be suitable for top mounting, with rotatable construction.
10. The probe shall be constructed out of single flexible probe with stilling well. Material of construction shall be suitable for the process fluid. However minimum requirement for the material of construction shall be SS 316.

14.5 Non-Contact Radar Level Transmitters

1. The Radar Level Transmitters shall be electronic, EEx'd' certified, 24V DC powered, 4-20mA, HART. If 24V DC powered is not available, 240 V AC UPS powered shall be used.
2. The level of the liquid (or solid) is measured by radar signals transmitted from the antenna at the tank top. After the radar signal is reflected by the liquid surface the echo is picked up by the antenna. As the signal is varying in frequency the echo has a slightly different frequency compared to the signal transmitted at that moment. The difference in frequency is proportional to the distance to the liquid, and can be accurately calculated. This method is called FMCW (Frequency Modulated Continuous Wave) and is used in all high performance radar gauges.
3. Radar Level Transmitter's Antenna shall be cone or parabolic type. Material.
4. Level transmitters shall have features to detect crippled modes, such as faulty transmitter, line breakage, short circuit etc.
5. The Transmitters shall be suitable for top mounting, with rotatable construction.
6. Non-Contact Radar is not suitable for interface measurements.

14.6 Differential pressure type Level Transmitter (Diaphragm seal & Capillary)

1. This is the most preferred form of level measurement. For measurement of viscous fluids, fluids containing solids, highly corrosive fluids or where temperature changes may influence the fluid conditions, the use of diaphragm seals and with capillary shall be considered.
2. The differential pressure type level transmitters shall be direct coupled type with diaphragm seal and flushing ring. The flushing rings shall have 1/4" vent/ drain connections. The diaphragm seal fill fluid shall be inert type compatible with process media.
3. Capillaries for remote seal applications shall be kept as short as possible and shall not exceed 6 m.

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4. DP Transmitters used for Level Measurements shall be supplied with integral 5 valve manifold and accessories.

14.7 Level Switches

1. Use of level switches is generally not recommended. However it can be used where no other alternatives exist or inside the package Equipment's.
2. Level switch shall be provided with adjustable set point and contact shall be rated for 1A@ 250 V AC/ 1A @ 24 V DC.
3. All the Level switches shall be Explosion Proof "EEx'd" and shall be certified for the hazardous area classification Zone 2, Class IIA/B, T3 and IP 65 in accordance with IEC 60529.
4. Level Switch shall be provided with ISO M220 Electrical cable entries.

15.0 PRESSURE INSTRUMENTATION:

15.1 General

1. All pressure devices shall be capable of withstanding up to 1.3 times (min) the design pressure and test pressure of the equipment on which it will be mounted.
2. All pressure instruments shall be provided with a 2-way manifold and 5-way manifold for differential pressure service. The manifold material shall be AISI 316 stainless steel as a minimum.

15.2 Pressure Gauges

1. For general local measurement of pressure, bourdon tube type indicating pressure gages shall be used. Bellows or diaphragm type pressure gages may be specified for very low-pressure applications exceptionally.
2. Bourdon tube pressure gauges should be of the full safety-pattern type in accordance with EN 837-1 with blow-out protection.
3. Wherever general-purpose bourdon pressure gauge are not suitable due to corrosion, plugging etc. pressure gauge with an integral diaphragm seal shall be used as identified in the project specific data sheets. The diaphragm seal and pressure gauge combination shall be supplied as an integral unit.
4. Minimum pressure gauge Accuracy shall be 1% of full scale. The minimum pressure gauge dial shall be 100mm.
5. When excessive vibration is probable, liquid filled dampening devices shall be used. Snubbers shall be provided for pulsating/ oscillating excessive vibrations services.

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6. Over-range protection shall be 130% of the full scale and where design pressure exceeds this limit gauge savers shall be provided.
7. Gauges on steam or other hot condensing vapor service shall be provided with pigtail shape syphon.
8. Element and socket material shall be minimum 316 SS and movement shall be stainless steel. Material of construction for gauges accessories shall also be minimum 316 SS. Other materials shall be as per the data sheet.
9. Dial shall have weatherproof IP65, Stainless Steel casing with BLACK letters on WHITE background. Glass shall be safety glass type and pointer shall be provided with external micrometre zero adjustment.
10. Flush mounted liquid filled pressure gauges shall normally be used in local equipment panels, (i.e. compressors, pump, heaters, etc.).
11. Pressure Gauges should be selected in such a way that the normal operating pressure shall be between 50% and 75% of their full scale measuring range.
12. All other required accessories for the pressure gauges shall be provided in accordance with the data sheets.

15.3 Differential Pressure Gauge

1. Differential pressure gauge shall be of diaphragm or bellows type.
2. Differential pressure gauge shall have 100mm dial and ½" NPTF process connection. Accuracy shall be 1.5% full scale.
3. Dial shall have weatherproof IP65, SS casing with BLACK letters on WHITE background. Glass shall be safety glass type and pointer shall be provided with external zero adjustment.
4. Gauges shall withstand the maximum static pressure indicated on the data sheet on either side (LP or HP).
5. Element material shall be minimum 316 SS and movement shall be stainless steel. Material of construction for gauges accessories shall also be minimum 316 SS. Other materials shall be as per the data sheet.
6. Gauge shall be provided with bracket suitable for 2" pipe mounting.

15.4 Diaphragm Seal

1. Diaphragm seals shall be direct or remote type. All capillary tubing for remote type shall be corrosion resistant and sheathed or armoured.

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2. Diaphragm and wetted parts material shall be suitable for the process and shall be AISI 316 SS as a minimum and the capillary material shall be SS 316 with SS 304 armouring with a neoprene or polyvinyl chloride (PVC) cover, according to MANUFACTURER'S standard. Diaphragm Seal shall normally be integral with instrument.
3. Lower housing material shall be the same as the wetted parts, minimum AISI 316 SS.
4. Seal fluid shall be suitable for the operating conditions as specified.
5. When used for differential measurement, then capillary length shall be the same and shall run side by side as far as possible.

15.5 Electronic Pressure Transmitters & DP Transmitters

1. Transmitters shall have built-in local span, zero, integral damping adjustment.
2. All transmitters shall have a body rating of 1.5 times the design pressure / static pressure as indicated on the data sheets. The hydrostatic test pressure shall be 1.5 times the process design pressure.
3. All parts in contact with the process fluid, including sensor element, shall be AISI 316 stainless steel as a minimum. Higher-grade material shall be utilized as dictated by the process medium or conditions.
4. Transmitters shall use FF protocol for communication. Smart type transmitters shall be supplied with required number of hand held calibrators.
5. Transmitters shall be immune to Radio frequency interference due to walkie-talkie, paging system, communication system etc. All electronic modules shall be designed for short circuit protection.
6. Span shall be continuously adjustable over the transmitter range. The Electronic PT shall be provided with ½"NPT (F) cable entries.
7. The transmitter signal range shall be FF type and capable of delivering the rated current signal into external load of 600 ohms when powered with 24V DC.
8. All transmitters shall be provided with integral output meters. The output meter shall be suitable for use in the hazardous area.
9. The change in out put due to change in ambient temperature (10 degree Celsius) should be very minimum.
10. Electronic PT shall have externally adjustable zero and span. Setting adjustment shall have locking adjustment
11. Process connection from bottom side, 316SS threaded ½" NPTF.

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16.0 CONTROL VALVES:

16.1 Valve Selection & Construction:

- 16.1.1 The Contractor shall select control valve based upon plant capacity. The Contractor shall select reduced trim as required to satisfy the expected flow rate range.
- 16.1.2 Valve selection shall consider all possible effect of erosion, cavitations and noise.
- 16.1.3 Maximum permissible noise level shall be 85 dBA at 1 m from valve in all direction.
- 16.1.4 When minimum flow would require valve to be positioned at 15% travel provision shall be made to prevent erosion of valve trim.
- 16.1.5 Equal percentage and linear trim characteristic shall be used as applicable to process requirement. Quick opening trim may be used for ON/OFF service only.
- 16.1.6 Globe valves are preferred for general service, and shall be cage guided except in dirty or abrasive services (Produced liquids) where post guiding is preferred.
- 16.1.8 Butterfly control valves shall be used for water services only.
- 16.1.9 Cage type and single seated globe body valves shall be having process Fluid tending to open the valve.
- 16.1.10 Shut-off leakage of valves shall be in accordance with ANSI B16.104. Generally shut-off shall be class IV or better.
- 16.1.11 Body rating and flange rating and facing shall be in accordance with the piping class specification for the associated piping
- 16.1.12 Valve packing boxes shall be flange bolted to the bonnet. Valve packing shall be spring loaded and adjustable. Teflon V rings shall be used up to 2120 C. Above this temperature graphite shall be used with an external lubricator and isolation valve.
- 16.1.13 Valve bonnets shall be flange bolted to the body. Screwed bonnet s shall not be provided. For operating temperature of 2000C or greater, a radiating finned bonnet may be required for temperature below 00C an extension bonnet is required. If bellows seals are required they shall be constructed from 316SS.
- 16.1.14 Minimum body size shall be DN25.
- 16.1.15 In cases where the above conditions cannot be satisfied through control valve selection as described above, the contractor shall present alternatives for the company consideration.
- 16.1.16 Where a valve is venting to flare, soft seals are preferred. For high-pressure drop application in gas service multiple orifice trim design shall be used.

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16.1.17 Pneumatic connections shall be ¼” NPTF as minimum. Larger Port sizes shall be used wherever required for larger sizes of actuators.

16.1.18 Flow direction shall be stamped or cast on the body of all valves.

16.1.19 The Contractor shall provide detailed pressure temperature envelope curves for each combination of valve body, trim and elastomer material.

16.2 Control Valve Sizing:

16.2.1 The Control valve shall be sized to pass high and low extremes of flow at no more than 80% and no less than 20% travel respectively. Butterfly valves shall be sized with 60% representing 100% Travel.

16.2.2 The Contractor shall submit Control Valve sizing calculation performed in accordance with ISA S 75.01 and based on Process data, Approved Process flow diagram and material balance.

16.3 Actuator:

16.3.1 Control valve actuators shall be pneumatic, spring return type, diaphragm or piston type. Spring shall be corrosion resistant, cadmium plated or equal. Piston type actuator shall be used where diaphragm actuator cannot be used due to capacity limitation. Electric actuator shall be used wherever specified.

16.3.2 Actuators shall be sized for operation under maximum shutoff pressure drop across the valve minimum instrument air pressure or voltage to the actuator as specified in this specification.

16.3.3 Actuators shall be selected to achieve specified valve failure positions. All accessories, including pilot valves, relays, volume bottles etc. for double acting actuator or air block relays for fail in position valves, shall be supplied with the valve.

16.3.4 A valve stem position indicator shall be provided. All control valve scales shall be calibrated from 0-100 %.

16.3.5 Detachable side mounted heavy-duty hand wheels shall be provided for control valves wherever specified.

16.3.6 Actuator action shall be field reversible.

16.3.7 Diaphragm actuators shall be multiple bolted, pressed steel with Nylon reinforced Neoprene or Buna N Rubber Diaphragm.

16.4 Positioner:

16.4.1 Control valve shall be supplied fitted with positioner for all services except on/off control.

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16.4.2 The control valve shall be provided with integral positioner with intrinsically safe “smart” type integral i/p converter, and shall be direct acting, with field reversible action.

16.4.3 Gauges shall be fitted to indicate both input & output pressure.

17.0 SAFETY AND RELIEF VALVES

17.1 The overpressure protection devices shall be installed to meet the requirements and sizing of safety devices for vessels, piping and equipment in accordance with the ASME Pressure Vessel Code, Section I and VIII, ANSI B31.3, API-RP520 and API-RP521.

17.2 Relief valves shall be provided on the discharge of all positive displacement pumps.

17.3 Vessels which may be blocked in shall be provided with safety valves for fire protection.

17.4 Any isolating valve to be installed beneath the relief valve shall have a fail-safe visible indicator, such as a rising stem, to clearly indicate the valve position, and shall be equipped to allow chaining or locking in the open position.

17.5 All vessels or drums which have insufficient strength to withstand such external pressure as may be applied shall have properly sized vacuum breakers.

17.6 Overpressure protection for fixed roof atmospheric storage tanks shall be in accordance with API-520 (maximum working pressure less than 100 kPa(g), API STD 2000 and API STD 620.

18.0 SAFETY AND RELIEF VALVES SIZING

18.1 Safety and relief valves shall be direct spring loaded type. For liquid service and non-coded duties i.e. thermal relief they can be semi-nozzle with screw connections.

18.2 Valves shall be sized for the maximum flow requirements at design rates that would occur from heat input, material input, cooling water failure, reflux failure, maximum pump rates, thermal expansion, accidental closing of valves, control valve failure, external fire and other possible causes of overpressure. Double jeopardy shall not be considered except in the event of direct related occurrences.

18.3 Safety valves for release of vapor generated by external fire will be sized using heat inputs based on API recommendation (API RP520).

18.4 Safety relief valves shall be sealed by an ASME accredited shop.

18.5 Pressure and vacuum relief valves for storage tanks shall normally be of the weight loaded or pilot operated type, and sized in accordance with API 620 and API 2000.

18.6 Flanged connections shall normally be provided on safety and relief valves, 1" inlet size or larger. Minimum inlet rating shall be ANSI Class 150. Valve flanges shall match the rating and facing of mating flanges on vessels or piping. Body flanges shall be in

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accordance with ANSI B16.5 except for the thickness.

- 18.7 Relief valves for liquid service in ¾" and 1" sizes shall have screwed connections. All other relief valves 1" and larger shall have flanged inlet and outlet connections. Inlet flanges shall match the flange rating of the pipe or vessel to which they are connected. The outlet flange shall be at least equal to the rating of the discharge piping. Screwed connections shall be supplied on valves with inlets ¾" and smaller and for thermal relief valves, unless process or operating conditions do not allow. Threaded connections on valves shall be ANSI B1.20.1 pipe threaded ends.
- 18.8 Centre to centre to flange face dimensions shall be in accordance with API Standard 526 except for pilot relief valves.
- 18.9 Plain lifting levers and gags shall be supplied for safety and relief valves in air, hot water over 60°C or steam service in accordance with the ASME Boiler and Pressure Vessel Code, Section I and VIII.
- 18.10 Packed levers shall be provided in accordance with the codes and process requirements.
- 18.11 As a minimum all relief valves shall have carbon steel bodies with stainless steel trim, but in all cases the material shall conform to the piping specification.
- 18.12 A balanced bellows type relief valve shall be provided when discharge is routed into a closed system and the downstream pressure may exceed 10 percent of the set pressure. Bonnets of balanced type relief valves shall be vented to atmospheric pressure in such a manner as to avoid a personnel hazard and permit ready observation of any flow from the vent line. A locked open block valve shall be provided at an accessible location in each vent. Applications where balanced bellows relief valves are used must be approved by the OWNER.
- 18.13 Relief valves 1 inch and larger, not in liquid service, shall be full nozzle construction.
- 18.14 Metal to metal seals shall be provided for the greatest fire protection.
- 18.15 Where two relief valves are specified in the same service, each shall be sized to handle the full relieving capacity. Where more than two relief valves are used at a location, the sizing shall be such that the removal of one relief valve from service will not reduce the relieving capacity below the required capacity.
- 18.16 Relief valves shall have materials identical to those specified for control valves. All relief valves shall have K-monel or aluminized carbon steel springs.

19.0 ANALYZERS:

19.1 GENERAL DESIGN REQUIREMENT:

The analyzer shall be microprocessor based aiming a high degree of self diagnostic and

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supporting on line statistical control of the calibration procedures. The Analyzers shall be hardwired / serial linked to DCS.

The Analyzer system shall be engineered, designed and assembled in such a way so as to perform continuous, automatic, unattended analysis in the minimum time.

The Analyzer system shall be in compliance with EMC requirements as per IEC -61000-4 & shall Guarantee an EMC for an electromagnetic environment of Level 2.

Local Indicator for the Analyzers shall be digital LCD display visible without opening enclosure.

The Analyzer shall be capable of providing the following Outputs:

- Isolated Current Output 4~20mA DC for each analyzed component;
- RS-485 Serial Output with MODBUS RTU Protocol or MODBUS TCP/IP Output, whenever specifically mentioned in datasheet;
- SPDT Contact outputs for various diagnostic alarms such as:
 - a) High or Low Set point alarm as measurement;
 - b) Analyzer failure;
 - c) Low Sample flow;
 - d) Temperature Control Failure;
 - e) Purge Failure.

Unless otherwise specified, all contacts shall be normally closed type (contact open in alarm) and shall be rated for 230V AC 5 Amperes.

In general all Analyzer systems shall be certified Ex'd' IIA T3 for Zone 1 as per ATEX directive. Where Ex'd' design not possible, pressurized design Ex'p' shall be provided.

Unless otherwise specified, the Analyzer including the sample handling system shall operate at 230V 50 Hz power supply.

The following shall govern the end connections unless otherwise specified:

- Threaded connection shall be NPT to ASME B1.20.1;
- Flanged connection shall be as per ASME B 16.5.

End connections of sizes 6mm or below shall be suitably protected against damage. All end connections shall be clearly identified by attaching labels or stainless steel plate of

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suitable size.

Analyzer system design shall ensure automatic as well as manual validation / calibration of analyser system.

Unless otherwise specified, all analysers shall be located inside the Analyser house.

Wetted parts shall be in compliance with NACE MR 0175/ISO 15156 in case of sour service.

19.2 GAS CHROMATOGRAPH:

19.2.1 General:

The Chromatograph shall measure and provide output data for the sample composition.

The selection of the columns shall be of a type that will provide adequate separation of components, minimize analysis time, minimize maintenance time and meet the performance requirements of this specification. Column life shall be 6 months, as a minimum, assuming normal chromatograph operation. Baseline separation of all measured components are preferred to other chromatographic methods. Detector selection shall be based upon the type required to accurately measure all components at their specific range.

Carrier gas / burner gas shall be used as required. The flow rate of the carrier gas shall be adjustable with the system on-line without opening the oven compartment. The Analyser shall be equipped with electronic pressure control.

All Safety accessories required for use with the carrier gas, including a system design which will limit or disconnect the detector power on loss of carrier gas, shall be provided.

The Analyser shall be automatically zeroed after each component measurement.

The Chromatograph shall separate measured peaks from all interferences so a few seconds of baseline are provided on either side of each peak.

The chromatograph oven shall be equipped with independent temperature controls to provide a stable operating temperature controls to provide a stable operating temperature for the analytical columns and detection assemblies to facilitate reproducible gas component analysis. The oven shall also be protected from overheating caused by malfunction or utility failure.

Chromatograph sampling shall be inhibited until the analyser detector reaches operating temperature.

Preferred detection devices shall be either FID (Flame ionization detector) or TCD (Thermal conductivity analyser) or FPD (Flame Photometry Detector) depending upon the application. Type of detectors and their quantity shall be decided based on the gas

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composition to be analysed.

All necessary requirements for the calibration of the proposed equipment shall be provided. The period between routine calibrations shall be defined. A permanently installed calibration system shall be supplied with the analyser by CONTRACTOR based on VENDOR recommendation.

Low carrier gas pressure alarm and low-air pressure for flame ionization detectors shall be generated and displayed in the Analyser.

Analyser System (I, e gas Chromatograph and programmer) shall be protected against EMF/RFI (Electromagnetic frequency / Radio Frequency Interference) and the certificate for EMF/RFI protection shall be submitted. The analyzer shall be shielded against common mode and normal mode noise in addition to RFI and EMI.

Unless otherwise specified, the gas Chromatograph shall meet the following performance specifications:

Sensitivity : $\pm 0.5\%$ of full scale or better.

Repeatability : $\pm 1\%$ of full scale or better.

The baseline drift per analysis cycle without auto zero shall be less than $\pm 1\%$ of span.

Details like cycle time, Sample flow rate and sample return pressure etc. shall be provided.

19.2.2 Gas Chromatograph Programmer: (Controller)

The Gas Chromatograph programmer shall be a microprocessor based device and shall directly interact with gas Chromatograph to control its various functions. The Programmer shall be capable of performing the following functions as a minimum:

- Proper control of the analysis cycle including oven temperature control;
- Automatic zero adjustment and calibration of the chromatograph system;
- Configuration of gas Chromatograph;
- Display analysis results and diagnostic messages;
- Provide chromatograph outputs to strip chart recorder;
- Provide hardwired analog outputs for each component;
- Provide RS-485 serial output with Modbus RTU protocol or Modbus TCP/IP output for components being analysed for communication.

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The programmer shall be dedicated to each chromatograph. It shall either have integral architecture (integral to the chromatograph) or split architecture mounted remote to gas chromatograph. CONTRACTOR shall ensure that the cables between the gas chromatograph and programmer shall be supplied by VENDOR in cse of programmer with split architecture.

Gas Chromatograph programmer shall be a programmable from programmer facia. The programmerfacia shall have a keypad performing following functions:

- Configuration / programming and program modifications of gas chromatograph
- To display analysis data and alarms;
- To display diagnostic alarms for rapid trouble shooting in the event of system mal-function.

In case the programmer has blind facia or facia does not meet above requirements in the part or full, a separate PC along with software to meet the above requirements shall be provided. The PC shall be supplied with 19" LCD color monitor and a keyboard.

The programming of the programmer shall be user friendly and shall not require the knowledge of any high level language. Field modifications of the data tables and chromatogram application shall be possible under password protection.

The programmer shall be able to provide following outputs:

- Isolate 4~20mA DC output for each component within the specific range in engineering units. For obtaining continuous analog outputs, peak pickers and long term memory circuit boards shall be provided for each component of interest;
- Alarm contact on high concentration and system failure;
- RS-485 serial output with Modbus RTU protocol or Modbus TCP/IP output.

When specifically indicted, chartless recorder shall be provided. Programmer shall provide an output either 0-10V/0-1V or serial output as per the selected recorder. It shall be possible to generate chromatogram or bar graph on the recorder.

In general the recorder shall have the following performance characteristics:

Accuracy : $\pm 0.5\%$ of full scale or better.

Repeatability : $\pm 1\%$ of full scale or better.

19.2.3 Communication Interface:

The Communication Interface shall serve as an interface unit between the

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Chromatograph and the AMADAS (Analyser Management & Data Acquisition System) in case the Chromatograph programmer does not provide communication output with standard Pre-defined protocol.

The Interface may either be an integral part of the programmer or may have a device external to the programmer.

Output of the Communication interface shall be serial digital signal to RS -485 with MODBUS RTU based protocol or MODBUS TCP/IP Output.

In case communication interface is a separate device serving a number of chromatographs then the device shall be redundant.

In case number of gas chromatographs are to be hooked to AMADAS through a common communication interface, this communication interface device shall serve as final interface with AMADAS.

19.3 Hydrogen Sulphide (H₂S) & Carbon di oxide (CO₂) analysers:

CO₂ Analyser shall be non-dispersive Infra-red (NDIR) type. The method of analysis of H₂S Concentration in the process gas stream shall be UV photometric (non-dispersive) technique.

CONTRACTOR may propose another measurement technique / alternate technology based on the process parameters if it meets the performance specifications mentioned in this section.

Analyser cell length shall be selected as per Analyser component range. In case of dual range analysers, the selected cell length shall be suitable for both ranges.

Analyser Cell material and window material shall be suitable for the process conditions.

The Analyser design shall be such that it is insensitive to source fluctuations or degradation or partial cloudiness of cell window.

Unless otherwise specified, analyser shall meet the following performance requirements:

Repeatability	:	±1% of full scale
Zero Drift	:	±1% of full scale per 24hours
Response Time	:	5 seconds for 90% of final reading or better.

The Analyser/ Transmitter should incorporate a display / keypad unit to facilitate set-up and Operation.

The Sample module shall consist of a Sample cell and peripheral equipment for drawing

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& Conditioning the sample, sample transport lines, sample probe assembly & Interconnecting tubes for vent & sample return. The Sampling System shall have flow meters / filters as necessary.

The Analyser system shall be microprocessor based with automatic zero controls. Verification of span shall be carried out at site based on Span gas composition recommended by VENDOR.

The Analyser output shall be 4~20mA @24VDC, isolated. Voltage free contacts shall be provided with RS-485 serial output with Modbus RTU protocol or Modbus TCP/IP output.

The analyser configuration and application program shall be stored on non-volatile memory. Battery backup shall be provided in case memory is volatile. The design shall ensure that the application program and data tables remain unaffected in case of power fluctuations or power failure.

20.0 SDV/ BDV:

1. Valves shall be ball or triple offset butterfly type. Ball valves shall be either full bore or reduced bore. The requirement of Double Block & Bleed design shall be as indicated in the P&ID's.
2. Valves materials of construction, valve design, and standards shall be selected in accordance with piping material specification.
3. Valve body thickness shall be according to Table-3 of ASME 16.34. Additional margin for corrosion allowance shall be considered if specified in relevant pipe class or instrument datasheets.
4. Valves shall be fire safe in accordance with API 6FA and tested according to API 607 / ISO 10497.
5. An anti-static feature/device shall be provided complying with API 6D. Seat design shall be fire-safe and be tested and certified as complying with API 6FA. Leakage class for ESD valves shall be Bubble tight shutoff as per API598.
6. Bodies shall be cast or forged with integral flanges. Flanges for valve sizes ≤ 24-inch flanges shall comply with ASME/ANSI B16.5.
7. ESD valves shall be fitted with air driven, spring opposed, piston-type actuators that provides inherent failsafe design. Where the single acting actuators cannot be used or are uneconomic then double acting actuator shall be used with an air reservoir providing an enough capacity for one open/shut strokes of the valve to maintain the failsafe condition.
8. The material of construction for the actuator shall be steel. An integral field „Open/Close“ indicator shall be included. This shall preferably be mounted on top of the actuator. Actuators shall be attached to the valve stem as per ISO 5211. ESD Valves shall not be fitted with hand wheels.

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9. Careful consideration shall be given to the actuator mechanism. Overrides shall not be provided for actuators on emergency shutdown valves.
10. The actuator shall be sized to shut off against the specified maximum differential pressure with the ability to be opened at this differential pressure. Actuators shall be designed for a minimum instrument air pressure of 4 barg and maximum air pressure of 8 barg.
11. The Actuator design and Torque calculations shall be carried out to achieve the closure time based on the maximum differential pressure (line design pressure) across the valve and minimum air supply pressure for the actuator. The safety factor of 1.25 shall be considered for all ESD valves and On/Off valves.
12. Solenoid valves shall be 24V DC powered, EEx'd' certified, IP-65 rated and three-port change over spring return type, normally energized with the valve opens for fail safe operation. Solenoid valves shall be supplied with low power consuming coils and it shall be class H insulation Type and fitted with quench diodes, suitably rated for continuous operation (energized condition). Bug screens shall be fitted to vent ports to prevent the intrusion of insects. Solenoid valve Body and Trim material shall be AISI SS316. Solenoid valve shall be provided with Auto Reset from the Control Room.
13. Limit switches shall be EEx'd' certified, IP-65, Magnetic proximity type, hermetically sealed single change over, contact rated for 24V DC, 2A. Limit switches shall be located in an industrial junction box mounted on the valve/actuator assembly.
14. The electrical signal cable entry for Solenoid valve and Limit Switch shall be ISO M20. Unused cable entries shall be plugged with certified cable entry plugs. Signal wiring terminals shall be of the screw type.
15. Air Filter Regulators shall be provided with SS316 pressure gauges for incoming air supply & control supply indication. Filter Element shall be 5 micron.
16. Instrument Air Tubing and fittings, etc. shall be minimum AISI SS316 and double compression Fittings shall be used.
17. Type of inspection and certification requirements shall be conform to CENELEC EN 10204. Material certificates shall be 3.1 for body and bonnet and 2.2 for all other metallic parts in contact with fluid and for bolting assembly. Original or red stamped copies shall be verified by LOM CONTRACTOR approved inspectors.
18. All shutdown valves with all their accessories shall be subjected to the following checks and tests as a minimum.
 - Dimensional check;
 - Hydrostatic test;
 - Performance and mechanical operation test.

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21.0 INSTRUMENT VALVES AND MANIFOLDS:

21.1 DESIGN AND CONSTRUCTION:

- 21.1.1 The instrument valves shall be of manufacturer proprietary design. However, the minimum requirement specified herein must be complied.
- 21.1.2 For all valves and manifold with body material of Carbon steel /Stainless steel, the valve trim material shall be SS316, as a minimum. Whenever body material is other than that specified above trim material should be same as body material as a minimum.
- 21.1.3 Unless otherwise specified, the valve packing material for all valves and manifolds shall be Teflon only. Also the O-ring materials wherever used shall also be of Teflon.
- 21.1.4 The finishing and tolerances of parts like stem, piston, stem threading etc. of the offered valves and manifolds shall be properly machined to avoid problems like galling.
- 21.1.5 The hand wheel material for all valves and manifolds shall be Zinc /Nickel plated Carbon steel.

21.2 Instrument Valves (Miniature)

- 21.2.1 The instruments valves shall be of globe pattern needle valves forged /bar stock with inside screwed bonnet, with back seated blowout proof system.
- 21.2.2 For Body material shall be 316 SS unless otherwise specified.
- 21.2.3 The cold working pressure (CWP) rating of the valve shall be 102kg/cm² unless otherwise specified.
- 21.2.4 The end connection shall be ½ “ NPTF to ANSI B1.20.1.
- 21.2.5 Flow direction shall be marked on the body.
- 21.2.6 The valve dimensions shall be as follows:
 - a) End to end dimensions 76mm (approximately).
 - b) Height in fully open condition – 135 mm maximum.

21.3 Valve Manifold

21.3.1 3-Valve and 5-Valve Manifolds

- a) 3-Valve manifold shall be designed for direct coupling to differential pressure transmitters having 2 bolt flanges with 54mm (2-1/8”) centre connection and 41.3 mm (1-5/8”) bolt to bolt distance.

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- b) 5-Valve manifold shall be designed for direct coupling to differential pressure transmitters having 2 bolt flanges with 54mm (2-1/8") centre-to-centre connection and 41.3mm (1-5/8") bolt-to-bolt distance.
- c) 3-Valve manifold shall contain two main line block valves and an equalizing bypass valve. The valves shall be needle type. They shall use self-aligning 316 SS ball seats, unless otherwise specified.
- d) 5-Valve manifold shall contain two main line block valves and a combination double block and bleed for the bypass line. The valve shall of needle type or special ball with bleed hole and bleed for the bypass line. The valve shall of needle type or special ball with bleed hole.

The flanges shall be integral part of manifold block.

The material of construction shall be 316 SS unless otherwise specified.

The process connection shall be 1/2" NPTF to ANSI B 1.20.1.

21.4 **2 Way Valve Manifold for Pressure Gauges**

The manifold shall be designed for use with pressure gauges with block and bleed valves. The manifold body shall be either straight or angle type as specified in the datasheet. The valve shall be needle type.

The body material shall be 316SS unless otherwise specified.

The cold working pressure ration of the manifold shall be 102 Kg/cm² unless otherwise specified.

The manifold shall have the following connection:

- a) The inlet connection shall be 3/4" plain ends with a minimum of 100 mm nipple extension suitable for socket weld or butt weld as per B 16.11 /16.9 as specified in the job specification.
- b) The gauge connection shall be with union nut and tail piece threaded to 1/2" NPT (F).
- c) The drain connection shall be 1/2" NPTF.

22.0 **INSTRUMENT WIRING**

- 22.1 Individual field instruments shall be connected to local field junction boxes. Multi-pair cables shall be used to connect the field junction boxes to the marshaling racks in the equipment room in the control building. Analog signals and digital signals shall be segregated and power cables shall not be run with signal cable.

Cables for intrinsic signals shall not be mixed with non-intrinsic signals. Junction boxes

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shall be constructed from 316 SS, Ex 'e' certified and shall be suitable for use in Zone 1 Gr. II, A & B hazardous area with temperature classification T3.

- 22.2 All cables shall be steel wire armored suitable to be run in pipe racks as well as buried below ground.
- 22.3 Single pair cables shall have 1.5mm² conductors and multi-pair cables shall have 1.0mm² conductors as a minimum. All cables shall be provided only with an overall shield. All multi-pair cables shall be provided with 10% spare conductors.
- 22.4 All cables shall utilize compounds that are low smoke zero halogen with an oxygen index of not less than 30, temperature index not less than 260°C, and acid emission less than 0.5% in accordance with IEC-752 part-2.
- 22.5 All cables used for process measurement and control and are not associated with any shutdown functions shall be flame retardant complying with IEC 60332 part 3 (Cat 'A'). All non-intrinsic safe circuit cables shall be provided with a black color outer sheath to be UV-resistant. All cables used in intrinsic safe circuits shall be provided with a blue color outer sheath.
- 22.6 All cables used in shutdown circuits and fire detection systems shall be fire resistant to IEC 60331.
- 22.7 All cable glands in outdoor service shall be weather proof as per IEC 60529 IP 65.
- 22.8 Cable glands used in the plant area shall be of the double compression type certified Ex'd' – brass nickel plated, suitable for Zone 1, Gr. II A & B hazardous area, complete with locknut, earth tag, sealing washers and PCP shroud.
- 22.9 Separate junction boxes shall be used for intrinsically safe wiring.
- 22.10 Instrument signal wiring junction boxes shall not be used for electrical cables.
- 22.11 All analogue signal cable shall be electrostatically shielded – the shield shall be aluminum backed by Mylar/polyester tapes bonded together with the metallic side down helically applied with both side 25% overlap and 100% coverage.

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0	Issued for ITB	15-07-19	RS	SN	CK	
A	Issued for Review/Approval	24-04-19	RS	SN	CK	
REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

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1.0 INTRODUCTION

OIL India Limited (OIL) is in the process of development of producing field in Baghjan area. As a part of this development scheme, OIL desires to construct a Field Gas Gathering Station (FGGS) comprising of natural gas production facility at Baghjan field in Upper Assam, India. The FGGS shall have Non Associated Gas (NAG) processing facility for 5.0 MMSCMD (2 trains x 2.5 MMSCMD) and provision to feed Associated Gas (AG) of 0.5 MMSCMD along with the NAG to a Glycol based Dehydration facility (5.0 MMSCMD) for achieving water dew point less than or equal to (0) Zero Deg C. The facility shall include Production and Test Manifolds, Gas /Condensate/Water Separators, Gas Dehydration, Flare system and Effluent Treatment and disposal system along with all the required utilities and auxiliary systems.

Jayathe Petrotech Engineers and Consultants (JPEC) has been awarded the contract for Engineering and Project Management Consultancy for developing the engineering and managing project execution.

2.0 PURPOSE

This specification defines the general requirements for the design, fabrication, testing and inspection of skid packages.

The detailed requirements for the specific equipment contained in the skid package shall be governed by a separate specific equipment/package specification.

3.0 CODES & STANDARDS

The design, manufacture, inspection, testing and supply of skids shall as a minimum comply with the requirements specified in the following International Codes, Standards and Practices as amended/supplemented by Project Specifications/ Standards.

Table 3.1 Codes and Standards

STANDARDS	TITLE
AWS D1.1	Structural Welding Code — Steel
IS 875	Code of Practice for Design loads (Other than earthquake) for Building & structures
IS 1893	Criteria for Earthquake Resistant Design of Structures.
ISO 9000	Quality Management Systems - Fundamentals and Vocabulary
ISO 9001	Quality Management Systems – Requirements
ISO 9004	Quality Management Systems - Guidelines for Performance Improvements
OISD 118	Layouts For Oil And Gas Installations
OSHA	Occupational Safety and Health Administration Regulations
WRC BULLETIN 107 (537)	Local Stresses in Spherical and Cylindrical Shells due to External Loadings
WRC BULLETIN 297	Local Stresses in Cylindrical Shells due to External Loadings on Nozzles- Supplement to WRC Bulletin No. 107

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Table 3.2 Project
Specifications

PROJECT SPECIFICATIONS	TITLE
FGGS-BJN-MEQ-DBM-4000	Mechanical Design Basis
FGGS-BJN-CIV-DBM-8000	Architecture/Civil/Structural Design Basis
FGGS-BJN-ELC-DBM-6000	Electrical Design Basis
FGGS-BJN-INT-DBM-7000	Instrumentation Design Basis
FGGS-BJN-PIP-DBM-5000	Piping Design Basis
FGGS-BJN-PIP-SPC-5000	Piping Material Specification
FGGS-BJN-PIP-SPC-5004	Specification For Painting
FGGS-BJN-PIP-SPC-5009	Specification For Insulation

4.0 ABBREVIATIONS / DEFINITIONS

4.1 ABBREVIATIONS

Table 4.1.1 Abbreviations

ABBREVIATIONS	DESCRIPTION
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
ANSI	American National Standards Institute
BJN	Baghjan
CPCB	Central Pollution Control Board
DB	Design Basis
EPCC	Engineering, Procurement, Construction and Commissioning
FGGS	Field Gas Gathering Station
F&G	Fire & Gas
FRP	Fiberglass Reinforced Plastic
JPEC	Jayathe Petrotech Engineers and Consultants Pvt Ltd
KOD	Knockout Drum

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KCAL	Kilo Calories
LPG	Liquefied Petroleum Gas
MH	Manhole
NFPA	National Fire Protection Association
NPS	Nominal Pipe Size
NPSHA	Net Positive Suction Head -Available
OEM	Original Equipment Manufacturer
OISD	Oil Industry Safety Directorate
OSHA	Occupational Safety and Health Administration
PFD	Process Flow Diagram
P&ID	Piping and Instrumentation Diagram
WN	Weld neck
WRC	Welding Research Council

4.2 DEFINITIONS

Table 4.2.1 Definitions

NOMENCLATURE	DESCRIPTION
Company	Oil India Limited (OIL)
Consultant	Jayathe Petrotech Engineers & Consultants (JPEC)
Project	Field Gas Gathering Station, Baghjan (FGGS-BJN)
Vendor/Manufacturer/Supplier	The person, firm, Company or Corporation including their assignees who supplies the equipment/materials required for the project
EPC	Engineering, Procurement & Construction
Shall	Indicates mandatory requirements
Should	Indicates strong recommendations to comply with the requirements of this document

5.0 GENERAL

5.1 Vendor's Responsibility

- 5.1.1 The Vendor shall have full responsibility for design, fabrication, testing, inspection, quality and selection of materials and quality of workmanship. Review of the Vendor's drawings or inspection by COMPANY shall not relieve the Vendor of any of these responsibilities.

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5.1.2 The Vendor shall provide and install all equipment and materials, except as specifically limited by COMPANY, to make a complete and fully operational skid package.

5.1.3 The Vendor shall supply equipment and materials with the skid package suitable for installation and operation in the location and climatic conditions specified in the data sheets. Where the COMPANY requires specific measures for extreme climatic conditions these requirements will be specified on the data sheets.

5.2 Measurement Units

5.1.1 Measurement units employed in this specification are based on the International System of Units (SI) with the exception of nominal pipe size, which may be expressed in inches (NPS) as per the ASME Standards.

5.1.2 SI units in all correspondence, specifications and drawings, etc. unless otherwise specified in data The Vendor shall use sheets.

6 SKID REQUIREMENTS

6.1 General

6.1.1 Unless otherwise specified, outside skid dimensions shall not exceed 9 m long x 2.5 m wide x 2 m high. Skid mounted equipment, piping, instruments, panels and other components shall be within confines of skid outer edge.

Modular Design: For units which can be modularized, the skid shall be self-containing, shall be pre-fabricated and assembled in the standard size of containers, transported in containers and placed at site on concrete foundation. Modularization is to achieve minimum fabrication/ construction job at site.

6.2 Skid Arrangement

6.2.1 Skid shall be:

- 1.Rectangular.
- 2.Designed such that equipment may be removed or maintained.
- 3.All grating panels shall span in the same direction and shall be removable.

6.2.2 Piping and instrumentation systems shall be designed to enable isolation and removal of equipment, including:

1. Isolation block valves and flanged spool pieces without bending or cutting pipe.
2. Drainable piping systems.
3. Skid piping tie-ins flanged and piped to skid edge.

6.2.3 Access shall be provided to accomplish daily operating tasks and routine maintenance from skid edge or through open areas with walkways, platforms, or both as follows:

1. Stairs, ladders, cages, platforms, handrails, etc., shall be provided as required, and shall conform to the following requirements as well as those of the OSHA regulations.

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2. Instrumentation panels and local gauge boards shall be accessible from one side of skid or centralized in an open access area.
3. Manual valves, switches, pushbuttons, and other devices required for daily operation shall be located within convenient reach of skid edge or an open access area.
4. Access areas with walkways or platforms shall be free of tripping hazards, overhead obstructions, dead ends, and constricted passageways.

7 STRUCTURAL DESIGN

7.1 General

- 7.1.1 Design of structural steel work shall be as per IS: 800 (Code of practice for general construction in steel). However, equivalent European or American codes and standards may be used if agreed in writing by COMPANY/ Consultant.
- 7.1.2 Minimum design loads shall be determined in accordance with Project specification FGGS-BJN-CIV-DBM-8000 (Architecture/ Civil/ Structural Design Basis).
- 7.1.3 Design considerations shall include:
 1. Location (land or marine).
 2. Equipment static and dynamic loads.
 3. Foundations, tie-downs, or anchorage.
- 7.1.4 Skid installations shall be sufficiently rigid to prevent damage during fabrication, assembly, transportation, or installation.
 1. Skid assemblies with rotating equipment as major components shall be designed with a maximum deflection value of 0.025 mm per 25.4 mm (0.001 inch per inch) of skid length for loading conditions.
 2. Other skids shall be designed with a maximum deflection value of $L/300$, where L is skid length.
- 7.1.5 Skid structures shall be designed for the most severe effect of the following loads during:
 1. Fabrication, assembly, and hydrostatic / pneumatic test.
 2. Transportation (land, sea, or air).
 3. Lifting and skidding on concrete supports
 4. Service, including effects of vibration, impact, and fatigue.

7.2 Design loads

7.2.1 General

- Loads which are permanent parts of structures such as equipment, empty pipe and vessels, etc. shall be classified as dead loads or empty loads. Loads which are temporary, such as occupants, repair / maintenance tools, cranes, equipment

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and loose parts or as specified by a code or standard shall be classified as live load. Wind load, seismic load, soil active or passive pressures, thermal or hydraulic loads shall be those loads specified herein for the processing facilities, and constitute live loads.

- Unless otherwise specified by Company, skid shall be designed as a simple beam supported at the extreme ends. Loads shall include:
 1. Skid dead loads.
 2. Equipment.
 3. Piping and supports.
 4. Piping reactions.
 5. Fluid loads.
 6. Live loads

7.2.2 Erection loads

Erection loads shall be considered in load combinations as live load.

7.2.3 Impact loads

- For structures supporting live loads that induce impact, the assumed live load shall be increased sufficiently to provide for the impact.
- Structures subjected to impact loads shall be designed as per loads given in IS 875

7.2.4 Maintenance loads

- Maintenance loads shall be considered in load combinations as live load.
- Heat exchanger supports shall also be designed to withstand the longitudinal bundle pull force.

7.2.5 Seismic loads

Basis of design for seismic load shall be in accordance with Project specification FGGS-BJN-CIV-DBM-8000 (Architecture/ Civil/ Structural Design Basis). Seismic zone V shall be applicable as per IS 1893.

7.2.6 Self-straining forces

Consideration of self-straining forces such as differential settlement, moisture expansion, shrinkage and creep shall be given in design of all structures and supports.

7.2.7 Thermal loads

- Thermal stresses and deflections of assembly shall be within allowables of equipment tolerances.

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- Thermal loads and displacements caused by operating conditions shall be based on the design temperature of the equipment rather than the operating temperature.
- Ambient temperature ranges from a maximum of 40 °C to a minimum of 7°C.

7.2.8 Transportation loads

- Unless otherwise specified, equipment connections to skid, skid structure, and skid tie- downs to transportation vehicle, ship, or barge shall be sized for a 1 g horizontal load, in any direction in conjunction with a vertical acceleration of ± 0.5 g combined with total dead load.
- A 1/3 increase in allowable stress shall be permitted.

7.2.9 Vibration loads

- Rotating equipment skid components shall be designed such that natural frequency of skid, as whole or as individual components, lies outside the range of 0.50 to 1.50 times equipment operating frequency.
- Dynamic stress and deflection amplitude shall not exceed equipment tolerances.
- Maximum peak vibration velocity shall be less than 2.54 mm (0.1 in) per second.

7.2.10 Wind loads

The design for wind load shall be as per IS 875 (Part III) , the parameters to be used shall be in accordance with Project specification FGGS-BJN-CIV-DBM-8000 (Architecture/ Civil/ Structural Design Basis).

7.3 Lifting loads

7.3.1 Skid supplier shall provide lifting rigging design.

7.3.2 For four-sling pyramid lifting arrangements (hook point located directly above package center of gravity), lifting slings, frames spreader bars, pad-eyes, shackles, and major structural members of skid assembly shall be designed for two load conditions in accordance with the following:

1. If lift load is split equally between the two diagonals:
 - a) Calculated Weight Contingency 1.1
 - b) Impact factor 1.5
2. For skew load effect, a 25%-75% split of lifting load shall be applied across the two diagonals:
 - a) Calculated Weight Contingency 1.1
 - b) Impact factor 1.15
3. For lifts with spreader bars, approval for percent split and impact factors shall be

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obtained from Company.

4. For lift conditions, no increase in basic allowable stresses shall be permitted.
5. Maximum loads on shackles shall not exceed manufacturer's testing load on shackles and maximum safe working load times a factor of 1.5.
6. Maximum loads on slings shall not exceed 33% of certified minimum breaking strength of slings.
7. The lifting lugs/ trunnions of the individual equipment supported by the skid like pressure vessels, heat exchangers, etc shall be designed for an impact factor of 2.

7.3.3 Pad eyes and connections to supporting structural members shall be designed for maximum sling loads in combination with an out-of-plane horizontal force to compensate for any side loading on pad eye.

1. Horizontal force shall be not less than 5% of sling load applied perpendicular to pad eye at pinhole center.
2. If spreader bars are used, value shall be 10%.
3. Pad eye design shall include the following stress checks:
 - Bearing against shackle pin.
 - Double shear for pin pull-out.
 - Tension through net section.
 - Combined stresses at various locations.

7.3.4 True sling angles shall be limited to a range from 60 to 75 degrees from horizontal.

7.3.5 If large spreader frames are used, vertical slings may be permitted.

7.4 Structural details

7.4.1 Load carrying members

- Load carrying members in skid assembly shall be compact sections.
- Webs of load carrying beams shall be designed to transmit shear and bearing loads without crippling.
- Plate, stiffeners, and beam or tubular sections in skid assembly shall be 6.35 mm (0.25 in) thick, minimum.
- Metal thickness at points of equipment bolting shall be 10 mm (0.375 in), minimum.
- Structural members with cut-outs of holes shall be checked for stress levels at net sections, including stress concentrations.
- If stresses exceed allowables, reinforcement shall be provided.

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7.4.2 Connections

- Connections shall be designed to develop full strength of connecting members.
- Unless otherwise specified, connections shall use full penetration welds.

7.5 Structural materials

- 7.5.1 Skid and support structural steel shapes, plates, pipes rolled from plate, and bars shall be IS: 2062 or equivalent.
- 7.5.2 Seamless steel structural tubulars shall be IS: 1161 Grade Yst 240 or higher.
- 7.5.3 Bolts, and nuts shall conform to IS: 1363 /1364 & IS: 1367.
- 7.5.4 Floor plates shall be of hot-dip galvanized gratings.

8 FABRICATION

8.1 Skid construction

- 8.1.1 Dimensional tolerances shall conform to structural steel design codes used.
- 8.1.2 Weld slag and splatter shall be removed.
- 8.1.3 Burrs, temporary tack welds, and sharp edges shall be ground smooth prior to coating.
- 8.1.4 Skid mounted assemblies, including piping, guards, ladders, platforms, and railings, shall be erected prior to coating.
- 8.1.5 If disassembly for shipment or field erection is required, clips shall be installed and required connection materials, such as bolts, nuts, and washers, plus an additional 10% shall be furnished.
- 8.1.6 Rotating equipment mounting pads shall be machined flat and parallel to within 0.05 mm per meter (0.002 inch per foot) after welding to skid supports.
1. Stainless steel, slotted, shim packs, 3 mm (0.125 in), minimum, shall be supplied under each foot.
 2. Horizontal and vertical jack screws shall be supplied at each foot of rotating equipment weighing more than 136 kg (300 lbs).
- 8.1.7 Skids shall have vertical jacking screws along main longitudinal members.
1. Intervals shall be 1524mm (5 ft), maximum.
 2. Anchor bolt holes shall be located in same reinforced area as jacking screws.
- 8.1.8 If inland-grouted skids are specified, each skid compartment shall have 153 mm (6 in) diameter grout holes in the center area with a 38 mm (1 1/2 in) raised lip. Corners of separate compartments shall have 6 mm (0.25 in) grouting vent holes.

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8.2 Structural welding

- 8.2.1 Structural components shall be welded in accordance with IS 816,823 & 861.
- 8.2.2 Approval of weld procedures and welding personnel qualification shall be obtained from Company/ Consultant.
- 8.2.3 Weld connections for both perimeter beams and main crossbeams shall be full penetration.
- 8.2.4 Skid areas shall not trap or hold drainage liquids.
- 8.2.5 Welding inspection shall be:
 1. Performed in accordance with applicable code
 2. Extent of inspection shall be as follows as a minimum
 - Lifting lugs, trunnions, and members connected to lifting points shall be 100% visual, 100% magnetic particle inspected.
 - Spliced joint members shall be 100% visual, 100% magnetic particle, and 10% radiography or ultrasonic inspected.
 - Other skid members shall be 100% visual and 10% magnetic particle inspected.
 - Secondary equipment support member and walkways, ladders, handrails, stairs, and decking shall be 100% visual inspected.
 - If defective welds are discovered, additional testing shall be required. Extent of additional testing shall be as instructed by Company/ Consultant.

8.3 Drainage and access areas

- 8.3.1 Areas beneath equipment or vessels subject to spills or leaks shall:
 1. Have sloped drainage areas, sloping 25 mm per 2,540 mm (1 inch per 100 inches), minimum.
 2. Be constructed with 6 mm (0.25 in) plate, minimum.
 3. Be supported in spans of 1 m (39 in), minimum.
- 8.3.2 Grating shall:
 1. Be non-skid.
 2. Be serrated bar type.
 3. Have a 38 mm by 5 mm (1.5 in by 0.1875 in) opening size, minimum.
 4. Not be used as a mounting surface for equipment or supports
- 8.3.3 Unsupported grating span shall be 1200 mm (48 inches), maximum.
- 8.3.4 Grating joints shall occur at points of support.
- 8.3.5 Grating bearing bars shall be 38 mm by 6 mm (1.5 in by 0.25 in), minimum, on 32 mm (1.25 in) centers.

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8.3.6 Floor plate shall be 6 mm (0.25 in) thick, minimum, and have non-skid construction.

8.3.7 Maximum unsupported spans shall be 1 m (39 inches), maximum.

8.3.8 Platforms and stairs shall be constructed with grating.

1. Platforms shall be 1 m (39 in), minimum, in width.
2. Ladders shall be 400 mm (16 inches), minimum, in width.
3. Rungs shall be deformed bar 19 mm (0.75 in), minimum, in diameter.

9 PIPING

9.1 Design

9.1.1 NPS of 1 ¼", 2 ½", 3 ½", and 5" shall not be used.

9.1.2 Carbon steel process piping shall be seamless.

9.1.3 Process piping shall be hydrostatically tested to 1.5 times design pressure in accordance with ASME B31.3.

9.1.4 Skid external connections shall be flanged and shall be NPS 1, minimum.

1. Socket welded, flange connections shall be used for process piping components NPS 1 to 1 1/2.
2. Weldneck flange connections shall be used for carbon steel process piping components NPS 2 and larger.
3. Skid drain connections shall be 25 mm (1 in), minimum, and may be threaded.

9.1.5 Piping shall conform to applicable sections of ASME B31.3.

9.1.6 Forces and moments on equipment nozzles shall be that specified in Mechanical design basis.

9.1.7 Flanges shall conform to ASME B16.5/ ASME B16.47.

9.1.8 Process drains and vents shall be connected to the respective common header and run to edge of skid.

9.2 Equipment piping

9.2.1 Rotating equipment suction and discharge piping shall have breakout spool pieces.

9.2.2 Rating of piping flange shall match connected equipment nozzle.

9.2.3 Spool pieces shall be removed during shipping.

9.2.4 Block valve shall be provided near each nozzle on auxiliary equipment items for isolation purposes.

9.2.5 Unless specified otherwise, cooling water connections to equipment shall be designed with upward flow.

9.2.6 Drains shall be provided at low points.

9.2.7 Vents shall be provided at high points.

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9.2.8 If temperature control is not provided, a throttling valve shall be installed on one side of each cooler or jacket water system.

9.3 Instrumentation tubing

9.3.1 SS 316 tubes shall be used for both instrument lines and process impulse lines. Instrument air tubing shall be ¼" OD and process impulse lines shall be ½" OD as minimum. Stainless steel double ferrule tube fittings shall be used.

9.3.2 Tubing valves shall be globe, needle, or ball type.

9.3.3 Globe and needle valves shall have 316 stainless steel bodies and stems with Teflon packing and stem tips or stem seats, minimum.

9.3.4 All Impulse tube fittings shall be SS and double companion fittings and tubing shall be fully type annealed seamless type.

9.3.5 Tubing and tubing fitting supplier shall be as per approved vendor list of EIL or any one subject to OIL's approval.

9.4 Equipment

9.4.1 Pressure vessels shall be designed and constructed in accordance with ASME BPVC, Section VIII, Division 1 or Division 2 as specified in the equipment data sheet.

9.4.2 Welding personnel shall be qualified in accordance with ASME BPVC, Section IX.

9.4.3 Shell and tube heat exchangers shall be designed and fabricated in accordance with API STD 660.

10 ELECTRICAL

10.1 General

10.1.1 Unless otherwise specified, electrical installation, equipment, and wiring shall be designed to operate in an ambient temperature of 40°C (104°F).

10.1.2 If skid unit is to be located in a hazardous (classified) area, equipment and wiring methods shall be in accordance with NEC, Articles 500 through 503.

10.1.3 Control and alarm circuits shall be of fail-safe design. Alarm contacts shall open to initiate alarms.

10.2 Equipment

10.2.1 Motor controllers

- Unless specified otherwise, motor controllers shall be furnished by others and be located off skid.
- Other control equipment and devices required to complete motor control system shall be furnished, installed, and wired by supplier.

10.2.2 Enclosures

- Junction boxes, panel boards, and control enclosures shall be:
 - Corrosion resistant.

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2. Compliant with specified NEC area classification.
 3. NEMA Type 4X, minimum, in non-classified, outdoor areas.
 4. Equipped with drain and breather fittings.
- b. Wiring inside enclosures shall be routed, bundled, and tied or supported in plastic conductor raceways.
 - c. Terminals in enclosures shall be mounted on stand-offs or on mounting strips.

10.3 Power

10.3.1 Each 415V load shall be supplied by an individual feeder.

10.3.2 Feeder shall be 415V, three-phase, 3-wire, ground-wire circuit routed directly to load from a dedicated junction box located on skid edge.

10.3.3 Feeder for each voltage level lower than 415 volts shall run to skid edge and shall connect to a single, skid-mounted junction box complete with terminals.

10.4 Wire and cable

10.4.1 Wire for voltages 415V and lower shall be single-conductor, stranded copper XLPE/SWA/PVC/FRLS.

1. Minimum conductor size for power circuits shall be 2.5 mm².
2. Minimum conductor size for control circuits shall be 1.5 mm².

10.4.2 Wiring for instrumentation shall be twisted, shielded, and either pair or triad construction, 16 AWG.

10.5 Wiring methods

10.5.1 General

10.5.1.1 Interconnecting wiring shall be enclosed in conduit, raceways, junction boxes, or panel boards.

1. Conduit fittings shall be supplied and installed where required.
2. Drain fittings shall be installed in vertical conduit runs.
3. Sealing fittings shall not be poured.

10.5.1.2 Alarm, instrument, and control devices shall be wired to terminal blocks mounted in junction boxes.

10.5.1.3 Separate junction boxes and cable runs shall be provided for the following:

1. Thermocouples.
2. Instrument signals.
3. 230 volt AC control and power.
4. DC pulsed or switched signals.

10.5.1.4 Junction boxes shall be mounted at edge of skid. Final location of boxes shall be shown on drawings. Prior to fabrication, approval for location shall be obtained from Company.

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10.5.1.5 Terminals shall be tubular screw clamps and rated for 415 volts for power and 230V for instruments and thermocouples.

1. Each terminal strip shall have 20% spare & 20% space terminals.
2. Two conductors, maximum, shall be terminated at a single terminal point.
3. Terminals shall be numbered in compliance with wiring diagrams.

10.5.2 Wiring

10.5.2.1 Wires shall be tagged at both ends with slip-on plastic wire markers printed with legend indicated on wiring diagram.

10.5.2.2 Wiring shall be continuous without splices from terminal to terminal.

10.5.3 Conduit

10.5.3.1 Unless otherwise specified, conduit shall be rigid galvanized steel.

10.5.3.2 If specified for corrosive environments, conduit and fittings shall be copper-free aluminum or coated with factory-applied, chemically bonded PVC (40 mils, minimum).

10.5.3.3 Watertight, flexible metal conduit shall be used for connections to motors and to other electrical equipment subject to vibration or requiring a flexible connection for maintenance.

10.5.3.4 Minimum conduit size shall be 19 mm (0.75 in), except that flexible conduit connections to instruments and other devices may be 13 mm (0.5 in).

10.5.3.5 Conduit connections to enclosures without factory-threaded hubs shall be made with watertight threaded hubs.

1. Conduit shall enter enclosures from bottom.
2. Horizontal conduit connections to enclosures shall be arranged for drainage away from enclosure to conduit low-point drain fitting.
3. Conduit union shall be installed between conduit seal and enclosure.

10.6 Lighting

10.6.1 Illumination levels shall be in accordance with OISD 149.

10.7 Grounding

10.7.1 Grounding shall be in accordance with NFPA 70, Article 250.

10.7.2 Two pads shall be welded to skid located at opposite corners of skid. Each pad shall have mechanical lug sized for Number 2/0 AWG conductor.

10.7.3 Frames and enclosures of electrical components, motors, vessels, tanks, and structural parts shall be electrically bonded to skid.

1. Conduit, cable shielding, and electrical enclosures shall be electrically bonded to provide continuous connection between respective items.
2. Cable shielding for analog and other low voltage instrument cables shall be

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grounded only at main panel.

3. Total resistance between any device on skid and skid frame shall not exceed 0,1 ohm.

10.8 Nameplates

10.8.1 Electrical equipment, enclosures, and control stations shall be identified with nameplates.

- a. Nameplates shall be stainless steel or laminated white / black / white phenolic engraved with a black legend.
- b. Nameplates shall be fastened with stainless steel screws.

11 Instrumentation

11.1 General

- **Instrument Protection**

The minimum degree of protection for junction boxes, electronic instruments and pneumatic instruments shall be IP 65 in accordance with IEC 60529.

Instruments located inside the enclosures shall be weatherproof to IP 55 and instruments inside air conditioned building shall be weather proof to IP 42.

Instruments shall be tropicalized for humidity and fungus.

- **Hazardous area Classification:**

Instruments/ Equipment's located in hazardous area shall be suitable for Installation in the area classified as per the Hazardous area classification drawings.

- **Electrical Connections:**

Minimum two electrical entries shall be provided wherever possible. Electrical entries shall be ISO metric. Size for the signal cable entry shall be M20. Larger size such as M25, M32, M40 shall be provided for the power supply connection based on manufacturer standard.

All electrical entries shall be provided with suitably certified flameproof plug. Sizes other than above shall be provided with flameproof adapters/reducers, as applicable.

For detailed specifications refer specification for General Instrumentation (FGGS-BJN-INT-SPC-7001) & INSTRUMENTATION DESIGN BASIS (DOC.NO. FGGS-BJN-INT-DBM-7000).

12 INSPECTION AND TESTING

12.1 General

12.1.1 The responsibility for inspection rests with the Vendor.

12.1.2 COMPANY reserves the right to inspect equipment at any time during working hours to ensure compliance with applicable specifications, codes and regulations.

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12.1.3 The Vendor shall notify COMPANY five working days before fabrication starts if he has not already been contacted by the COMPANY's Inspector.

12.1.4 The Vendor shall provide suitable facilities, provide adequate warning and time his work to meet the requirements of the COMPANY's Inspector.

12.1.5 Notice of the equipment's readiness for inspection and/or testing shall be given at least five working days prior to the start of any of the following phases of fabrication:

1. Fabricating piping phase:

a) Notice is required when fabrication begins.

b) Notice is required when 50 percent of welding is complete.

c) Notice is required when welding is complete but before assembly, except when assembly of unit will allow convenient 100 percent radiography weld inspection, both internally and externally.

2. Assembly phase: notice is required when assembly is complete.

3. Hydrostatic testing phase: notice is required when ready for hydrostatic testing.

4. Preparation for shipment phase: notice is required when partially dismantled and properly prepared for shipment.

12.1.6 The interior surfaces of all components shall be thoroughly cleaned. Slag from welding and cutting, weld flux, steel, dust, water and other debris shall be removed.

12.1.7 After cleaning, all openings shall be immediately covered to prevent foreign matter and debris from re-entering the components.

12.1.8 Check general appearance, workmanship and operability, such as correct height of push- button stations.

12.1.9 Check safety hazards such as conduit run above grating (tripping), burrs on structural steel or handrails.

12.1.10 The following outlines, but does not limit, the scope of intended inspection, the requisite duties of the fabricator and condition of components to enable the inspection at various phases to be performed.

12.1.11 As a minimum, but at COMPANY's discretion, the COMPANY's inspector shall normally require to:

a) review Vendor's schedule;

b) review Vendor's quality control procedures;

c) review welding procedures and welder's qualifications before fabrication commences;

d) check code material specifications, mill certificates (when applicable), thickness and pressure ratings;

e) check welding procedures are being followed;

f) check welding electrode control is acceptable;

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- g) check impact test requirements are being followed;
- h) select welds for NDE;
- i) review radiographs and other NDE reports;
- j) visually inspect all welding;
- k) check welders have stamped welds or weld map is prepared;
- l) check location of thermocouples prior to stress relief;
- m) check stress relief temperature/time chart;
- n) witness hydrostatic test;
- o) check equipment layout and interconnecting piping, wiring and tubing matches layout drawings, material lists, and P & ID's, and is suitable for operation and maintenance;
- p) check skid assembly meets COMPANY specifications and drawings;
- q) check surface preparation for painting and coating;
- r) check painting and coating for number of layers and thickness;
- s) check coating for holidays;
- t) witness the test run of any rotating equipment including the testing of the control and shutdown logic;
- u) check skid preparation for shipment; and
- v) witness loading.

12.1.12 COMPANY may use any method of inspection necessary to establish quality control and ensure adherence to specifications. Any weld judged by the COMPANY's inspector as not meeting the specifications, applicable code requirements or is unacceptable for the service for which it is intended, shall be cut out and repaired at no expense to COMPANY.

12.2 Fabricated piping inspection

12.2.1 When fabrication begins:

1. Review welding procedures and welding performance qualifications.
2. Check materials.
3. Check wall thickness.

12.2.2 When 50 percent of welding is complete:

1. Visual: internal and external
2. Radiograph: random or 100 percent as specified in the purchase order

12.2.3 When welding is complete: same as item 12.2.2 for remaining work.

12.2.4 Piping conforms to project requirements.

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12.3 Assembly inspection

12.3.1 The assembly shall be complete with the exception of covers that would require removal for inspection of circuitry. Terminal boxes and vessel manways are two examples of devices that shall be left open.

12.3.2 The fabricator shall provide electrical power as required and an instrument air test harness, if required. The air test harness assembly shall consist of two needle valves, a bleed valve, a pressure gauge and a regulator. This assembly applies a simulated pressure signal to a device.

12.3.3 Dimensional checks shall be made on all interconnecting piping components for tolerance compliance and dimensions as shown on the drawings.

12.4 Structural inspection

12.4.1 Check members compliance with specifications and drawings.

12.4.2 Welded quality: butt welded joints in main beams shall be examined by magnetic particle or other approved NDT methods at the discretion of the inspector.

12.4.3 Check that compartment drains are adequate.

12.4.4 Check that piping and equipment supports are complete and ready for shipment.

12.4.5 Check lifting lugs, slings and clamps. Lifting lug welds and spreader bar welds shall have 100 percent NDT of an approved type. All lifting devices shall have valid test certificates available for inspection.

12.5 Instrumentation inspection

12.5.1 Check for compliance with specifications.

12.5.2 Check hookup according to instrument drawings and specifications.

12.5.3 Check for proper support of valves, instruments, air lines, etc.

12.5.4 Stroke valves and simulate operation. Test in accordance with project specifications.

12.6 Electrical inspection

12.6.1 Verify that component quantities and description are compatible with requirements.

12.6.2 Test in accordance with project specifications for the following items.

1. Perform point-to-point continuity test.
2. Check all equipment for proper voltage, phase and frequency.
3. Perform manual operation of all mechanical linkage for proper alignment.
4. Energize all equipment, run motors with couplings disconnected and perform operational tests by causing relays, solenoids, etc. to function by simulation of control action to test integrity of circuit.
5. Perform high voltage test for conductors (including insulation where appropriate) and/or equipment involved.
6. In cases involving explosion-proof equipment, fabricator shall not pour seals until

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inspection is completed.

7. Verify that grounding points are installed properly.

12.7 Painting inspection

12.7.1 Verify paint is in accordance with job specifications.

12.7.2 Check general appearance.

12.7.3 Verify that paint has been removed, if necessary, from all control valve stems and other machined surfaces, instrument glass, nameplates, flange faces and other items that are not supposed to be painted.

12.8 Hydrostatic or pneumatic testing

12.8.1 Piping on assembled skid units shall be pressure tested in accordance with ASME B31.3.

12.8.2 Water for hydrostatic pressure testing shall be clear, non-toxic, non-corrosive, neutral fresh water. Water used for testing carbon steel systems shall have a chloride content not exceeding 250 ppm. Water used for testing austenitic stainless steel systems shall have a chloride content not exceeding 50 ppm.

12.8.3 An approved corrosion inhibitor shall be applied to the internal surfaces of all skid components.

12.8.4 Hydrostatic or pneumatic testing shall be performed prior to painting and/or application of insulation.

12.9 Insulation inspection

12.9.1 Check proper materials and thicknesses.

12.9.2 Check banding, caulking and general workmanship.

12.10 Certifications

The following items shall be verified and certified in writing:

- a. Pressure Vessel/ Heat Exchanger code certification forms
- b. All hydrostatic test charts
- c. All material certifications
- d. All welder qualifications
- e. All welding NDT
- f. All electrical code certifications
- g. Structural design certification, if required
- h. Lifting devices certification and test lift certification, if required
- i. Cleanness of interior surfaces of all components

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13 PREPARATION FOR SHIPMENT

13.1 General

- 13.1.1 All equipment shall be drained thoroughly of test water.
- 13.1.2 All skid edge tie-in points shall be protected in accordance with Mechanical Specification FGGS-BJN-MEQ-SPC-4001
- 13.1.3 When so specified by COMPANY, equipment shall be prepared for extended storage. Rotating machinery which requires extended storage should be run for a short period with its normal lubricating oil and then nitrogen purged and sealed. A film of heavier oil shall be applied inside cylinders when the normal lubricating oil is extremely light. Screw compressors shall be barred weekly to avoid brinelling.
- 13.1.4 All equipment shall be supported and tied down or removed and packed separately so that it is not damaged during lifting or shipment.
- 13.1.5 Lifting points shall be clearly identified.
- 13.1.6 All protrusions which have to be removed for shipment shall be removed by the Vendor. All equipment shall be loaded by the Vendor. It shall be the responsibility of the Vendor to ensure that all packing list shall identify all loose shipped components. All shortages shall be clearly indicated items which have been removed for shipment are loaded with the main equipment. A comprehensive Equipment, piping, electrical, instrumentation and other components shall be securely anchored to the skid to prevent damage during shipment. Shipping supports, tie-downs and temporary welding shall be marked and noted for removal.

Instruments to be removed, as required by other relevant specifications, shall be tagged and crated in waterproof boxes constructed from 5 cm (2 in) lumber or equivalent.

1. Instruments shall be packed with sufficient desiccant for protection in transit and during storage at job site.
2. Boxes shall be securely attached to the skid for shipment.

Any equipment extending beyond the skid edge shall be removed, tagged and crated in waterproof boxes constructed from 5 cm (2 in) lumber or equivalent. Boxes shall be securely attached to the skid for shipment.

13.2 Partially dismantled and properly prepared export shipment

- a. Check Bill of Material or packing list against all back-ordered and/or boxed items.
- b. Verify proper removal, packaging and safe storage of dismantled components.
- c. Check for proper material preservation.

13.3 Openings protection

- a. All openings, flange faces, threaded connections, valve stems and other component parts subject to mechanical damage or corrosion shall be adequately protected. Such protection shall consist of, but not be limited to:
 1. Bolted wood or plastic flange covers

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2. Sealing with waterproof tape
3. Enclosing with temporary metal housings
4. Coating all machined and threaded surfaces with a rust preventative
5. Protective covers on lubrication fittings

- b. This protection shall be applied to all components: those removed and boxed and those remaining in place on the skid assembly.

13.4 Skid preparation

- a. All piping and handrails removed for shipment shall be properly tagged and secured to the skid from which it was removed.
- b. A lifting sling assembly, including spreader bar, if required, for a minimum four-point pickup, shall be furnished with each skid.
- c. The completed skid, after being prepared for shipment, shall be test lifted to ensure a balanced and level lift and structural integrity. Measure deflection of skid to ensure no damage to equipment.
- d. The skid shall be securely fastened to the barge ship or other means of transport at the designated tie down points.

14 INSULATION

- 14.1 The insulation of vessels, instrumentation and piping shall comply with Project Specification FGGS-BJN-PIP-SPC-5009 as applicable.

15 PAINTING

Surface preparation and painting shall comply with Project Specification FGGS-BJN-PIP-SPC-5004.

16 DRAWING APPROVAL

- 16.1 Within 21 days of receipt of purchase order the Vendor shall provide six sets of prints and one set of reproducible shop detail drawings. These drawings shall be complete and shall include:
 - a) P & ID;
 - b) Layout of all equipment items;
 - c) Layout of all piping;
 - d) Vessel and other static equipment drawings and design calculations;
 - e) Skid detail including anchor bolt or pile location plan including key dimensions; materials
 - f) Skid structural design calculations
 - g) Wiring diagram for power and control circuits;
 - h) Control logic diagram;

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- i) Panel layout;
- j) Make, model, size, rating and body material of all bought out equipment; and
- k) Completed package weight.

- 16.2 The P&ID shall indicate the line number including the piping class as per the project procedures on each line.
- 16.3 Inspection, material certifications and test reports (certified as necessary) shall be submitted prior to shipment
- 16.4 The Vendor shall not commence fabrication of any item until he has received approved drawings from COMPANY/ Consultant for that item.

17 FINAL REPORTS AND DATA SHEETS

- 17.1 The reports and data sheets required for the pressure vessels shall be in accordance with Mechanical Specification FGGS-BJN-MEQ-SPC-4012.
- 17.2 The Vendor shall also supply:
- a) three sets of copies of the “as-built” drawing of the package;
 - b) one set of “as-built” reproducible drawings of the package;
 - c) three operating manuals which, when applicable, shall include:
 - i) operating and maintenance instructions and spare parts lists for main equipment items;
 - ii) operating and maintenance instructions and spare parts lists for bought out equipment items;
 - iii) meter run certificates;
 - iv) piping NDE reports including weld map;
 - v) mill test certificates (when specified by COMPANY);
 - vi) recording charts showing temperature conditions during stress relief;
 - vii) pressure test reports; and
 - viii) pressure recorder chart, if used.

18 VENDOR’S GUARANTEE

The Vendor shall guarantee the skid package to be free from defects in design, workmanship and performance, and shall agree to replace, at his own expense, any equipment or part proving defective within 18 months of shipping date or 12 months of date of commissioning whichever is earlier.

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SPECIFICATION FOR PROTECTION OF GOODS DURING SHIPMENT

0	Issued for ITB	15-07-19	RS	SN	CK	
A	Issued for Review/ Approval	24-04-19	RS	SN	CK	
REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

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1.0 INTRODUCTION

OIL India Limited (OIL) is in the process of development of producing field in Baghjan area. As a part of this development scheme, OIL desires to construct a Field Gas Gathering Station (FGGS) comprising of natural gas production facility at Baghjan field in Upper Assam, India. The FGGS shall have Non Associated Gas (NAG) processing facility for 5.0 MMSCMD (2 trains x 2.5 MMSCMD) and provision to feed Associated Gas (AG) of 0.5 MMSCMD along with the NAG to a Glycol based Dehydration facility (5.0 MMSCMD) for achieving water dew point less than or equal to (0) Zero Deg C. The facility shall include Production and Test Manifolds, Gas /Condensate/Water Separators, Gas Dehydration, Flare system and Effluent Treatment and disposal system along with all the required utilities and auxiliary systems.

Jayathe Petrotech Engineers and Consultants (JPEC) has been awarded the contract for Engineering and Project Management Consultancy for developing the engineering and managing project execution.

2.0 PURPOSE

This specification defines the minimum requirements and procedures for protecting equipment and materials during export shipment.

It is intended to serve as a minimum requirement guide and will depend on use of Vendor's judgment to determine if physical characteristics of items being packed will require more than these minimum standards to ensure safe arrival at their destination. When portions of these instructions are not applicable, the best commercial export packing methods to attain comparable protection shall be used. In all cases, materials shall be prepared for shipment to withstand multiple handling, outside storage, exposure to rain, dust and salt spray.

If the Vendor's standard export packing will provide equal or better protection at a lesser cost, this information should be brought to the attention of the COMPANY/ CONSULTANT. If an area of doubt should arise, the COMPANY/ CONSULTANT shall be contacted.

3.0 CODES & STANDARDS

In connection with this specification the following International Codes, Standards and by Project Specifications shall be referred to as applicable:

Table 3.1 Codes and Standards

ASME CODES	TITLE
ASME B 16.20	Metallic Gaskets for Pipe Flanges Ring-Joint, Spiral-Wound and Jacketed
ASME B 16.21	Non-metallic Flat Gaskets for Pipe Flanges
ASME B 16.25	Butt Welding Ends
ASME B 16.9	Factory Made Wrought Steel Butt Welding Fittings
ASME B1.1	Unified Inch Screw Threads
ASME B16.47	Large Diameter Steel Flanges NPS 26 Through NPS 60
ASME B16.5	Pipe Flanges and Flanged Fittings NPS ½ Through NPS 24
ASME SEC II PART A, B, C, D	Boiler and Pressure Vessel Code – Material Specifications and Properties
ASME SEC IX	Welding, Brazing and Fusing Qualifications
ASME SEC V	Non-Destructive Examination

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OTHER STANDARDS	TITLE
AWS D1.1	Structural Welding Code — Steel
BS 3692	ISO Metric Precision Hexagon Bolts, Screws and Nuts – Specification
BS 4190	ISO Metric Black Hexagon Bolts, Screws and Nuts – Specification
BS 4320	Specification for Metal Washers for General Engineering Purposes Metric Series
IS 875	Code of Practice for Design loads (Other than earthquake) for Building & structures
IS 1893	Criteria for Earthquake Resistant Design of Structures.
ISO 10474	Steel and Steel Products — Inspection Documents
ISO 9000	Quality Management Systems - Fundamentals and Vocabulary
ISO 9001	Quality Management Systems – Requirements
ISO 9004	Quality Management Systems - Guidelines for Performance Improvements

4.0 ABBREVIATIONS / DEFINITIONS

ABBREVIATIONS

Table 4.1.1 Abbreviations

ABBREVIATIONS	DESCRIPTION
ASME	American Society of Mechanical Engineers
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
ANSI	American National Standards Institute
BJN	Baghjan
CPCB	Central Pollution Control Board
DB	Design Basis
EPCC	Engineering, Procurement, Construction and Commissioning
FGGS	Field Gas Gathering Station
F&G	Fire & Gas
FRP	Fiberglass Reinforced Plastic
JPEC	Jayathe Petrotech Engineers and Consultants Pvt Ltd

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ABBREVIATIONS	DESCRIPTION
KCAL	Kilo Calories
MH	Manhole
NFPA	National Fire Protection Association
NPS	Nominal Pipe Size
OISD	Oil Industry Safety Directorate
VPI	Vapor Phase Inhibitor
WN	Weld neck

DEFINITIONS

Table 4.2.1 Definitions

NOMENCLATURE	DESCRIPTION
Company	Oil India Limited (OIL)
Consultant	Jayathe Petrotech Engineers & Consultants (JPEC)
Project	Field Gas Gathering Station, Baghjan (FGGS-BJN)
Vendor/Manufacturer/Supplier	The person, firm, Company or Corporation including their assignees who supplies the equipment/materials required for the project
EPC	Engineering, Procurement & Construction
Shall	Indicates mandatory requirements
Should	Indicates strong recommendations to comply with the requirements of this document

5.0 WORKMANSHIP

Work shall be carried out in accordance with code requirements and industry standards for good workmanship.

6.0 AIR FREIGHT

The packing standards, as outlined in these instructions, are for ocean freight shipments only and do not apply to air freight shipment. Vendors' standard domestic packing shall be provided for air shipment. Vendor to obtain COMPANY/ CONSULTANT approval of its standard domestic packing.

7.0 EXPORT PACKING STANDARDS

It is important that all materials arrive at a destination in an undamaged condition. This Specification serves as a minimum requirement for "Commercial Packaging for Export", but compliance does not relieve Vendor of responsibility for adequately packing materials, supplies and equipment.

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7.1 Packaging materials

7.1.1 Lumber shall be new, sound and well-seasoned, knots are permitted provided they are sound and tight and do not exceed one-third of the board width. Knots shall be located as not to cause railing interference which would result in structural weakness. Lumber shall be certified completely free from bark, insect infestation and decay.

7.1.2 Nails shall be galvanized.

7.1.3 Metal strapping shall be annealed steel and applied to all packages with a stretching tool and secured with crimped steel seals.

7.1.4 All boxes constructed with lumber should be lined with water repellent paper. Ventilation holes shall be drilled upward at 45° at intervals around the sides and ends of the box. Drainage hole shall be provided in base of skidded items.

7.2. Packing methods and prohibited materials

7.2.1 When consolidating materials in a box or crate, items shall be packed or nested to reduce volume as much as possible. All items shall be braced and/or cushioned as necessary within the container to prevent damage from shock, vibration and rough handling. Finished and painted surfaces will be protected from abrasion.

7.2.2 Small items and spare parts not secured to main item shall be separately boxed with box properly identified as to its main item.

7.2.3 It is necessary that all shipping containers be tightly packed. Where void appear, they will be filled with cushioning material or securely blocked off to prevent any movement of contents. Wood wool may be freely used for packing but restricted materials include:

- (a) Used sacks and sacking - including jute and Hessian.
- (b) Hay and straw - including straw envelopes.
- (c) Rice Husks.
- (d) Agricultural waste products.
- (e) Any packing materials which may have come into contact with animals or soil.
- (f) Grass and similar matting.
- (g) Articles of peat.
- (h) Used wool packs and wool packers.

7.2.4 Containers shall be packed in such a manner to insure an even distribution of weight within the case. All cases will bear warning signs on the outside denoting the center of gravity and sling marks. Top-heavy containers will be so marked as either "Top-Heavy" or "Heavy End".

7.2.5 Heavy items should be securely blocked and braced to prevent damage to lighter materials packed in the same box. Heavy items, where possible, should be packed on the bottom with lighter items on top.

7.2.6 Palletizing

Items which are not crated or boxed and are impervious to damage from moisture, water handling and external damage, which can be conveniently secured to a pallet to facilitate

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handling, shall be palletized.

7.2.7 Bundling

All items shall be segregated to length and size and bundled into units not to exceed 1134 kg unless previously approved by COMPANY/ CONSULTANT. Apply steel strap with a stretching tool and secure with crimped steel seals spaced up to 92 cm apart.

7.3 Boxes

The construction and reinforcing of a wooden box depend upon the size of the box and the weight of its contents. Following are minimum requirements for various boxes.

(a) Up To 140 kg

Box shall be made of a minimum of 2.5 cm nominal lumber or 1 cm plywood sheathing, 5.1 x 10.2 cm nominal skids, and 2.5 x 10.2 cm frames with completely cleated ends. All boxes over 22.6 kg to be skidded.

(b) 140 to 450 kg

Box shall be made of a minimum 2.5 cm nominal lumber, or 1.3 cm plywood sheathing with 5.1 cm nominal decking and 5.1 x 10.2 cm nominal skids. Box to have cleated ends, with 5.1 x 10.2 cm or 5.1 x 15.2 cm battens. Plywood boxes shall be constructed with uprights set on 60.9 cm centers. All seams should be backed with an upright or brace.

(c) 450 to 4500 kg

Box shall be constructed with a 10.2 x 10.2 cm nominal skid base, 5.1 cm nominal floor, 2.5 cm nominal lumber or 1.6 cm plywood sheathing, with cleated ends. Top and sides to be diagonally braced, with corner posts, bracing and stiffening members of 5.1 x 10.2 cm nominal lumber. Load bearing members shall be placed as needed. Top and upper edge members of large or heavy boxes shall be reinforced with 10.2 x 10.2 cm or 10.2 x 15.2 cm spreaders to prevent crushing of boxes when lifting-slings are used.

(d) Strapping

All boxes must be strapped with a minimum of 2 steel bands running parallel to skids. 1.9 cm banding may be used on boxes less than 181 kg 3.2 cm or 5.1 cm banding must be used on boxes or crates over 181 kg.

7.4 Open crates

Open crates are not allowed.

8.0 PROTECTION METHODS

8.1 Equipment that should be sealed off from the atmosphere shall be protected in one or more of the following manners:

- Wrapping in water-proof fabric with all lines, joints, and folds sealed with waterproof adhesive.
- Packing in a totally enclosed box lined with Kraft paper impregnated with Shell "VPI-270". The Kraft paper shall have a waterproof backing.
- Packing in an airtight carton after dusting paper wrapped equipment with "VPI-250", or after suspending sacks of "VPI-250" within the equipment.

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- (d) Enclosing within a waterproof heat-sealed carrier bag or shroud, or a sealed plastic film.
- (e) Vapor phase inhibitors equal to the above specified; Shell "VPI" products may be substituted with COMPANY/ CONSULTANT approval.

8.2 Equipment that cannot be sealed off from the atmosphere by wrapping or boxing shall be protected by coating the unpainted surfaces with the following:

- (a) Esso Rust-Ban 373 for hard surface protection.
- (b) Esso Rust-Ban 394 for soft surface protection.
- (c) Esso Rust-Ban 339 rust preventative for light oily surface protection.

8.3 Flange openings shall be coated with a layer of anti-corrosive material then closed off with wooden, metallic or plastic, fastened in place with tape or non-rusting devices.

8.4 Caution shall be exercised in applying preservatives so that items fabricated of leather, mica, rubber, and similar material, are not coated with the preservative compound because of the damaging effect on such items.

8.5 Shipping containers shall be constructed and sealed in a manner that shall provide maximum protection from pilferage and theft.

After rust-treating and sealing, equipment shall be boxed and crated as specified in Section 7.0 of this specification.

9.0 RUST PREVENTATIVE APPLICATION

9.1 Shell Company VPI

9.1.1 Shell Company VPI-250 or 270 can be applied dry by use of a DeVILBISS Company Floc Gun or other dusting device. VPI powder should be dispersed over exposed metal surfaces or suspended in finely meshed sacks at intervals within the equipment. For sensitive or precision operating equipment, the "VPI-250" should be suspended in sacks within the equipment housing.

Since VPI can protect metal only 305mm distant from its location, it should be fairly evenly dispersed or placed in small porous sacks suspended within 305 mm of the surface to be protected. Dosage is as follows:

- (a) VPI-270 = 1 gram per 246 cc (15 cubic inches).
- (b) VPI-250 = 3 grams per 28.3 liters (1 cubic foot).

9.1.2 VPI is a salt that liberates nitrite ions which are deposited on the exposed metal surfaces and gives protection against oxygen and moisture. VPI provides excellent protection to ferrous metals and most non-ferrous materials. VPI does not provide protection for pure lead, solder, or pure antimony.

9.1.3 VPI, when inhaled, may irritate the nose and throat and leave a bitter taste in the mouth. There is no harm in breathing VPI and there are no cumulative toxic effects.

9.2 Esso Rust-Ban in most cases can be either brushed or sprayed on metal surfaces or parts can be dipped. The following is a description of the Rust-Ban to be used:

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Rust Ban	Appearance	Thickness	Life	Converge	Removal
373	hard dark	0.56mm	1yr. Outside, 2yr. Inside	350sq.ft/US gal	solvent film alkali or emulsion
394	soft tan	0.025mm	not for outside, 1yr. Inside	950sq.ft/US gal	same film
339	clear oily	0.0076mm	6 months Indoors	400sq.ft/US gal	solvent film

9.3 Some substitutes for Esso Rust-Ban are as follows:

Esso Rust Ban	Pennsylvania Refining Co.	Shell Oil Company	E. F. Houghton & Co.
373	Petrotect IX	Ensis Fluid 264	Cosmoline 1058
394	Petrotect 2	Ensis Fluid 210	Cosmoline 1059
339	Petrotect 3	Ensis Oil 30	Cosmoline 1049

10.0 INSTRUMENTS

- 10.1 Board-mounted and all electronic instruments shall be shipped to the panel fabricator enclosed in plastic bags with VPI 250 in protective cartons. All these instruments will be unpacked and mounted on the board at the panel fabricator's shop for check-out.
- 10.2 When the panel-board check-out is complete, all the instruments will be enclosed in the original plastic bag with additional VPI 250 added, and placed in their original cartons before boxing in accordance with Section 7.
- 10.3 Panel boards consist of painted steel plates on a steel framework. To prevent rusting, the panel board sections shall be packed in boxes in accordance with Section 7 that have first been lined with Kraft paper impregnated with VPI 260. After the panel is set in the box, the unit will be dusted with VPI 250, sealed with impregnated Kraft paper, and the last wooden closure installed. All precautions should be made to have the enclosure air tight. This preparation should keep the panel in good condition until it is ready for installation. If inspection is necessary, then open the box at one end, and after inspection, add a small amount of VPI 250 before resealing.
- 10.4 Field mounted transmitters and controllers shall be enclosed in plastic bags that contain VPI 250. Bags shall be thoroughly sealed and instrument placed in a protective carton before boxing in accordance with Section 7.
- 10.5 Pressure gauges, dial thermometers, pressure and temperature switches, and all other small articles shall be individually wrapped in Kraft paper impregnated with VPI 270 and placed in protective cartons before boxing in accordance with Section 7.
- 10.6 Level gages, continuous drainers, etc., shall be protected internally with VPI 250, sealed off from the atmosphere, and the external surfaces covered with Rust-Ban 339 before packing

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and boxing for equipment.

10.7 Relief Valve & Control Valves

10.7.1 All relief valves and control valves shall have the flanges painted with "Rust-Ban 373", and the rest of the unpainted interior and exterior surfaces coated with "Rust-Ban 339". Flange covers with gaskets will be installed before shipping.

10.7.2 All relief valves and control valves shall be shipped in totally enclosed wooden boxes that have been lined with Kraft paper treated with Shell VPI 260.

10.8 Protective Products

If any of the protective products mentioned in Sections 8, 9 & 10 are not available, the approval of COMPANY/ CONSULTANT must be obtained before a substitute is used.

11.0 MARKING INSTRUCTIONS

11.1 All cases, packages and boxes are to be stenciled in Black weatherproof ink on top and two adjacent sides in clear legible characters. On bundles the markings are to be embossed on a metal or similar tag and securely strapped on. Paint shall be used on metal surfaces. Where the surface to be marked is dark, a coat of flat-zinc-white paint shall be applied and allowed to fully dry before applying the specific marking.

11.2 Do not use linen paper or light cardboard tags. Special marks, such as "fragile" or arrows, shall be in Red. No advertising and no identification of contents, other than that required by legislation and/ or the purchase order shall appear on packages.

11.3 Weights must be shown in kilograms; dimensions in centimeters. (Imperial weights and dimensions may be shown but they must not be more than half the size of metric figures).

11.4 Shipping marks must appear on all packages, tags, labels and packing list(s).

SHIP TO:

MADE IN:

P.O. NO.:

EQU. TAG NUMBER:

PACKAGE NO.:

 of

GROSS WEIGHT:

 kg

NET WEIGHT:

 kg

DIMENSIONS:

 (L) x

 (W) x

 (H) mm

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12.0 PACKING LIST

One (1) copy of the packing list and technical data shall be placed in a sealed waterproof envelope and firmly fastened to the non-working surface of the equipment in such a fashion that it will not be torn away.

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ELECTRICAL DESIGN BASIS

0	Issued for ITB	16-07-19	KS	MKV	CK	
C	Issued for Approval	13-07-19	KS	MKV	CK	
B	Issued for Approval	18-05-19	KS	MKV	CK	
A	Issued for Review/Approval	14-03-19	KS	MKV	CK	
REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

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1.0 INTRODUCTION

M/s Oil India Ltd (OIL) is a Navaratna Company under the Ministry of Petroleum and Natural Gas, Govt of India. As an integrated upstream company with pan India presence and overseas wings spreading over different parts of the globe, OIL is engaged in exploration, production and transportation of crude oil and natural gas and production of LPG with its headquarter at Duliajan, Assam. In line with OIL's strategy for balanced growth, an ambitious plan for development of non-associated gas fields is presently underway in OIL's Upper Assam operational area. As a part of this development scheme, OIL desires to construct a modular Field Gas Gathering Station (FGGS) for augmenting natural gas production facility at Baghjan field in Upper Assam, India.

Jayathe Petrotech Engineers and Consultants (JPEC) have been awarded the contract for Engineering and Project Management Consultancy for developing the engineering and managing project execution.

1.1 PROJECT OBJECTIVE

The Baghjan field is having huge amount of Non-Associated Gas (NAG) potential and the expected gas production from this area in 7.5 MMSCMD. To explore these resources one modular Field Gas Gathering Station (FGGS) having the facilities for production of natural gas is to be created. The proposed FGGS shall have Non-Associated Gas (NAG) processing facility for 5.0 MMSCMD (2 trains x 2.5 MMSCMD) and provision to feed Associated Gas (AG) of 0.5 MMSCMD along with the NAG to a Glycol based Dehydration facility (5.0 MMSCMD) for achieving water dew point less than or equal to (0) Zero Deg C. The facility shall include Production and Test Manifolds, Gas /Condensate/Water Separators, Gas Dehydration, Flare system and Effluent Treatment and disposal system along with all the required utilities and auxiliary systems. Space provision will be made within the plant to augment its capacity by installing one more train of 2.5 MMSCMD in future.

2.0 PURPOSE

This design basis outlines the general technical requirements to be followed for design and selection of Electrical Equipment for supplying power to the new Field Gas Gathering Station at Baghjan, Upper Assam.

3.0 ABBREVIATIONS / DEFINITIONS

3.1 ABBREVIATIONS

Table 3.1.1 Abbreviations

ABBREVIATIONS	DESCRIPTION
AC	Alternating Current
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ATS	Automatic Transfer Switch
BJN	Baghjan
BWPD	Barrels of Water per day
CBCT	Core Balance Current Transformer
CBD	Closed Blow Down
CD	Closed Drain

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ABBREVIATIONS	DESCRIPTION
CS	Carbon Steel
DBM	Design Basis Memorandum
DC	Direct Current
DCS	Distributed Control System
DG	Diesel Generator
EERA	Escape, Evacuation and Rescue Analysis
EIA	Environmental Impact Assessment
ELR	Earth Leakage Relay
EPCC	Erection, Procurement, Construction and Commissioning
EPS	Early Production Station
ERA	Environmental Risk Assessment
ESD	Emergency Shutdown
ETP	Effluent Treatment Plant
F&G	Fire & Gas
FFG	Flame Front Generator
FG	Fuel Gas
FGGS	Field Gas Gathering Station
GG	Gas Generator
H&MB	Heat & Mass Balance
HP	High Pressure
IGBT	Insulated-Gate Bipolar Transistor
IP	Ingress Protection
JB	Junction Box
JPEC	Jayathe Petrotech Engineers and Consultants Pvt Ltd
MCC	Motor Control Center
MMSCMD	Million Standard Cubic Meter per Day
MOV	Motor Operated Valve
MPP	Multi-Phase Pump
MTO	Material Take-Off
NPSHA	Net Positive Suction Head Available
P&ID	Piping and Instrumentation Diagram
PCV	Pressure Control Valve
PFD	Process Flow Diagram
PIT	Pressure Indicating Transmitter
PLC	Programmable Logic Controller
PMCC	Power Motor Control Center
SCMD	Standard Cubic Meters per Day
SDV	Shutdown Valve
SIL	Safety Integrity Level
SPIR	Spare Parts Interchangeability Record
TC	Temperature Control
TIT	Temperature Indicating Transmitter
UPS	Uninterruptible Power Supply
WTP	Water Treatment Plant

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3.2 DEFINITIONS

Table 3.2.1 Definitions

NOMENCLATURE	DESCRIPTION
Company	Oil India Limited (OIL)
Consultant	Jayathe Petrotech Engineers & Consultants (JPEC)
Project	Field Gas Gathering Station, Baghjan (FGGS-BJN)
Vendor	Supplier of Equipment/Package

4.0 CODES AND STANDARDS

The design, installation, testing & commissioning shall be as per established codes, standards, and sound engineering practices. [Relevant standards and shall conform to the statutory regulations applicable in the country.](#) The main codes, standards and statutory regulations are as follows. The latest edition of these shall be followed.

- Central Electricity Authority
- Indian Electricity Act.
- The Factory Act.
- The Mines Act. (OMR-2017)
- The Petroleum Rules (Ministry of industry, Govt. of India)
- State Electricity Rules
- DGMS Guidelines
- OISD Guidelines

4.1 INDIAN STANDARD

IS	-	14122	Built in thermal protection for electric motors rated up to 660 V AC
IS	-	5572	Classification of Hazardous Area (other than mines) having flammable gases and vapours for electrical installation
IS	-	8239	Classification of maximum surface temperatures of electrical equipment for use in explosive atmosphere.
IS	-	3202	Code of practice for climate proofing and electrical equipment
IS	-	2274	Code of practice for electrical wiring installation – system voltages exceeding 650 V.
IS	-	732	Code of practice for electrical wiring installations –system voltages not exceeding 650 V.
IS	-	1646	Code of practice for fire safety of buildings – electrical installations.
IS	-	3034	Code of practice for fire safety of industrial buildings – electrical generating and distributing station.
IS	-	10028	Code of practice for selection, installation and maintenance for transformer
IS	-	10118	Code of practice for selection, installation and maintenance for switchgear and control gear

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IS	-	13408-1	Code of practices for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres
IS	-	6665	Code of practice for industrial lighting
IS	-	1944	Code of practice for lighting of public thoroughfares.
IS	-	3043	Code of practice for Earthing
IS/IEC	-	60079-0	Electrical Apparatus for explosive gas atmospheres – General requirements
IS/IEC	-	60079-1	Equipment protection flameproof enclosures “d”
IEC	-	60079-5	Equipment Protection by Powder filling “q”
IEC	-	60079-6	Equipment Protection by Oil immersion “o”
IEC	-	60079-7	Equipment Protection by Increased Safety Type “e”
IEC	-	60079-11	Equipment Protection by Intrinsic safety “I”
IEC	-	60079-12	with air according to their maximum experimental safe gaps and minimum igniting currents
IS/IEC	-	60079-15	Electrical apparatus for explosive gas atmosphere – construction, test and making of type of protection “n” electrical apparatus
IS	-	7752	Guide for improvement of power factor- consumer installations
IS	-	7689	Guide for control of undesirable static electricity.
IS	-	5216	Guide for safety procedures and practices in electrical works.
IS	-	5571	Guide for selection of electrical equipment for hazardous area.
IS	-	5728	Guide for short circuit calculations
IS	-	3716	Insulation coordination application guide.
IS	-	3646	Interior illumination: Part i and Part-ii
IS/IEC	-	60947	Low voltage switchgear and control gear: All parts
IS	-	2309	Protection of buildings and allied structures against lighting
IS	-	694	PVC Insulated cables for working voltages up to and including 1100 V.
IS	-	9676	Reference ambient temperature for electrical equipment
IS	-	325	Three-phase induction motors
IS	-	5422	Turbine type generators
IS	-	585	Voltage and frequency for AC transmission and distribution system.

4.2 OISD STANDARDS

OISD	-	STD-113	Classification of Area for Electrical Installations at Hydrocarbon Processing and Handling Facilities.
OISD	-	RP-149	Design aspects for safety in electrical systems.
OISD	-	STD-173	Fire Protection System for Electrical Installations.

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OISD	-	STD-116	Fire Protection Facilities for Petroleum Refineries and Oil/Gas Processing Plants
OISD	-	STD-147	Inspection and Safe Practices during electrical installations.
OISD	-	STD-137	Inspection of Electrical Equipment
OISD	-	STD-118	Layouts for Oil and Gas Installations.
OISD	-	STD-110	Recommended Practices on Static Electricity.

5.0 SCOPE

This specification covers the basic requirement of design and engineering of electrical system together with project design criteria and data sheets.

The electrical system shall cover the following:

- Design calculations (Load List, Cable Sizing etc.)
- Power Generation
- Power distribution system
- Sub-stations
- Area classification
- Power layouts including cable tray/ trench arrangement
- Lighting layouts
- Earthing and lightning protections layout

The designed electrical system shall provide: -

- Safety to personnel and equipment
- Reliability of service
- Minimum fire risk
- Ease of maintenance and convenience of operation
- Adequate provision of future expansion and modification.
- Maximum interchangeability of equipment
- Automatic protection of all electrical equipment through selective relaying systems.

6.0 ENVIRONMENT CONDITIONS

6.1 SITE CONDITIONS

The following site conditions shall be applicable as their specific value specified in project design criteria/ data sheets.

Design ambient temperature Maximum, °C	41
Design ambient temperature Minimum, °C	7
Dry bulb temperature Maximum, °C	36
Dry bulb temperature Minimum, °C	8

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Average Rainfall (in full monsoon)	194.2 cm
Average Rainfall (in 24 hours)	15.9 cm
Wind velocity at 10m height	50 m/s
Maximum relative humidity	93%

6.2 DESIGN TEMPERATURE

All electrical equipment and systems shall be designed for a rated output in an ambient temperature of 41°C.

6.3 DEGREE OF INGRESS PROTECTION

The following minimum degrees of enclosure protection shall apply.

Sl no	Equipment	IP Rating
1	Switchboards, distribution boards and electrical control panels	IP 42
2	Alternator	IP 23
3	UPS	IP 31
4	Motors	IP 55
5	Lighting fixtures in process and utility areas	IP 55
6	Junction boxes	IP 55
7	Convenience receptacles in process areas	IP 55
8	Local control stations (local pushbutton stations)	IP 55

7.0 HAZARDOUS AREA CLASSIFICATION

7.1 BASIS OF AREA CLASSIFICATION

Classification of hazardous area shall be as per following national/ international standards as applicable.

- IS - 5572 (Classification of Hazardous Area (other than mines) having flammable gases and vapours for electrical installation) / 5571(Guide for selection of electrical equipment for hazardous area.)
- BS - 5345 (Code of practice for Selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosive processing and manufacture)
- IEC - 79 (Electrical Apparatus for Explosive Gas Atmospheres)

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API-RP - 505 (Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2)

OISD - 113 (Classification of Area for Electrical Installations at Hydrocarbon Processing and Handling Facilities.)

7.2 EQUIPMENT SELECTION CRITERIA

The following factors shall be considered for proper selection of equipment for use in hazardous area.

- Area classification i.e., Zone-0, 1 or 2.
- Gas group classification. The characteristics of the gas or vapor involved in relation to the ignition current or minimum ignition energy and safe gap data.
- Temperature classification - The ignition temperature of gas or vapor involved or the lowest value of ignition temperature if more than one combustible material is present.
- Environmental conditions in which equipment is to be installed – The selected electrical equipment shall be suitably protected against corrosive and solvent agents, water ingress, thermal and mechanical stresses as determined by the environmental conditions.

The types of protection for electrical equipment in hazardous area, generally used are as follows:

Zone 0	- Intrinsically Safe only, Type of Protection “i”
Zone 1	- Intrinsically Safe, Type of Protection “i”
	Flameproof equipment, Type of protection “d”
	Pressurized enclosure, Type of protection “p”
	Sand filled equipment, Type of protection “q”
	Oil immersed equipment, Type of protection “o”
Zone 2	- Protection as suitable for Zone 0 and 1
	Increased safety equipment, Type of protection “e”
	Non sparking equipment, Type of protection “n”

Notes

1. Electrical equipment installation in Zone-0 area should be avoided.
2. For OIL FGGS installations all electrical equipment shall be Flameproof type (Ex-d) only. Type “e” or “n” is not acceptable.
3. Switchgear and control room should be located in safe area.
4. For hazardous area location i.e., Zone1/Zone 2, motors and generators Shall comply to IS: 5572 or equivalent.

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7.3 APPROVAL/CERTIFICATION

Electrical equipment and protective system intended to be used in hazardous area shall be approved by one of following recognized testing and certifying authorities:

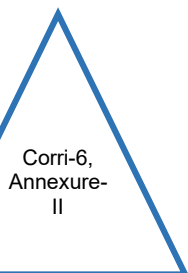
UL	-	Underwriters Laboratories inc (USA)
FM	-	Factory Mutual Research Corporation (USA)
BASEEFA	-	British Approvals Service for Electrical Equipment in Flameproof Atmospheres.
PTB	-	Physikalisch Technische Bundesanstalt (Germany)
CIMFR & CCE	-	Central Institute of Mining & Fuel Research Station & Chief Controller of Explosives (Indian).
RS	-	Research Institute of Industrial safety (JAPAN) 5.0
EU/ ATEX	-	ATEX 2014/34/EU

In addition to above all electrical equipment intended for use in hazardous area must be certified by CMRS as flameproof for use in Zone-1 and Zone-2, gas group-IIA & IIB of oil mines. All approvals must be valid and approval number must be mentioned on equipment name plate.

7.4 ELECTRICAL EQUIPMENTS FOR HAZARDOUS AREAS

The electrical equipment for hazardous areas shall be selected as per IS- 5571 and Petroleum rules. The minimum requirements are summarized below.

Equipment	Zone-1	Zone-2
	Gas group IIA, IIB	Gas group IIA, IIB
Motors	Ex-d	Ex-d
Push buttons station	Ex-d	Ex-d
Motor starters	Ex-d	Ex-d
Plug and socket	Ex-d	Ex-d
Lighting Fixtures		
i. Lighting Fitting	Ex -d	Ex-d
ii. Control gear box	Ex-d	Ex-d
Junction boxes	Ex-d	Ex-d
Hand lamps		
i. Light fitting	Ex-d	Ex-d
ii. Plug and socket	Ex-d	Ex-d
Break glass unit (Fire alarm system)	Ex-d	Ex-d
Lighting panel/ power panel	Ex-d	Ex-d



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Notes

- 1 The electrical equipment for hazardous areas shall generally be suitable for gas group IIA & IIB and temperature classification T3 as applicable to the selected type of explosion protection.
- 2 Irrespective of the area classification (whether Zone-1 or Zone -2) all lighting fixtures within the hazardous areas shall be flameproof type.

8.0 DESCRIPTION OF ELECTRICAL SYSTEM

Power supply and electrical systems for process operation, illumination, etc. shall be from Gas Driven Generator Sets (Three operating and one standby).

8.1 STATUTORY REQUIREMENTS AND APPROVALS

The designed electrical system shall conform to all statutory and government regulations. As a minimum, EPC CONTRACTOR need to meet and fulfil the requirements of following statutory Acts/regulations and obtain all statutory approvals/certificates, as required, from concerned authorities:

- Indian Electricity Act, 2003
- Central Electricity Authority (Measures Relating to Safety and Electric Supply) Regulations, 2010
- The Mines Act (DGMS) / Oil Mines Regulations, 2014
- Fire Insurance Regulations
- The Petroleum Rules
- State Electricity Rules / Regulations laid down by Chief Electrical Inspector of State
- Any other applicable rules / regulations of central / state / local statutory body

Note:

- 1 Special attention is to be paid to Chapter IX of CEAR, 2010, while designing electrical system in oil mines.
- 2 Further, the electrical system and equipment shall conform to the following Regulations of CEAR, 2010:
 - a) Resistance grounding system for generator neutral shall be employed to limit the ground fault current to 750 mA. (CEAR 100).
 - b) Earth Leakage relay (ELR) Protection is to be used in the supply to every electrical installation. (CEAR 42). Additionally, earth leakage relay/protection is to be provided in every motor feeder/ outgoing feeders so as to cut off the supply to the particular equipment/feeder in case of an earth leakage.
 - c) Remote control circuit/supply voltage shall not exceed 30 Volt and the circuits shall be intrinsically safe within Zone-1 Hazardous area. [CEAR 102 (iv) & 110 (4) (i)].
 - d) Voltage shall not exceed 250 V between phases when used for lighting. [CEAR 102 (ii) (b)].

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- e) Every incoming and outgoing feeder of an MCC/PMCC panel shall have an MCCB as a breaker, with either thermal-magnetic or microprocessor-controlled trip unit with adjustable current and time settings. These breakers should trip on long time/short time/instantaneous short circuit/ground fault and earth leakage faults. Panel incomer MCCBs should be provided with microprocessor-controlled trip units.

8.2 POWER SUPPLY

IN PLANT POWER SUPPLY

It is arranged through in plant generator set using Gas as fuel; this power shall be used for all the loads. Diesel generator shall be used as an emergency supply.

CRITICAL POWER (UPS)

It is arranged through uninterrupted power supply system. Critical power shall feed the following type of loads, at least for 2 hours whenever GG power is not available. The critical loads shall be of following types:

- Critical instrumentation loads/ controls
- Critical security system loads
- Critical communication loads
- Plant shut down loads
- Critical Lighting loads

Critical loads are those, which require continuous power without momentary interruption.

BLACK START / EMERGENCY POWER (DG Set)

It is arranged through DG Set. Black Start power shall feed the following loads to prepare gas (fuel) required for GG set. The Black Start loads shall be of following types:

- Instrument air system
- Water treatment system (for firefighting system)
- Lighting
- UPS
- Any other load considered essential

8.3 CAPACITY OF ELECTRICAL PLANT

Power Source Details

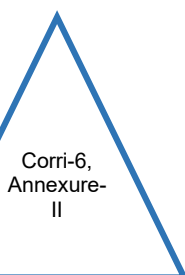
General

A. Independent system or existing system : Independent system

Baghjan

Power supply at Baghjan FGGS shall be arranged by four operating gas Gen. Gen sets. Running philosophy shall be 3W+1S. A suitably rated DG set shall also be required for Black Start/Emergency as gas will not be available for GG sets. The following loads shall be considered on DG set for Black start:

- i) Instrument air system



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- ii) Water treatment system
- iii) Lighting
- iv) UPS

After the gas is available start GG set and change over the supply manually to GG.
Provision of start, within 30 secs, for all the running loads shall also be made.

Generator (with Gas fuel)

- A. Number of generators : 4 Nos. (3W+1S)
- B. Generator rating/Voltage/Power factor : 1500kWe/ 1875kVA/ 415V/ 0.8
- C. Starting : Electrical
- D. Paralleling Facility : Required

Generator (with Diesel fuel)

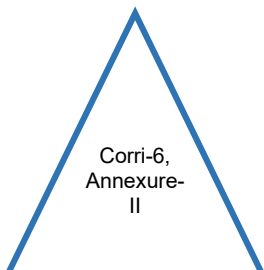
- E. Number of generators : 1 No. only for black start
- F. Generator rating/Voltage/Power factor : 750kVA/ 415V/ 0.8
- G. Starting : Manual
- H. Paralleling Facility : Not Required

8.4 UTILIZATION VOLTAGE AND OPERATING PHILOSOPHY

A. Large motors in plant	440 / 415 Volts
B. Motor rated below 0.18 KW	240V AC, 1 ph. / 415V 3ph 4W
C. Plant distribution	440 / 415 Volts
D. Lighting as per CEAR and DGMS guidelines	240 V, AC (phase to phase)
E. Switchgear control supply	240 V, AC (phase to phase)/110V DC
F. Anti-condensation space heaters, convenience outlets	240 V, AC 1 Phase, 50 Hz
G. Critical & Exit lights for 1-hour duration, Generator, Breaker Controls / Instrument supply etc.	110 V DC, 2 wire (Battery back-up)
H. Instrument supply, Fire and Gas detection system etc.	24 DC, 2 wire (Battery back-up)
I. Communication, Instrument control, Process control, PLC/Distributed Control System, fire suppression system, Emergency lighting etc.	240 V AC, UPS
J. SCADA / As Applicable	240 V AC, UPS
K. UPS system in coming power supply	415 V AC 3 ph.
L. Power Panels and Auxiliary Service Boards incoming power supply	415 V AC 3 ph.
M. Bulk load like process heaters etc.	415 V AC 3 ph.

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N. Lighting for non-hazardous area	Lighting for non-hazardous area-415 V AC 3 ph. (through 415/415, 3-ph Isolation transformer with neutral solidly earthed.)
O. Convenience outlets for non-hazardous area	Convenience outlets for non- hazardous area-415 V AC 3 ph. (through 415/415,3-ph Isolation transformer with neutral solidly earthed).
P. Lighting for hazardous area	240 V AC 3 ph. (through 415/240, 3-ph lighting transformer)
Q. Convenience outlets for hazardous area	240 V AC 3 ph. (through 415/240, 3-ph lighting transformer)
R. Motor operated valves	415 V AC 3 ph. (if any)
S. UPS output voltage	230V AC

The short circuit levels for all voltage levels shall be calculated and systems shall be accordingly designed.

8.5 VOLTAGE AND FREQUENCY VARIATION

AC SYSTEM

The following maximum variations from its nominal value shall be considered for equipment:

Voltage	- 415V $\pm 5\%$
Frequency	- 50Hz $\pm 3\%$

The following maximum variations shall be considered: -

For electrical control circuit	- $\pm 5\%$
For Instrumentation	- Refer Instrument Design basis.

8.6 VOLTAGE DROP

Voltage drop at the worst affected bus during largest motor starting or re- acceleration of a group of motors shall not exceed 15 percent.

The available voltage at motor terminal during start up shall be sufficient to ensure positive starting or re-acceleration of the motor (even with the motor fully loaded) without causing any damage to the motor.

8.7 SYSTEM NEUTRAL EARTHING

Neutral of the GG sets shall be grounded through Neutral Earthing Resistor with neutral contactor in the respective circuits.

8.8 CONTROL OF ELECTRICAL SYSTEM

All circuit breaker shall be controlled locally i.e., from respective switchboard/panel. No remote control is envisaged for circuit breakers. No auto-changeover/bus transfer Scheme is envisaged for incomer breakers.

Motors shall be controlled from field as well as from a remote distribution control system (DCS), located in Control Room. Local push button stations shall be provided in field

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near each motor. Control from DCS shall be as follows in conformity to Operating philosophy:

- Stop command from DCS
- Feedback – Available to DCS
- Feedback – Run to DCS
- Feedback – Trip on Fault to DCS
- Permissive interlocks as required from DCS
- Selection of Local/Remote control from DCS

For wiring of motor starter interface with DCS, a marshalling section will be provided with PCC/MCC, where wiring from all starters shall be terminated. The marshalling cabinet shall consist of aux. relays with coil rated for 24 V DC output to be generated by DCS for motor Start/Stop and Local/Remote selection. All the signals will be hard wired from DCS to marshalling cabinet from where the signals will be internally hardwired to respective MCC modules. For status feedback of motors to DCS the signals of motor starter status to be hard wired up to marshalling cabinet and converted to signals suitable for transmitting to DCS/PLC through serial link.

For package equipment, the control/feedback shall be hardwired directly to vendor's panel from/to motor starters. PCC\PMCC shall have Emergency Stop push button, Auto/Manual selector switch and ammeter, other control like start/ stop will be provided in LCS located near to motors.

9.0 POWER SYSTEM DESIGN

The power distribution system shall be designed considering following possible factors, which affect the choice of system to be finalized

- Total load
- Concentration of loads
- Size of individual load
- Reliability of power sources
- Continuity of supply
- Flexibility of operation
- Initial cost
- Operating and maintenance cost.

9.1 LOAD ANALYSIS

In order to determine the distribution of load throughout the installation and to establish the single line diagrams a load analysis shall be carried out as part of basic design which shall be rechecked during detail design by EPC contractor. Preliminary data from suppliers shall be the basis of the preliminary analysis and shall be updated on a regular basis until all purchased supplier data is received.

Each electrical load shall be categorized as continuous, intermittent or standby as appropriate.

9.2 CABLE SIZING AND VOLTAGE DROP CRITERIA

Cable sizing shall be carried out taking into account the following considerations:

- Continuous current rating

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- Voltage drop criteria (for starting and running)
- Fault ratings
- Grouping factors
- Ambient temperature
- Under ground or over ground

Distribution system cable sizing shall be such that the following voltage drops at the circuit full load current are not exceeded:

SI No	Description	Voltage Drop (%)
1	Power/distribution feeders	3
2	Motor feeders (during running condition)	5
3	Motor feeders (during starting condition)	15
4	Lighting and small power • To lighting/small power panels in field • Total for sub-circuit	3

9.3 LIGHTING CALCULATION

Lighting calculation shall be done either manually or by using vendor software (point to point calculations). Lighting levels shall be considered as per NEC/IS/DGMS as applicable.

9.4 EARTHING CALCULATION

Protective earth conductors shall be sized according to the short circuit withstand capacity and clearance time, material, permitted temperature rise and earth loop impedance values.

The resistance value of earthing system shall be decided on the basis of IS- 3043.

9.5 SHORT CIRCUIT CAPACITIES

Each short-circuit interrupting device shall be designed to have rupturing capacity equal to or higher than the maximum value of short circuit current calculated at its location. The related switchgear and cables shall withstand the above maximum available fault current for one second.

9.6 PROTECTION AND METERING SCHEMES

The protective system shall be selected and coordinated to ensure the following:

- Protection of equipment against damage, which can occur due to following.
 - Internal or external short circuit
 - Over load
 - Over voltage
 - Under Voltage
 - Single Phasing

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- Lower/ Higher frequency
- Reverse Power flow (as applicable)
- Surge
- Earth fault

- b) As far as possible, the continuity of operation of those parts of the system which are unaffected by the fault.
- c) Personnel and plants safety.

Accordingly, relays and protective devices shall be suitably selected and coordinated.

All electrical feeders shall be provided with CBCT and ELR of 500mA sensitivity.

9.7 METERING

The metering device LV and MV switchboards shall be as below

Feeder Type	A	V	Hz	PF	Kwh	Speed
PCC/PMCC Incomer	x	x	x	x	x	
PCC bus P.T	-	x				
LDB incomer	x	x				
DG Set	x	x	x	x		x

Notes

1. Ammeters are to be provided in PMCC for all motor feeders.
2. Indicating lamps in switchboards shall be cluster type LED lamp.

9.8 DESIGN CRITERIA

The EPC contractor shall note the following:

- 9.8.1 The diversity factor, load factor and utilization factor for Process loads are to be indicated in the proposed load list. Suitable derating factors shall be taken into consideration while sizing gen sets, cables, motors etc. These shall be shown in the sizing calculations.
- 9.8.2 Four gas gen sets (3W+1S) are envisaged for the project. During outage of one of GG, the other all three GG are capable of feeding the full load. Thus, there will be no interruption in power. The operating philosophy will be 3W+1S, the three units will run in parallel to cater the full load by load sharing philosophy.
- 9.8.3 The gas gen sets shall be provided with auto-synchronization and automatic load changeover (from running to incoming) facility in addition to manual synch facilities and shall be capable of parallel running.
- 9.8.4 The 415V system shall be non-effectively earthed (resistance earthed) as per DGMS/CEA guidelines. Hence the gen sets provided for the installation shall be supplied with neutral grounding resistor and NGR monitoring panel/scheme comprising:
- 9.8.5 NGR and Ground Fault Monitor
- Residual Current Transformer
- 9.8.6 The NGRs will be interlocked in such a fashion that during parallel operation any

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one NGR will come into operation.

9.8.7 Since 415V system is non-effectively earthed, neutral cannot be used for 240 V supply. Hence isolation transformer (415 V Ph-Ph/415 Ph-Ph-N) will have to be used for supplying power to equipment having dedicated 240 V Ph-N supply.

9.8.8 The Lighting transformers will be 415 V/240 V 3 phase, effectively earthed and considered as per DGMS/CEA guidelines. As the lighting transformer will be providing 240 V Ph-Ph supply, all light switches/power socket switches shall be 2 pole type.

9.8.9 415 V, 3 phase, 3 wire resistance grounded AC Power supply, generated by the 415V Gas Genset at Captive Power Plant area will be fed to PCC/PMCC panel (s) at substation room.

9.8.10 The PCCs/PMCC will feed power to process loads located in proximity with the process area, Utility Loads, Fire protection loads and other auxiliary's loads for the FGGS.

9.8.11 Grouping of Loads will be based on process and nature of loads (Continuous/Intermittent).

9.8.12 A source of emergency D.G. power for UPS loads shall also be considered.

9.8.13 Grid power is not available for Baghjan FGGS loads.

9.8.14 Suitable precautionary measures shall be taken for preventing damage of electronics/ instrumentation panels against surge voltages/spikes/dips/brown outs etc.

9.8.15 [It shall be obligatory to control harmonics of load at levels prescribed by the IEEE STD 519-1992.](#)

9.8.16 [Reference will be made to OISD-RP-149 for deciding lux levels in various areas.](#)

9.8.17 All feeders in LV Panels will be provided with either ELCBs or highly sensitive CBCT connected to residual current monitoring system (RCD/earth leakage circuit breakers); the monitoring system will be provided with NO & NC contacts, the same will be wired to respective incomers / outgoing feeders to trip the particular feeder against earth leakage.

9.8.18 All PMCCs will be provided with 2 incomers with mechanical interlock (2 lock with one key) and electrical interlock such that during normal operation any one incomer will come in to operation.

9.8.19 MLDB fed from PMCC will cater plant lighting loads, street lighting loads and area lighting loads through k-rated 415V/240V 3phase Lighting Transformer via Distribution Boards located at various building / structures in the Plant.

9.8.20 MPDB fed from PMCC will feed the following DBs and Loads

- Power Distribution Boards – 5/15A Receptacles for Light duty applications, Portable Tools etc.
- Ventilation Distribution Boards (VDBs) feed the Ventilation loads of Admin Building, exhaust fans etc.
- 30A Receptacles for Air Conditioners

9.8.21 [UPS power is envisaged for critical instrumentation and control loads. Battery backup for UPS backed loads will be considered for 2 hours. UPS Power Supply will be derived from parallel redundant UPS with static bypass, for feeding critical loads and Control Panels located at Control Room. The UPS will be fed from two sources of power, one from generator incomer PCC/PMCC and another from DG set. UPS Power is distributed through UPSDB's located near load centers. 230V,](#)

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AC UPS Power Supply System with 2 hours back up consists of the following equipment.

- a) SMF VRLA Type Battery
- b) 2 X 100% parallel Redundant with static by-pass, 1 – Phase UPS
- c) UPS Distribution Boards to feed DCS and Instrumentation Loads

9.8.22 110V, 2 wire ungrounded DC Power Supply System [2 hour back up](#) is planned for feeding more critical loads & lighting loads, DC power supply system with Insulation monitoring device (IMD) consists of the following equipment:

- a) [110V Ni. Cd. Type Battery](#)
- b) Float and Float cum Boost Battery Charger fed from PCC to charge the Battery for Control and Protection
- c) DC Distribution Boards to feed Control Power Supply for Panels

9.8.23 Control and Indication supply Voltage shall be as follows

- a) 110V, 2 Ph, AC supply – MCC / DBs with MCCB Incomer derived from respective incomers using control transformers.
- b) 110V, DC Supply – PCC, GCP, MCC with ACB Incomers
- c) 30V AC Supply – Push Button Stations derived from respective incomers using control transformers and Intrinsic Safety Barrier (ISB)

9.8.24 The remote control (start/stop) push button stations for motors in hazardous areas shall be controlled from the MCC/PMCC panels through Intrinsic Safety Barriers; i.e., the ISB is the interface between hazardous area equipment (PBS) and safe area equipment (MCC panel). The motor starters for hazardous area motors shall incorporate the ISB in the MCC panel itself.

9.8.25 The PCC incomers and outgoing feeders status (On, Off, Trip) and Metering (MFM details) will be monitored from DCS/PLC. However, the PCC incomers and outgoing shall be controlled locally from near the panel only.

9.8.26 The Gas based genset protection and controls shall be wired to local control panels located in CPP room which in turn connected DCS/PLC, such that the entire CPP system is monitored and controlled from common control room.

9.8.27 GENERATOR CONTROL SYSTEM

The Generator Control System shall be provided for control and monitoring of power generation (gas gen set) plant and distribution. The following main functions shall be included:

Operation and control of the generators for

- Auto synch and auto changeover of load to incoming gen set with manual override
- Load sharing
- Start inhibit
- Load dependent start/stop of generators

The generator control system shall perform a steady state active and reactive load sharing between the main generators in parallel operation.

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10.0 SUBSTATION

Top of floor of main substation shall be 1 to 1.5m above finished ground level. The substation building shall be sized keeping in mind the need for future expansion and taking into care adequate clearance between equipment's as per statutory regulations for small substation, cables shall be laid in trenches the bottom of the trenches shall be elevated above surrounding grade level.

The Modular containerized substation shall be designed, manufactured and supplied by OEM of Low Voltage Switchgear and the main LV Switchboard, PMCC & PCC shall be from single OEM

The sub-station is of unattended type, necessary monitoring, operation and alarm facilities shall be provided in the control room.

11.0 ELECTRICAL EQUIPMENT

The equipment in general shall conform to relevant Indian Standards and shall be suitable for installation and satisfactory operation in the service conditions mentioned in project design data.

If not specifically mentioned therein, a maximum ambient temperature of 41°C and an altitude not exceeding 1000 meters above mean sea level shall be taken into consideration.

11.1 CAPTIVE POWER PLANT

Gas Engine Generator Set (GEG) (Configuration - 3x100%) (3W+1S), 1500kWe/1875 kVA (site rating), 415V AC, 50 Hz, 3 Phase, 3 Wire with associated electrical instrument and control, accessories etc.

The line and neutral ends of each phase winding of the generator shall be brought out on suitably located terminals.

The terminal box for the line terminals shall have sufficient space for the termination of cable size calculated for the capacity of the generator, the neutral box shall, in addition to space for neutral earthing cable, have sufficient room for current transformers used for protection of generator.

All terminal shall be stud type. The terminal boxes shall be complete with suitable lugs and double compression cable glands to facilitate the entry of the cable. Suitable clamping arrangement shall be provided for connecting the cable to the machine terminals. The terminals shall be suitably enclosed to prevent short circuit by rodents etc. Appropriate phase markings shall be provided inside the terminal boxes, the markings shall be non-removable and indelible.

Current transformers saturation point shall be selected with respect to fault current at primary side.

Suitably rated anti-condensation heaters shall be provided within the enclosure, Location and maximum surface temperature of the heaters shall be such that no damage can be caused to any insulation. The leads of the heater shall be brought to a separate terminal box.

The generator shall be provided with two grounding terminals with clamps suitable for connection to the grounding grid.

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The generator shall be provided with winding and bearing RTDs. Alternator enclosure shall be rated for Ip23 as minimum. Insulation class shall be class H and temperature rise shall be limited to class B.

Synchronizing facilities shall be provided in generator. When Auto/Manual switch on the control panel is in manual mode, following operation shall be done manually.

- a) GEG Start/ Stop
- b) Speed raise/ Lower
- c) Voltage raise/ Lower
- d) Close GEG Breaker.

When Auto/ Manual switch on the control panel is in Auto mode, following operation shall be done automatically without any operator.

- a) GEG Start/ Stop
- b) Speed raise/ Lower
- c) Voltage raise/ Lower
- d) Close GEG Breaker.
- e) Load GEG set/ Synchronize GEG's

11.2 EMERGENCY GENERATOR

Emergency Diesel Generator set shall be capable for 'black start and emergency' loads and be directly connected to dedicated Emergency Switchboard

The generator set shall have minimum Stand-by Power rating at the site conditions.

The rating of the generator set shall be the total net output rating at the generator terminals at site condition. The rating of any significant electrical auxiliaries, such as electric cooling fans, shall be deducted from the output rating. The generator set shall have a power rating as required, at a power factor of 0.8.

The generator set shall be capable of delivering the rated kVA and kW output at site continuously. Site rating of the set shall be based on operation at rated generator speed, at maximum site temperature and elevation. The set shall be capable of delivering 10% overload for one hour in any period of twelve hours continuous running. The set must be capable of accepting full load from cold start within 20 seconds.

The engine shall be capable of withstanding over-speed to 120% of rated speed without experiencing permanent deformation and damages which may affect the mechanical integrity and reliability of the equipment. Over-speed trip shall be set at 105% speed.

To reduced maintenance and increased life, it is recommended that the engine speed shall not exceed 1500 rpm.

The generator shall be of self-ventilated and drip-proof construction, self-excited brushless type, suitable to generate, 415V AC, 50Hz, 3 Phase power of required KW rating as specified in Single Line Diagram.

The emergency diesel generator shall be suitable for manual starting. It also shall have

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provision for 'AUTO START' in case of normal power outage. Necessary switches, manual controls for speed/frequency and voltage adjustment shall be provided.

The engine shall be equipped with a 24 volt battery powered, electric starting system of sufficient capacity for a minimum of 3 cranking cycles, each 15 seconds crank and 15 seconds rest.

The fuel tank capacity shall be sufficient for not less than 8 hours continuous operation at full load.

The cooling system shall be provided with a closed -loop circuit engine driven water circulating pump, an expansion tank and radiator with fan.

The exhaust silencers shall be the spark arresting type, residential silencing grade or better with a stainless-steel expansion joint between the exhaust manifold and the silencer.

VENDOR shall provide an acoustic enclosure over all the equipment to meet the noise level within the permitted levels. Enclosure shall have removable panels allowing total access to the engine and generator for major repair and maintenance. All enclosure hardware such as fasteners, hinges and latches shall be galvanized/ suitably coated.

Enclosure shall be ventilated to provide not less than 20 changes of air per hour within the enclosure, or to limit the temperature rise within the enclosure to not more than 5 °C above the ambient air temperature, whichever requires the greater flow rate. The ventilation shall be achieved through the radiator fan.

Electrical power supply required for the DG auxiliaries shall be derived internally within the package.

The generator package shall be supplied with a unit control panel. The control panel shall include the gauges, metering, controls, indicators, alarms and other protection instruments for Engine and Generator.

The unit control panel shall be powered with internal supply. All instruments, monitoring, indication and alarm devices will be powered from the unit control panel.

The package shutdown and control system should be fully autonomous, in order to ensure operation and safety of the package in case of communication loss.

Emergency generator set shall be designed to black start loads and feed the selected loads. It shall be capable of taking care of the load variations (e.g., starting of the largest rated motor with specified base load during black start).

Regulation of generator voltage shall be automatic and necessary instruments for metering viz., ammeter, voltmeter, frequency meter, kWh meter, power factor meter, hour run counter etc. shall be included in the control panel. Warning of abnormal conditions shall be incorporated prior to automatic trip to prevent unnecessary shutdown.

The unit shall be complete with necessary engine starting equipment, associated control panel and shall be suitable for remote starting. The emergency generator set shall have auto/manual starting arrangement but only with manual switching off feature. 'Fail to start' annunciation shall be provided, in case the engine fails to start.

Load shall be automatically switched on to the generator only after the requisite voltage

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build-up.

11.3 PCC/ PMCC / MCC / SWITCHGEAR PANELS

11.3.1 Switchgear panels (MCC/PMCC/PCC) will distribute and supply electrical power to all electrical drives and controls, UPS, lighting etc. Hence these panels shall be designed for proper control and discrimination properties.

11.3.2 The following Switchgears/Panels are envisaged under the Power Distribution System.

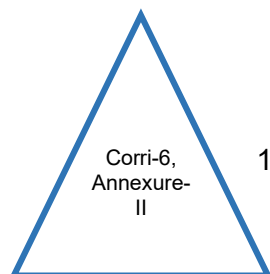
- f) Generator control panels
- g) Generator Breaker Panel
- h) NGR monitoring panel
- i) PCC (Power Control Centre)
- j) MCC (Motor Control Centre)
- k) PMCC (Power and Motor Control Centre)
- l) MLDB (Main Lighting Distribution boards)
- m) MPDB (Main Power Distribution boards)
- n) AC Distribution Boards
- o) DC Distribution Boards, Battery Chargers
- p) UPS, UPS Distribution Boards & its Auxiliaries

11.3.3 All panels shall be steel clad, single / double front and draw out design for ACB incomers & bus coupler, other outgoing feeders will be fixed/draw out type cubicles self-supporting floor mount type. However smaller MLDB/ACDB/LDBs etc. can be wall mount type also. **These shall be indoor type, dust and vermin protected. Ingress protection shall be minimum IP-42.** Compartments/cubicles shall be capable of withdrawing to a test position. This test position isolates the power cables to allow the live commissioning of control circuit. The switchgear is to be provided with a minimum 30% fitted spare motor starters and feeder modules (subject to minimum 01 of each rating and type). Circuit breakers shall have a rating of at least 120% of the maximum continuous rating of the connected loads.

Each starter unit shall have component designed for Type – 2 co-ordination as per IEC / IS – 13947. All load feeders shall be provided with either ELCBs (up to 7.5 kW) or earth leakage protection of adjustable leakage current settings from minimum 30 mA up to 3.0 A and time setting from instantaneous to 3 seconds in variable steps.

11.3.4 All components used must be suitable for the environment as mentioned. All hardware should be of high tensile steel & galvanized/ Zinc passivated. Size of spring washers & flat washers should be as per relevant IS for individual bolt.

11.3.5 **There will be two identical incomers for panels if defined in SLD (MCC/PCC/PMCC), with 415V (Ue), 690V (Ui), with rated breaking capacity, three pole fixed type Moulded case circuit breaker, (electronic/ microprocessor controlled) with adjustable settings with separate earth leakage module.** The earth leakage protective device may be either a CBCT + EL module combination



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or a separate, but MCCB mountable EL module. One digital multi-function meter indicating Voltage, Current, Frequency, Power factor, Power, Energy and maximum demand indicator, with RS-485 capability shall be provided in each incomer of the panels.

All incoming and outgoing terminals of MCCB are to be fitted with spreader links supplied by MCCB manufacturer or brought out phase links of copper in rectangular sections with hole. Zinc passivated nut bolts with flat and spring washers for connection shall be provided for cable termination. Detachable gland plate shall be provided.

- 11.3.6 Busbars and bus chamber:** Bus chamber shall be steel clad having front and rear bolted covers. The busbars shall consist of 1 set of hard drawn, high conductivity, three phase, electrolytic grade, virgin copper bars rated according to the calculated panel capacity. Busbars shall be rated to withstand short circuit fault currents. Main busbars shall be full length of the panel. Vertical bus bars for feeding individual starter/feeder shall be full height of the panel. Sufficient clearance shall be maintained in the bus chamber for proper cooling of the busbar. Busbar should be extensible type to facilitate future extensions.

11.3.7 Description of Starter/feeder panels:

MCCB isolator (Isolation requirement):

Each motor starter shall be provided with one no. 415V(Ue), 600V(Ui), min. rated breaking capacity, three pole MCCB fitted with inbuilt thermal overload, short circuit releases with adjustable settings for current and with Rotary Handle operating mechanism. For feeder panels also, three pole MCCB shall be used with identical capacity and type.

The MCCBs shall be operated from outside the panel. The MCCB handles shall also project outside the panel doors enabling breaker operation from outside the panel. All MCCB used shall be suitable for isolation as per IEC 947-2. Control supply of individual starters shall be tapped from its own line; the starter shall be in-operative if the MCCB is off. Alternatively, control supply of individual starters can be provided with from a separate control bus, powered from control transformer.

- 11.3.8 Panel components:** Various starters and feeders shall be housed in individual cubicles. Starter components shall be mounted on sheet steel base and all apparatus shall be suitable for front removal. All starters/feeders shall have suitably rated MCCBs as incomers. For feeder/starters above and including 20 HP, MCCB incomer connection to busbars shall be through suitably rated copper bus links/spreader bars only. This is to avoid mechanical stresses that may develop during short circuit condition.

- 11.3.9 Starter panel components like MCCBs, contactors, overload relays, RCBOs etc.** shall conform to IEC60947-2/IS: 13947-2 and IS: 12640. All starter/feeders shall be provided with Type II protection.

Main components of individual starter/feeder panels:

- Incomer MCCB (as isolator/main switch)
- RCBO in the downstream of MCCB (through separate CBCT & earth leakage relay or directly mountable as an add-on module on the MCCB with variable current and time settings (0.03- 3.0 A and 0-3 second, in steps)

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- c) For starter panels only- Motor Starter magnetic contactor and adjustable thermal overload relay with built in SPP
- d) For large starter panels (40 HP and above)- soft starter/VSD are to be used
- e) Remote/ local selector switch- for facilitating remote/local starting of motor
- f) Local start/stop switch- for starting/stopping of motor from panel
- g) Low voltage (maximum 30 V) supply system for remote pushbutton station, along with intrinsically safe barrier (with transformer type isolation) for isolating hazardous areas and non-hazardous areas (safe area), i. e., in the panel. Intrinsically safe isolators/barriers shall be in the panel itself.
- h) For starter panels only- Ammeter (accuracy class 1.0), directly mounted for starters below 15kW and through CT for and above 15kW.

11.3.10 Important points to be considered while designing the starter/feeder panels:

- a) As the panels will be installed in a gas mine, as per Central Electricity Authority Regulations 2010, **the remote starting facility for motors shall be suitable for voltage below 30 Volt and intrinsically safe.** However, the control supply of contactor coils etc. shall not be 30 V.
- b) MCCBs, contactors, overload relays shall preferably be of one make only. However, earth leakage relays, CBCT etc. may be of different make than contactors/OLR etc. CBCT and sensing earth leakage relay shall be compatible and from the same manufacturer.
- c) As far as practicable, one rating of components shall be used for a range of starters (e.g., one rating of contactors in all starters up to 20 HP). All device selection shall take motor starting current into consideration.
- d) For hazardous areas, 3 phase 3 wire connection shall be used including lighting loads (through lighting transformer). However, in case 3 phase, 4 wire supply (for neutral) is required, power from the 3-pole feeder will be supplied through isolation transformer (415 V/415 V, delta/star-neutral) only.

11.3.11 For the PMCC, feeders for more than 630 ampere rating shall be provided with ACB. Feeders up to 630 ampere rating shall be provided with MCCB. All lighting / auxiliary / power panel main incomers will be MCCB. All lighting sub-distribution board incomers up to 63 amperes shall be MCB and beyond 63 amperes MCCB shall be provided. Bus bar and isolating devices are rated at 125% of total design load. Bus bars are generally identified as R, Y & B with phase colored as red, yellow and blue. All the switchgears are industrial grade equipment installed in freestanding sheet metal cubicles of modular design. All equipment and switchgear ratings are decided based on actual design calculations (actual requirement) and 10% spare capacity (if spare capacity is not particularly mentioned). Cable entry to all panels of switchgear and control panels shall be from bottom. Bus coupler switch gear rating shall be higher of the following:

- Largest incoming breaker
- Maximum load on either side of bus section
- Maximum of current rating of bus- bars on either side of coupler

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- 11.3.12 Switch board components such as breakers, MCCBs, horizontal and vertical bus bars shall be designed to withstand design fault current of 50 kA or maximum fault current at the point of installation, whichever is higher for a minimum period of 1 sec.
- 11.3.13 Motor feeders:
The motors of the respective package units will be controlled & monitored from common control room via Plant Control System / PLC / SCADA.
- 11.3.14 **Modular Design:** For units which can be modularized, the skid shall be self-containing, shall be pre-fabricated and assembled in the standard size of containers, transported in containers and placed at site on concrete foundation. Modularization is to achieve minimum fabrication/ construction job at site.

11.4 MOTOR

All the motors required by mechanical packages shall meet the requirement of relevant National / International standards. The voltage ratings for motors shall be as below: Also, all electric motors installed outdoor shall meet the criteria for the hazardous area requirement and the below mentioned criteria in addition to the standard specifications and data sheet for same:

Enclosure : TEFC (totally enclosed fan cooled) with IP-55

Insulation : Class "F" with temperature rise limited to Class "B"

Starting : Requirement of starters shall depend on SEB

[regulations Space heater: For motors rated 75 KW or above.](#)

- 11.4.1 Starting torque and minimum torque of the motor shall be compatible with the speed torque curve of driven equipment under specific operating conditions. For DOL start applications, LV (up to 250V) motors shall be suitable for starting with 80% of the rated voltage at the terminals and MV (up to 650V) motors with 75% of the rated voltage at the terminals. For heavy duty drives such as reciprocating compressor, agitator, crusher etc. high starting torque motors (minimum 150 % of rated torque) shall be provided to limit starting current and time.
- 11.4.2 Motors shall be capable of satisfactory operation at full load at a supply voltage of 85% of the rated voltage.
- 11.4.3 For Hazardous area location i.e., Zone1/Zone2, motor shall comply to IS: 5572 or equivalent.
- 11.4.4 For Flame proof enclosures located in hazardous gas, group classification i.e., IIA/ IIB/ IIC shall be as per IS: 2148.
- 11.4.5 Type of Motors shall be based on the hazardous area classification.
- 11.4.6 All Motors shall be Energy Efficient - IE2 type.
- 11.4.7 Irrespective of the Hazardous area classification, the motors to be used in Hazardous areas will be flameproof (and weatherproof) construction type Ex-`d'.
- 11.4.8 The exact type of motors to be employed will be decided by the Package Vendor during the stage of detailed Engineering.
- 11.4.9 Motors when started with the driven equipment coupled shall be capable of withstanding at least two successive starts from cold conditions & one start from hot condition without injurious heating of windings. The motors shall also be suitable for three equally spread starts per hour.
- 11.4.10 Local start /stop lockable push button stations will be provided for all motors.

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11.4.11 Noise level shall be maintained as IEC 60034-9.

11.4.12 Motor vibration shall be within IS -4729.

Limiting condition for motor start up

- i. Motors : 660% up to 75 KW,
550% above 75 KW
- ii. Method of starting
 - a) Up to 9kW shall be started on DOL.
 - b) Above 9kW and up to 30kW shall be started by star delta starter.
 - c) Above 30kW shall be controlled by soft starter with bypass contactor with comprehensive motor protection relay.

Motor starter type:

- i. MCCB and Contactor with O/L relay, SPP & ISB : For all motor feeders
& CBCT with ELR for earth Fault protection.
- ii. Ammeter on MCC/PMCC : For all motor feeders

11.5 INPLANT GENERATOR

Power generator with acoustic enclosure shall form a complete package consisting of engine, alternator panel, control panel etc. Generator shall be designed to have allowable voltage dip when largest motor of the system is started with all other loads are ON. Unless otherwise specified the excitation, system shall be brushless type. The generator shall have automatic voltage regulator. Proper instrumentation shall be provided for monitoring all parameters. Necessary alarm/ annunciation shall be provided for abnormal condition.

The generator shall have protection against short circuit, earth faults, overloads, field failure, prime mover failure & earth leakage etc. Stator ends shall be brought out to terminal box mounted externally. The terminal box shall have sufficient space to receive the specified size of cables. Rotating rectifier diodes shall be located in easily accessible location to have ease of maintenance.

Breaker in generator control panel shall be closed on to load only after the requisite voltage builds up.

Where four operating generators are provided, they shall be suitable for auto mains failure. Provision of paralleling shall also be provided.

11.6 UPS & BATTERY BANK

- 11.6.1 The UPS will be 3 ph. to 1 ph., 50 Hz, on-line, 2 x 100% Parallel Redundant UPS power supply with static bypass and will be fully rated suitable for input supply 415±10% to feed instrumentation loads, fire detection system, computers & emergency lighting system etc.
- 11.6.2 The two parallel redundant UPS will be on-line and share the load equally. Each of these shall have the capacity to take the entire UPS load of the plant in case the other one fails. At normal times, each of the UPS shall however carry 50% of

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the load. Each UPS shall have its own battery bank, each capable of supplying the entire UPS load

11.6.3 The static by-pass transfer switch will be provided which comprise an automatic transfer circuitry that synchronizes the inverter output with that of the by-pass source before automatic by-pass is affected. For 1-Phase UPS, the 415V/240V static by-pass transformers shall be provided. The transformer shall be provided with voltage stabilizers.

11.6.4 The source of power for UPS will be arranged from main gas genset PMCC and a second source from emergency DG set supply. During normal operation, the AC Supply will be fed to UPS Distribution boards through the two parallel redundant UPS with 50% loading each and a small trickle charging current will be feeding to battery for charging and the bypass source is kept open. Once the normal (gas genset) AC supply fails, the battery will feed the UPS distribution loads through UPS until D.G. started. Once the D.G. set comes in line then UPS feeding from the DG set will take care of entire load. In case of failure of both the UPS then static by pass will come into picture automatically.

11.6.5 For UPS, Ni Cd type Lead Acid battery shall be used. The UPS shall be provided with a Battery backup time of 2 hours. Battery shall be sized considering Temperature correction factor, contingency factors.

11.6.6 The battery shall be provided with a MCCB on the UPS cubicle for total isolation of the battery from the rest of the UPS system.
UPS and DC supply shall be provided as per project requirement. Separate battery room is to be provided in all switch gear rooms. Generally, the following shall be required:

11.6.7 UPS (for communication, Instrumentation and Control application)

Input	: 415 Volts +/- 10%, 50 Hz +/- 3%
Output	: 240 Volts (AC), 1-phase
Type	: Parallel redundant with bypass Back up
time	: 2 hours for full rating of UPS
Battery type	: Ni Cd Battery
Capacity	: To be decided during detailed engineering (spare capacity of 50 % is to be provided).

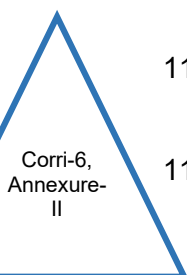
11.7 DC SYSTEM

11.7.1 The 110V DC system will be designed to cater the loads for control, protection and indication, 415V PCC, 415V Motor Control Centre with ACB controlled Incomers, Gas Genset Control Panel and critical lighting.

11.7.2 Insulation monitoring device will be provided at the incomer of DCDB, to protect entire DC system against earth leakage.

11.7.3 One (1) 100%, 110V adequately rated Ni Cd battery bank with 1 x 100% Float and Float cum Boost charger and DC switchboard will be provided separately. The DC system will be unearthed.

11.7.4 Under normal operating conditions one Float charger will feed 100 % DC loads and trickle charge the battery and the other Float cum boost charger will be in standby mode. In case of failure of one float charger the other Float cum boost charger will feed the loads as well as trickle charge the battery after a manual



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change over. In case of AC supply failure in the plant / to charger, battery will meet the DC load requirement.

11.7.5 After restoration of AC supply the fully / partly discharged battery will be recharged using one of the Float cum boost charger in the boost mode. During this time the continuous load on DC bus will be met by the Float charger with a back-up from battery.

11.7.6 Battery with adequate rated Capacity **with 2 Hour backup** will be considered. Battery shall be sized to cater to the following loads duty cycle Momentary load for 1 minute

- Breaker trip & Close coils
- Emergency load
- Indicating lamps
- Control & Relay Panels
- Breaker controlled feeders

11.7.7 **DC supply system shall be provided with charger, Ni Cd batteries, and DC distribution board.** DC supply shall be sized during detail engineering.

11.7.8 DC Voltage levels:

a) Output: 110V DC **(2-hour battery backup)**

To cater to specialty lighting, i.e., critical and exit lights, breaker controls /instrument supply etc.

b) Output: 24 V DC

To cater to the starting requirement of Emergency services (if any), Fire water pumps.

11.8 CABLES AND WIRES

The power cable shall be XLPE insulated, PVC sheathed, armoured copper conductors. Control cables shall be XLPE insulated, PVC sheathed armoured copper conductor. All cables shall be low smoke, Halogen free, FRLS type.

Cables shall be sized based on maximum continuous full load current, voltage drop during starting (for motors) and drop over the length laid, system voltage, system earthing and short circuit withstand criteria as applicable. The derating due to ambient air temp., ground, grouping and proximity of cables, etc., shall be taken into account.

All the power and control cables are indented to be used in mines and shall accordingly be identified on outer sheath as per IS

In case of difficulty in connection to relays instruments 1.5 mm² conductor may be used

- Lighting – 2.5 mm² copper for circuit mains
- Power sockets & other utility – 4 mm² copper for circuit mains
- For lighting inside building, (point wiring) 1.5 mm² copper conductor. PVC insulated, FRLS type wires shall be used in conduit system.
- All field cables shall have one additional core for internal earthing of the equipment, i.e., all Power cables to motor, etc. shall be 4 core or 3.5 cores. Control cables also must have one additional core for internal earthing.

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11.9 CABLE CARRIER SYSTEM

- 11.9.1 Cables from switchgear, PMCCs, MCCs and MLDBs will be routed on prefabricated ladder type galvanized iron cable trays supported on site fabricated tray supports inside the buildings.
- 11.9.2 Separate cable trays will be used for 415 V power, control and instrumentation cables. G.I. sheet cover of 1.5mm Thickness will be used in all exposed cable trays in outdoor areas.
- 11.9.3 In Substation / Indoor areas the cables will be laid on galvanized Iron ladder type/perforated cable trays running in the built up RCC trenches.
- 11.9.4 In outdoor open areas, cables shall be laid in overhead cable racks / RCC trenches filled with sand. In other areas where cables are laid in overhead galvanized Iron ladder/perforated cable trays, these shall be supported from slabs/walls/columns and pipe racks as found suitable.
- 11.9.5 For street lighting cables will be directly buried in ground. Standard installation practice for directly buried cable as per IS will be adopted.
- 11.9.6 Road crossing will be through concrete electrical road crossing (ERC) or overhead cable rack.
- 11.9.7 Multi cable transit (MCTs) shall be used for entry/exit of switch room/control room etc. where trenches are used.

CABLE TRAYS

- 11.9.8 All cable trays will be of ladder type or perforated type construction of various sizes with accessories. There will be a maximum spacing of 1500 mm between cable tray supports, except fittings (elbows, tees, etc.) which will be supported at each splice.
- 11.9.9 Solid bottom trays will be provided for all special noise-sensitive circuits and analog instrumentation circuits. For instrumentation and control cables perforated cable trays will be used.
- 11.9.10 Clearance: The minimum design vertical spacing for trays will be 300 mm measured from the bottom of the upper tray to the bottom of the lower tray excluding the thickness of the support of the upper tray. At least a 300 mm clearance will be maintained between the top of a tray and beams, piping, or other obstacles to facilitate installation of cables in the tray. A working space of not less than 600 mm will be maintained on at least one side of each tray.
- 11.9.11 The trays will be prefabricated hot dip galvanized sheet iron trays.

CONDUIT

- 11.9.12 Conduits will be used to protect un-armoured conductors routed to individual devices and where the quantity of cable does not economically justify the use of cable tray. Galvanized rigid iron heavy duty conduit will be used for conduits routed in true ceiling and Mild Steel heavy duty conduit will be used for above false ceiling areas and PVC heavy duty conduit will be used for conduits encased in concrete.

FIRE STOP AND FIRE BREAK

- 11.9.13 Fire barriers and fire sealants (Fire stop) of two hours rating shall be provided for switchgear openings, wall openings, floor openings, cable trays such that fire at one location shall not spread over to other areas. All openings in the floor/wall/cable trenches made for cable installation shall be sealed and made water proof.

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11.9.14 Fire break of thirty minutes rating shall be provided along the horizontal and vertical trays. The fire-break shall be provided by applying a suitable fire- resistant coating on cables and cable trays for the required length. Fire break shall be provided every 30mts of interval.

11.10 BUS DUCT

- 11.10.1 Bus ducts will be provided for interconnection of the gas gen sets and generator synchronization panel and outgoing from the synchronization panel to the 415V PCC-01, PCC-02 and PCC-03.
- 11.10.2 Non-phase segregated, self-cooled type, 3 phase, 4 wire, sandwiched type.
- 11.10.3 Copper bus bars with heat shrinkable PVC Sleeves.
- 11.10.4 Enclosure will be fabricated from 3mm thick (min) aluminum sheets for ratings above 3000A and 2mm thick (min) sheet steel otherwise.
- 11.10.5 Seal-off bushings with wall frame assembly wherever the bus duct crosses wall from outdoor to indoor
- 11.10.6 All bus ducts shall have temperature monitoring system and connected to nearest data concentrator or switch board HMI or DCS. If there is no provision to hookup to the nearest system then standalone temperature indicator with alarm shall be provided
- 11.10.7 The Rating of the bus bar ducts connected to breakers shall have same continuous and short circuit rating as that of breakers. Similarly, bus ducts connecting to two bus sections shall have same continuous and short circuit rating as that of main bus bars
- 11.10.8 Neoprene rubber bellows for enclosure wherever expansion joints are provided.
- 11.10.9 The outdoor portion of the bus bar shall be minimum IP 55
- 11.10.10 The adopter box on both ends of the bus duct shall be designed as part of the bus duct.

11.11 CONTROL STATION

Each motor shall be provided with a control station in the field. The control station enclosure shall have suitable protection for site conditions such as flameproof, weatherproof, dustproof, corrosion resistant, etc.

The control station shall include the following equipment as per individual requirements:

- Start/ stop push button
- Cable glands

Stop push button shall generally have stay put feature except in the case of critical drives such as lube oil pump etc.

11.12 POWER/LIGHTING PANELS

Power Panels and Normal Lighting Panels/Hazardous area lighting panels shall be located at various places throughout the plant for feeding lighting fixtures /convenience receptacles.

11.13 CONVENIENCE RECEPTACLES

These shall have the necessary built-in mechanical interlocks and necessary earthing facilities. The enclosure shall have suitable protection as specified (explosion proof, weatherproof, dustproof, corrosion resistant, etc.)

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Adequate number of sockets for lamps and portable tools shall be provided at suitable locations to ensure accessibility with a 15 meters length of cable to any point in the process area. These shall be rated for 15A single phase, supplied at 240V.

11.14 FOR MOTOR ACTUATORS OPERATED VALVES

Generally, MOVs requiring only local control shall be provided with integral starters, MOVs requiring local/ remote control shall have remote mounted starters. The necessary local/ remote selector switch, start/ stop control switches or push buttons, torque limit switches, etc. shall be provided on actuator for local/remote control depending on mode of selection. In case of failure of torque limit switches, the mechanical design shall be adequate to stall and trip the motor without damage.

The control circuits shall be AC operated with Intrinsic Safety barrier (ISB). The actuator shall be provided with an anti-condensation heater.

11.15 CATHODIC PROTECTION

Impressed current type, cathodic protection shall be provided for all buried pipelines and tanks/vessels resting on the ground.

A separate impressed current type cathodic protection shall be provided for the steel piles used in all civil foundations for building and equipment, Pipe support, structural foundation at FGGS.

11.16 ELECTRIC HEATER

Tubular type Electric Heaters shall be provided for the fuel gas system where uniform heating is required to maintain the gas temperature as per process conditions.

Control and protection of electric process heaters shall be by means of a fused switch or an MCCB supplemented with a contactor if required.

Electrical heaters will be tripped based on the high temperature feedback given from the field.

Remote monitoring shall also be provided by DCS system.

Electric heaters shall be provided in accordance with electric heater specification FGGSB-BJN-ELC-SPC-6014.

11.17 AIR CONDITIONING SYSTEM

Suitable air conditioning system shall be installed in the control room, UPS/rack room, IM office, and conference room. These shall be either package type or room air conditioner (single split design). Cooling air calculation shall be done to size the AC system properly. Occupancy level, ambient conditions, RH level etc. shall be taken into consideration while sizing the AC system.

12.0 LIGHTING SYSTEM

SYSTEM CONCEPT

The plant lighting system will essentially comprise the following three (3) categories.

- a) Normal 240V AC Lighting System
- b) Emergency AC Lighting System

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c) Critical DC Lighting System

12.1 NORMAL 240V AC LIGHTING SYSTEM

Normal (and emergency) lighting shall be fed from 240 V phase-to-phase AC supply as the installation is a gas mine, as per CEAR 2010.

Additional precautions as per Chapter IX of CEA Regulations are to be adopted in mines and oil fields.

Normal lighting system shall provide enough illumination so as to enable plant operators to move safely within the accessible area of plant to perform routine operation including reading of field instruments, operation of all valves etc. and to carry out all the necessary maintenance and adjustment to equipment.

- a) Normal lighting will be provided by A.C. lighting fixtures distributed throughout the plant. These lights will be ON as long as the A.C. supply is available.
- b) A.C. lighting fixtures will be fed from respective area lighting panels, which in turn will be fed from main lighting distribution board. The main lighting distribution boards will be fed through respective suitably 415V/240V Dyn11, 4% impedance OFTC +5% in steps of 2.5% lighting transformer, which forms a part of the MLDB. Normal A.C. supply thus made available by the MLDB is 415V/240V-3ph-3W-50HZ effectively grounded. Minimum two/three nos. of lighting transformers shall be provided to cover the entire installation.
- c) Incomer of all the MLDB's will be provided with drop-out-contactors in order such that loss of power may lead to disconnection of MLDB.

12.2 EMERGENCY A.C. LIGHTING

Emergency lighting shall be fed from 240 V phase-to-phase AC supply as the installation is a gas mine, as per CEAR 2010. However, these shall be fed from emergency DG set/UPS supply at the time of failure of normal AC supply.

- a) During normal operation, both emergency and normal lighting shall be fed by normal power source. On failure of normal supply, emergency lighting load shall be transferred to emergency power supply source.
- b) In case normal power supply fails, emergency A.C. lighting fixtures will be fed from respective emergency area lighting panels, which in turn will be fed from emergency lighting distribution board. The emergency lighting distribution boards will be fed through suitably rated 415V/240V Dyn11, 4% impedance OFTC +5% in steps of 2.5% lighting transformer. This transformer shall be fed in turn from emergency DG set. However, emergency lighting fixtures may also be directly supplied from UPS DB, wherever applicable. Minimum one no. of emergency lighting transformer shall be provided to cover the emergency area of the installation.
- c) Areas requiring AC emergency lighting shall include, but not limited to, the following:
 - All Areas requiring DC critical lighting
 - Strategic locations in progress, utility areas where specific safety/shutdown operation are to be carried out

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- d) At least 20% of the fixtures will be kept plugged in the normal AC lighting system and they will come in service automatically on failure of the normal AC supply and will provide illumination for 2 hours.
 - e) All emergency fixtures and associated Junction Boxes in Hazardous areas shall be flameproof type.
 - f) Semi Portable Lighting Fixtures- At some of the prominent & critical areas where DC lighting cannot be provided in the off-sites and substations, normal fixtures with battery backup will be provided.
- Generally, 20-25% of the total lighting fixtures shall be fed from AC emergency supply.

12.3 D.C. CRITICAL LIGHTING

DC critical lighting system will be fed from 110 V DC system through battery bank, DCDB and DC LDB.

- d) At least 20% of the fixtures shall powered by DC distribution board for Control rooms and other critical areas. During normal supply failure DC fittings will come into operation until the D.G. is switched on.
- e) Critical lighting shall be normally kept 'OFF' and during failure of AC power; battery bank shall feed the critical lighting system.
- f) All DC critical lighting (if specified) fixtures and associated Junction Boxes in Hazardous areas shall be flameproof type.
- g) Areas requiring DC critical lighting shall include, but not be limited to, the following:
 - Control rooms
 - Substations
 - DG shed
 - Central fire station
 - Fire water pump house
 - First aid center
- h) DC critical lighting shall be provided in the pipe rack, exit/entry points only if considered for process units.
- i) In addition, DC critical lighting shall be provided in Emergency Escape route and exit signs also.
- j) Adequate number of self-contained portable hand lamps and battery-operated emergency lighting units shall be provided for immediate use for buildings where no DC supply is available.

12.4 GENERAL NOTES REGARDING LIGHTING

The following operational philosophy is recommended. Under normal operation, both emergency and normal lighting shall be fed by Normal power source. On failure of normal supply emergency lighting load will be transferred to emergency source after the start of emergency gen set automatically. Critical lighting (D.C. supply based) will be normally kept 'ON' and during Normal/emergency power failure, battery will provide

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power.

- a) Lighting system shall consist of lighting transformers, lighting distribution boards (LDBs), lighting and power panels, fixtures, junction boxes etc. as specified. All outdoor lighting shall be automatically controlled by means of photoelectric cell/synchronous timers with manual overriding control as specified. Lighting and power panels shall be fed from LDB through 415/240V, Dyn11, dry type lighting transformer having taps up to $\pm 5\%$. (Refer clause 12.1 above for mine and oil fields installations). The lighting and power panels shall be provided with MCB and ELCB as incomer and miniature Circuits Breakers (MCBs) for outgoing feeders control and protection of lighting circuits. ELCBs shall not be provided at the incomers of lighting and power panels, in case ELCBs are provided in the outgoing feeders of LDBs/ASBs feeding to these lighting and power panels. MCBs shall not be loaded beyond 80% of rated capacity. A minimum of 20% of miniature circuit breakers of each panel shall be left as spares. In general, the load on each circuit shall be limited to 1.5kW.
- b) LED lamps shall generally be used for outdoor plant lighting. LED lamps shall be used for indoor lighting for non-process buildings and control room. Safe area street lighting and area lighting may employ LED lamps. All chemical handling facilities including battery rooms shall be provided with chemical resistant fixtures. Low pressure sodium vapor lamps shall not be installed in hazardous areas. DC critical lighting shall employ LED lamps. Tall structures shall have aviation obstruction lighting as per statutory requirements.
- c) Telescopic tubular high masts shall be provided for illumination of tank farm/general area. The high masts shall be of continuously tapered polygonal cross section and fabricated out of steel plates. The masts shall be provided with motorized racking mechanism for lowering and hoisting lantern carriage. LED lamp shall be considered for HM light fittings.
- d) Lighting design shall conform to relevant Indian and international codes and standards, IES Hand Book and shall take into consideration the requirements from point of view of safety and ease in operation and maintenance factor of 0.9 shall be assumed for lighting illumination level calculations for normal areas. However, for dusty areas, maintenance factor as per relevant codes and standards shall be considered.
- e) Wiring for lighting and convenience outlets in outdoor areas shall be carried out with PVC insulated armoured cables run along the column/platforms and structures. Double compression cable glands required for terminating armoured cables in lighting fixtures, control gear boxes and junction boxes in hazardous areas shall meet the requirements of IS/IEC 60079-0. For outdoor/indoor safe area equipment double/single compression cable glands shall be used respectively. Adequate number of ceiling fan points shall be provided in administration building, offices, rooms allocated for operating and maintenance personnel etc. Two pole isolation devices shall be used for controlling lighting fixtures and sockets in hazardous areas to isolate both the phase (as the 240 V supply shall be phase-to-phase for all mine and Oil field installations).

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- f) For buildings with false ceiling, concealed conduit wiring shall be used below the false ceiling and surface conduit wiring above the false ceiling. Adequate number of pull boxes shall be used to aid wire pulling and inspection. No joints shall be allowed inside these pull boxes.
- g) Battery room shall have fixtures mounted on wall in order to facilitate easy replacement of fused lamps. Switches controlling the lighting fixtures and exhaust fan shall be installed outside the battery room.
- h) Locally mounted lighting fixtures on platforms, walkways, staircases shall be installed in such a way that replacement of fused lamps can be done without the use of ladders.

12.5 STREET LIGHTING

The Lighting panels used for street lighting will be additionally provided with a timer device having twenty-four-hour hand set dial with a facility for setting ON & OFF times. There will be a provision of selecting either the manual control or the automatic control. The selector switches will be mounted on the front door of the switchboard.

12.6 PERIPHERAL LIGHTING, SEARCH LIGHTING & HIGH MASTS

- a) Peripheral Lighting shall be provided using Double Pole structures of required heights.
- b) Search lighting with revolving facility shall be considered at the top of the watch tower along the periphery.
- c) High mast lighting facility shall be provided at the road junctions near to tank farm area.

12.7 RATING & REQUIREMENTS

- a) The lighting system will be supplied from 415 V/240 V $\pm$ 4%, Dyn11, indoor, dry type lighting transformers. Rating of each transformer shall be decided to limit the fault level.
- b) All equipment and accessories shall be designed for continuous operation under site conditions without exceeding permissible temperature rise as stipulated in relevant standards c) Switch, miniature circuit breakers (MCB), bus bars shall be fully rated for short circuit level at the point of application. MCB shall have back-up HRC fuse if its rating is less than the available short circuit current.
- c) The incomers of Lighting Distribution Boards are provided with RCCB (Residual case circuit breaker) or MCB with ELCB (Earth leakage circuit breaker) for Earth leakage protection.
- d) All wiring from lighting panels to fixtures and receptacles shall be carried out by PVC wires in G.I. Conduits.
- e) All equipment and accessories shall have proper enclosure to suit the site conditions. Hazardous areas shall have flame-proof enclosure.
- f) Heavy duty 2XWY FRLS cables will be used only for connections:
 - From main lighting distribution boards to area lighting panels

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- From street/area lighting panel to street light poles/towers
- g) Suitable number of Flood Lighting Towers / Lighting Masts with adequate LED Flood Light will be provided in the necessary outdoor areas.
- h) Each lighting panel shall be provided with adequate number of outgoing miniature circuit breaker for controlling fixtures. 5/15A, 3Pin sockets shall be fed from the lighting panel through separate circuits.
- i) Lighting fixtures shall be designed for minimum glare. The surface finish shall be smooth, unobtrusive and scratch resistant.
- j) Reflector shall be of sheet steel or aluminum, minimum 20 SWG thick, securely fixed by fastening device of captive type.
- k) Fixture shall be suitable for 19 mm conduit entry and 16 SWG G.I. earth-wire connections.
- l) Fixture shall also be suitable for case coupling entry wherever required.
- m) High bay fixtures shall have provision for vibration damper to ensure rated lamp life.
- n) Fixture shall be furnished complete with lamps and integrally/non-integrally or separately mounted control gear & accessories or applicable for different types of fixtures. These shall include holders, ballast, capacitor, starter, igniters (separate type) etc.

12.8 METHOD OF CALCULATION

- a) Standard Lumen method shall be adopted for interior & exterior lighting in order to determine the number and type of lighting fixtures for obtaining the desired average level of illumination.
- b) The coefficient of utilization shall be considered to take care of Lumen loss due to:
 - Effect of room dimensions
 - Absorption of light in luminaires
 - Absorption of light at various room surfaces in ceiling, wall etc.
 - Floor cavity, ceiling cavity
 - Mounting height
- c) The following LUX level will be considered in the lighting design as per OISD-149.

Sl. No.	Name of the Area	Lux Level Considered
1	Main roads (along process units, power houses, workshops, etc.)	7 - 10
2	Secondary roads (along storage tanks settling basins etc.)	3 - 5
3	Tank farm	10

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4	Pump houses, sheds	100
5	Main operation platforms & access stairs	60
6	Ordinary platforms	20
7	Process areas, pipe racks, heat exchanger, heater, separators, cooling tower, columns, pig launching/ receiving loading area, flare etc.	60
8	Switchgear bldg.	150-200
9	Transformer bay	100
10	Battery room	150
11	Control room bldg./laboratory	400
12	Boiler house	150
13	Charger/UPS rooms	150-200
14	Cooling tower	60
15	Switchyard (i) operating area	100
	(ii) other areas	50
16	Warehouse	100
17	Office	300
18	Compressor area	200
19	Watch room	100
20	Stairs	50
21	Corridors/lifts	70
22	Tube well, gate & watchman booth	100
23	Fire house, garage	100-150
24	Escape lighting	
	(a) Escape way (interior)	5
	(b) Areas at exit door and at points where there is potential hazard	30
Applicable to this particular installation		
25	Indirect Bath Heater Unit	60
26	Chemical Dosing Unit	60
27	Dehydrator Unit	60
28	Cooling Tower + Heat Exchanger	60
29	Effluent Treatment Plant with Oil Sludge Pit	60
30	Compressor House	200
31	Water Treatment Plant	60
32	Parking Area	30
33	Office & Admin Building	300
34	Control Room	400
35	Electrical Sub-Station	150-200
36	Captive Power Plant	60
37	Watch Tower	100
38	Security Building	100

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12.9 DGMS GUIDELINES FOR LIGHTING SYSTEM

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The oil and gas installations come under DGMS (OMR) jurisdiction; hence the lighting system shall be as per DGMS (OMR) requirements given below. [Oil Mines Regulations, 2017](#) state that the lighting systems installed in the mine shall comply with the provisions of the Indian CEA Regulation, 2010. Indian Electricity Rules indicate additional precautions to be adopted in mines and oil fields. Additional precautions for oil mines state that wherever electric lighting is used; the voltage between phases shall not exceed 250 V if the neutral of the system is connected with earth. Lighting system shall be maximum 250 volts, 3-phase, 3-wire system with lighting equipment connected between phases. It would also be essential to control all lighting through two-pole switches. In order to comply with the above statutory requirements, the lighting system for the installations in oil mines under the jurisdiction of DGMS shall be designed on the following basis:

- Phase to phase voltage in the lighting system shall be limited to maximum of 250 V.
- Lighting transformers shall be 415 / 240 V, three phase delta-star connected with neutral point of secondary connected to earth and taps of + 5 % and + 2.5 % on primary.
- Further distribution from lighting transformers to MLDB and LDBs shall be at a voltage of 240 V, 3-phase (3-wire system without neutral).
- All lighting distribution boards and lighting panels shall have three phase buses rated for 240 V, 3-phase and shall be without neutral bus.
- Outgoing circuits from lighting panels shall be controlled by 2 – pole MCBs. Earth leakage protection shall also provide isolation in both poles.
- All lighting fixtures and equipment's shall be connected between two phases at a voltage 240 V phase to phase.
- In case of lighting of building within the plant premises, double pole switches or 2-pole MCBs shall be used in the lighting circuits instead of conventional single pole switches.
- All 240 V, 1-phase sockets in plant area as well as in buildings shall also be connected between phases at a voltage of 240 V phase to phase and controlled by 2-pole MCBs or double pole switches.

13.0 EARTHING & LIGHTNING PROTECTION

Earthing system in general, shall cover the following:

- Equipment earthing, static charge earthing of vessel and earthing for personnel safety.
- System neutral earthing.
- Lightning protection using dissipation array technology for high buildings and storage tanks.

The earthing system envisaged an earthing network with designed number of earth electrodes attached to it. The following shall be earthed:

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- System neutral
- Current and potential transformer secondaries.
- Metallic non-current carrying parts of all electrical apparatus such as transformers, switchgears, motors, lighting/ power panels, cable trays, terminal boxes, etc.
- Steel structures
- Vessels and Storage tanks
- Cable shields

System Earthing

Each generator shall be grounded through Neutral Earthing Resistor with neutral contactor in the respective circuits. Lighting transformer neutrals shall be connected to earth grid.

Equipment Earthing

Earthing shall be carried out with GI electrodes and GI earthing strips as main earthing equipment. For equipment earthing, the following earthing schedule shall be followed.

Equipment Description	Conductor Size
Main Earthing Conductor	As Calculated
Gas Gen set Neutral	As Calculated
Switchgear and Panels-	As Calculated
Motors up to 3.7 KW	No. 8 SWG solid wire
Motors 5.5 KW to 37	GI Strip of suitable size
Motors 37 KW and above	25 x 5 mm strip
Building Columns	40 X 5 Strip
Storage Tank (Vertical & Horizontal)	40 X 5 Strip
Loading Racks	40 X 5 Strip
Pipe racks, Vessels & Heat Exchangers	25 x 3 mm strip
Small Equipment & Instruments	No. 8 SWG Solid
Lighting, Power & Instrument Panels	10 mm Wire
Push Button Stations	No. 8 SWG Solid Wire
Street Light Poles	10 mm Wire
Lighting Transformer	GI strip

All utility, process pipelines, vessels, tanks, manifolds and flanges shall be earthed on entering or leaving the hazardous areas, except where conflicting with the requirements of cathodic protection. In addition, steel pipe racks in the process units and offsite areas shall be earthed at every 25 meters. Equipment located remote from main earth network, may be earthed by means of individual earth conductors and earth electrodes.

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For sensitive electronic process equipment & PLC system, separate earth pit with copper plate electrodes & copper strips of suitable size shall be provided. Power system earth pits shall be isolated from electronic system earthing.

Lightning protection generally shall be provided for the equipment, structures and buildings, which are higher than 20 meters. Self-conducting structures shall not be provided with aerial rod and down conductors they shall be connected to the earthing system at two points of the base. An independent earthing network shall be provided for lightning protection and this shall be bonded with the main earthing network only at the buried electrode.

The resistance value of an earthing system to the general case of earth shall be as follows:

- For the electrical system and equipment, a value that ensures the operation of the protective device in the electrical circuit but not in excess of 1 ohm. However, for generating stations and large substations this value shall not be more than 1 ohm
- For lighting protection, the value of 5 ohms as earth resistance shall be desirable, but in no case it shall be more than 10 ohms.

The main earthing network shall be used for earthing of equipment to protect against static electricity.

Earth rods and conductors shall be designed to cope up with the conditions imposed. The earth conductor shall be adequately sized to carry the applicable maximum earth fault current without undue temperature rise. All joints shall be protected to prevent corrosion.

All the electrical equipment operating above 250 volts shall have two separate and distinct connections to earth grid.

Normally earthing system shall comprise of GI strip as main earth grid along with suitably located GI disconnecting plates to provide multiple earth connections between earth grid and equipment and for connections between main earth grid and electrodes.

Connections between GI earth electrode and the disconnecting plates shall be done by GI strip.

Connections between the disconnecting plate and various equipment shall be done by G1 wire or G1 wire rope.

In corrosive areas aluminum disconnecting plates along with suitably sized PVC insulated aluminum conductors' cables, may be used for earthing grid/ connections.

Lightning protection system shall be provided for equipment, structures, tankages, buildings etc. as per OISD Std.180 and IS/IEC 62305 with independent earthing system of earth resistance less than 5 ohms. Calculations for positioning of the air-terminations towards lightning protection in the installation shall be done utilizing the rolling sphere method as given in the IS/IEC 62305-3 & 4 with due approval from OIL.

13.1 EARTHING MATERIALS

The material for the earthing and lightning conductors will be as follows:

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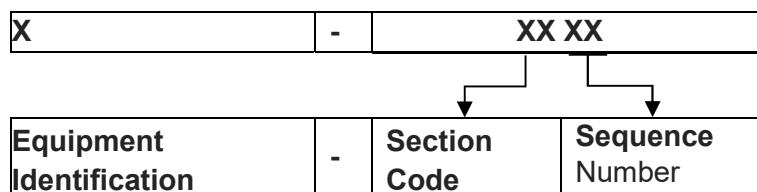
Sl. No.	Earthing Conductors	Material Used
a	Conductors above ground	Galvanized Iron (GI)
b	Conductors buried in ground	Galvanized Iron (GI)
c	Embedded in concrete /Floor slab	Galvanized Iron (GI)
d	Pipe electrodes for earth Pit (Maintenance free electrode)	50/70/100 mm dia Cu. Bonded low carbon or chemical filled earth electrodes
e	Lightning protection System For Horizontal / Vertical air terminations and down Conductors for buildings	Galvanized Iron (GI)

Design and installation of lightning protection shall be as per IEC-62305. However, DGMS & OISD requirements for lightning protection shall also be complied.

14.0 ELECTRICAL EQUIPMENT NUMBERING

14.1 EQUIPMENT NUMBERING

Tag numbering for equipment shall be given such that the information on location, type of equipment, area code is traceable as well as every equipment shall have unique number. In order to meet foresaid requirement equipment numbering shall be provided as follows:



Example:

PM	-	10	01

14.2 EQUIPMENT IDENTIFICATION

Typical list of Electrical equipment along with Identification Letter to be used for FGGS, Baghjan:

Equipment Identification	Equipment Description
PM	- Pump Motor
HE	- Electric Heater
KM	- Compressor Motor
BM	- Blower/ Fan Motor
VF	- Ventilation Fan
CSO	- Convenience Socket outlet

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ISO	- Instrumentation socket outlet
GG	- Generator Driven by Gas Engine
GD	- Generator Driven by Diesel Engine
PMCC	- Power Motor Control Center
EMCC	- Emergency Motor Control Center
ELTR	- Emergency Lighting Transformer
UCP	- Unit Control Panel
UPS	- Uninterruptable Power Supply
BC	- Battery Charger
BB	- Battery Bank
PDB	- Power Distribution Board
LDB	- Lighting Distribution Board
PDB	- Power Distribution Board
NLDB	- Normal Lighting Distribution Board
ELDB	- Emergency Lighting Distribution Board
LPBS	- Local Push Button Station
MPDB	- Main Power Distribution Board
MLDB	- Main Lighting Distribution Board
MELDB	- Main Emergency Lighting Distribution Board
NGR	- Neutral Ground Resistor
LTR	- Lighting Transformer
UPSD	- UPS Distribution Board
DCDB	- DC Distribution Board

14.3 SECTION CODE

This corresponds to a specific system in the facility/plant. Following sections are identified for the FGGS, Baghjan

Section code	Section Description
10	- HP & LP Gas KOD /Gas Dehydration
15	- Fuel Gas Conditioning
20	- Effluent Treatment Plant
25	- Instrument Air
30	- Power Generation
35	- Potable and Service Water
40	- Drain/ Closed Blow Down
45	- Chemical Injection

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50	-	Fire Water
55	-	Flare
60	-	Substation
65	-	Control Room / Office Building
70	-	Diesel Engine Generator Room
75	-	Security Room
80	-	Street Light Area/Car Parking Area
85	-	Watch Tower

Sequence Number: This corresponds to Equipment sequence number for the section normally between “00” to “99 “

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REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT
0	Issued for ITB	19-06-19	AW 	RD 	KPM 	
A	Issued for Review	14-03-19	AF	RD	KPM	

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1.0 INTRODUCTION

M/s OIL India Ltd (OIL) is a Navaratna Company under the Ministry of Petroleum and Natural Gas, Govt of India. As an integrated upstream company with pan India presence and overseas wings spreading over different parts of the globe, OIL is engaged in exploration, production and transportation of crude oil and natural gas and production of LPG with its headquarter at Duliajan, Assam. In line with OIL's strategy for balanced growth, an ambitious plan for development of non-associated gas fields is presently underway in OIL's Upper Assam operational area. As a part of this development scheme, OIL desires to construct a modular Field Gas Gathering Station (FGGS) for augmenting natural gas production facility at Baghjan field in Upper Assam, India.

Jayathe Petrotech Engineers and Consultants (JPEC) have been awarded the contract for Engineering and Project Management Consultancy for developing the engineering and managing project execution.

1.1 PROJECT OBJECTIVE

The Baghjan field is having huge amount of Non Associated Gas (NAG) potential and the expected gas production from this area in 7.5 MMSCMD. To explore these resources one modular Field Gas Gathering Station (FGGS) having the facilities for production of natural gas are to be created. The proposed FGGS shall have Non Associated Gas (NAG) processing facility for 5.0 MMSCMD (2 trains x 2.5 MMSCMD) and provision to feed Associated Gas (AG) of 0.5 MMSCMD along with the NAG to a Glycol based Dehydration facility (5.0 MMSCMD) for achieving water dew point less than or equal to (0) Zero Deg C. The facility shall include Production and Test Manifolds, Gas /Condensate/Water Separators, Gas Dehydration, Flare system and Effluent Treatment and disposal system along with all the required utilities and auxiliary systems. Space provision will be made within the plant to augment its capacity by installing one more train of 2.5 MMSCMD in future.

The entire plant will be modular in structure both in terms of layout and operation. All units are in pre-fabricated standard size containers. Piping shall be pre-fabricated in package supplier's facility and transported to the site. The skid fabrication at site should be minimized as low as possible by the package supplier. All the associated facilities of the package skid such as instrumentation, piping, valves, control system and electrical items etc., should not be fabricated at site.

2.0 SCOPE

This specification covers the general design requirements with respect to layout and detailed design of piping systems for Refinery and Petrochemical plants covered by ASME B31.3. These shall be adhered by Engineering / EPC contractor during the course of Engineering, Procurement & Construction.

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3.0 REFERENCE CODES & STANDARDS

The following codes and standards (Latest edition) shall be followed unless otherwise specified.

ASME B 31.3	-	Process Piping
ASME B 31.4	-	Pipeline Transportation Systems for Liquids and Slurries
ASME B 31.8	-	Gas Transmission and Distribution Piping Systems
ASME B 36.10	-	Welded and Seamless wrought steel pipe
ASME B 36.19	-	Stainless steel pipe
ASME B 16.34	-	Valves flanged, threaded and welding end
ASME B 16.5	-	Pipe Flanges and Flanged Fittings
ASME B 16.9	-	Factory Made Wrought Steel Butt welding Fittings
ASME B 16.10	-	Face to Face and End to End Dimensions for Valves
ASME B 16.11	-	Forged fittings, Socket welding and Threaded
ASME B 16.20	-	Metallic Gaskets for pipe flanges-Ring Joint, Spiral Wound and Jacketed
ASME B 16.48	-	Steel Line Blanks
ASME B 18.2.1	-	Square and Hex Bolts and Screws(Inch Series)
ASME B 18.2.2	-	Square and Hex Nuts (Inch series)
ASME B 1.20.1	-	Pipe Threads, General Purpose
ASME SECTION II	-	Material Specifications
ASME SECTION V	-	Non Destructive Examination
ASME SECTION VIII	-	Rules for construction of Pressure Vessels.
ASME SECTION IX	-	Qualification Standard For Welding, Brazing and Fusing Procedures; Welders; Brazers; and Welding, Brazing and Fusing Operators
API 598	-	Valve Inspection & Testing
API 600	-	Steel Gate Valves, Flanged and Butt welding Ends
API 610	-	Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Service.

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API 618	-	Reciprocating compressor for General Refinery
API 619	-	Rotary Compressors for Petroleum, Chemical and Gas Industry Service.
API 602	-	Compact Steel Gate Valves
API 607	-	Fire Test for Soft Seated Quarter turn valves
API 661	-	Air cooled heat exchanger.
API 6A	-	Specification for Wellhead and Christmas Tree equipment
API 6D	-	Specification for Pipeline valves
API RP 520	-	Sizing, Selection and Installation of Pressure Relieving Devices in Refineries
API RP 1104	-	Standard for Welding Pipelines and Related Facilities
API RP 1110 :	-	Pressure Testing of Liquid Petroleum Pipelines
API 6FA	-	Specification for Fire Test for Valves
BS EN ISO 15761	-	Steel Globe, Gate and Check Valves for sizes DN100 and smaller for the Petroleum and Natural Gas Industries (replaces BS 5352)
BS EN ISO 17292	-	Metal Ball Valves for Petroleum, Petrochemical and Allied Industries (replaces BS 5351)
BS 1873	-	Specification for Steel Globe, Globe stop and Check Valves
MSS SP 97	-	Integrally Reinforced Forged Branch Outlet Fittings
NACE MR 0175	-	Material Requirement - Sulfide Stress Cracking Resistant Material for Oilfield Equipment
OISD-118	-	Layouts for Oil and Gas Installations
EJMA	-	Expansion Joints Manufacturers' Association

4.0 DESIGN CRITERIA

4.1 Equipment Layout:-

4.1.1 Basis of Equipment Layout :-

Equipment layout shall be developed based on the following data:

- P& IDs / PFDs.
- Process / Equipment Data Sheets.
- Overall Plot Plan.
- Wind direction at site

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- Conceptual layout from Process
- Equipment Data sheets

4.1.2 Development of Equipment Layout :-

The following aspects shall be considered during the development of equipment layout:-

- a) Process Requirement-i.e. proper flow sequence between equipment as per P&IDs to achieve the intended process parameters.
- b) Economy of Piping material-Minimize the quantity of costly piping.
- c) Erection & Construction requirement:-Erection scheme and delivery schedule of all equipment must be considered during equipment layout to have smooth erection.
- d) Safety Requirements.
 - OMR'84 & OISD Std. 118 shall be followed.
 - Fire fighting facilities as per TAC & OISD/NFPA norms.
- e) Constructability, Operation and Maintenance Requirements.
 - Overhead and side clearances for pumps.
 - Provision of Heat Exchanger tube bundle pulling area.
 - Horizontal & overhead clearances for easy movement of working personnel.
 - Provision of monorail for pumps (and prime movers).
 - Provision of EOT/HOT crane for compressors.
- f) Similar equipment grouping – columns, exchangers, pumps etc. should be grouped together (in separate groups for similar equipments) for convenience of maintenance and safety wherever feasible.
- g) The technological structures should be interconnected for easy movement of operational personnel.

NOTE: Accessibility to pump/compressor shed for replacement of major Equipment in the form of approach road, adequate space for operation of Mobile cranes, vehicles and equipments to facilitate repair, replacement job is required.

4.1.3 Pipe-rack

In general, equipment layout shall be prepared considering straight pipe rack, however other shapes like L/T/U/H/Z etc can be considered based on area available.

The total width of pipe rack shall include 25% extra space initially to cater for the modifications in unit at later stages of design.

The width of the rack shall be 6M, 8M or 10M for single bay and 12M, 16M or 20M for double bay having 4 tiers maximum. The spacing between pipe rack portals shall be taken as 6M in general. However it can be increased to 8M depending on the size of the pumps to be housed below pipe rack.

- Clearance beneath pipe rack shall be 3M minimum.
- Road clearance shall be 7M minimum for main road and 5M for secondary road.

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- Flare lines shall be routed to highest level. Instrument and electrical cable trays shall be planned at the top tier with walkways.
- Water lines more than 30" shall not be routed on pipe rack, these shall be routed underground.

4.1.4 Tower and Vertical Vessels:-

Towers and vertical vessels shall preferably be arranged in a row with common centerline, decided by the largest vessels, placing O.D.of the equipment minimum 4M away from the pipe rack. A minimum clearance of 3M shall be allowed between tower shells, but in any case adjacent towers shall be checked so that platforms and foundations do not overlap (minimum 100mm gap shall be provided between platform of adjacent towers) and that a minimum 900mm is left between tower plinths. Also the gap between vertical vessels shall allow full opening of manhole covers without restriction. To handle heavy items (like relief valves, blinds etc.) a davit is usually needed. The davit shall be on the side of the vessel away from the rack. The area at grade shall be kept clear for dropout.

4.1.5 Horizontal Vessels:-

The horizontal vessels shall be laid perpendicular to pipe rack and shall be placed minimum 4M away from the pipe rack. The clearance between horizontal vessel shells shall be minimum 2M or 900mm clear aisle whichever is higher.

4.1.6 Pumps:-

Pumps shall be arranged in rows with the centerline of the discharge on a common line, whenever practicable. Pumps shall be kept outside the pipe rack. Gap between each pump base plate and columns of technical structure should be sufficient for easy access of equipment after piping. The foundation of pump shall not overlap the foundation of the technological structures/pipe rack. Clearance between two adjacent pumps shall be such that clear 900mm aisle is available. Wherever this is not feasible, common foundation for a pair of pumps may be considered with 300mm gap between two the base plates. However each pump is to be provided with proper access from at least one side.

All pumps not open to sky with motor rating $\geq 75\text{KW}$ shall be provided with monorail. No monorail should normally be provided for pumps outside rack and sufficient space below rack shall be available for maintenance.

4.1.7 Compressors and their Prime Movers:-

Two major types of compressors are used in process plants:-

- Centrifugal compressors
- Reciprocating compressors

Compressors shall be located to keep suction lines as short as possible. Drivers for

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compressor may be electric motor, gas engine, gas-fired turbine or steam turbines as per P&ID. The gas compressors shall be located downwind side of furnace so that leaks are not blown towards furnace. In general compressors are kept under shed, sides are fully open for the low shed or partially closed from top for high shed to avoid accumulation of heavier gases in the shed. For turbine driven compressor, if exhaust steam is condensed, turbine and compressor shall be located at an elevated level and condenser below turbine. A major consideration in centrifugal compressor location is the lube and seal oil console. It must be accessible from road and must be lower than the compressor to allow gravity drain of oil to the consoles oil tank. Inter-coolers shall be located in the shed near the compressor. Knockout pots and After Coolers may be located outside but near the compressor house.

4.1.8 Clearance and Accessibility:-

➤ Tube Bundle Pulling:-

All exchanger tube bundles shall be “jacked out” against shell. A clear space for tube bundle removal shall be provided. Dropout bay may be considered for exchangers at elevated structures.

➤ Access to Pumps:-

Clear access of 3M both vertically and horizontally shall be provided centrally under main pipe ways for small mobile equipment to service pumps, wherever these are put under pipe ways with prior specific approval. Pumps outside rack shall be approachable by small cranes etc. from under the pipe rack/from roadside as applicable.

➤ Access to Lower Items to Grade (Lowering Area):-

Clear access shall be provided at grade on the access side for lowering external and internal fittings from tall elevated equipment/structures by providing pipe davits/monorails/hoist as required.

➤ Layout & Access Requirements for Platforms Ladders and Stairs:-

For providing platform ladder & staircase following guidelines shall be followed:-

- Two means of access (i.e. two ladders or one ladder and one staircase) shall be provided at any elevated technological structure, which serves three or more vessels.
- Platforms, ladders and stairways shall be minimum, consistent with access and safety requirements.
- Stairways for tanks to be provided on upstream of predominant wind direction.

i. Platform at elevated structure:-

- a) Dual access (i.e. one staircase and one ladder) shall be provided at large elevated structure if any part of platform has more than 22.65M (75 ft) of travel.

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- b) For inter-connecting platforms between towers, consideration for expansion of towers should be taken care of.
- ii. Platforms with stair access shall be provided only for:-
 - a) Location at which normal monitoring is required or where samples are taken (once a day or more).
 - b) Locations where vessels or equipment items have operator attention such as compressors, heater, boilers etc.
- iii. Platforms with ladder access shall be provided for:-
 - a) Points which require occasional operating access including valves, spectacle blinds and motor operated valves, heater stack sampling points.
 - b) Man ways above grade on equipment.

➤ **Clearances:-**

Minimum clearances shall be as indicated in Annexure-E.

4.2 Unit Piping:-

4.2.1 Basis of Unit Piping:-

- Piping & Instrumentation Diagram
- Equipment Layout
- Equipment Data sheet & Setting plan
- Line list
- Instrument data sheet
- Structural & Building drawing
- Topography of the Plant
- Piping Material Specification
- Overall Plot Plan

The following objective shall be ascertained during piping layout:-

- Proper access to all operating points including valves, and for all orifice tapping points, safety relief valves and instruments in particular (refer Annexure-B).
- Proper access to inter related operating points for specific purpose and for maintenance.

4.2.2 Pipe Ways / Rack piping:-

- Predominantly process lines shall be at lower tier and, utility & hot process lines on upper tier.
- Generally the top tier is to be kept for instrument ducts & electrical cable trays (if located above ground). Necessary clearance for fireproofing of the structure shall be

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considered while locating cable trays. Racks shall be designed to give the piping shortest possible run and to provide clear head rooms over main walkways, secondary walkways and platforms.

- Generally the hot lines and cold lines shall be kept apart in different groups on a tier.
- Generally the bigger size lines shall be nearer to the column.
- Minimum spacing between adjacent lines shall be decided based on O.D. of bigger size flange (minimum rating 300# to be considered), O.D. of the smaller pipe, individual insulation thickness and additional 25 mm clearance, preferably. Even if flange is not appearing, the minimum spacing shall be determined as above.
- Actual line spacing, especially at 'L' bend and loop locations, shall take care of thermal expansion / thermal contraction / non-expansion of adjacent line. Non-expansion / thermal contraction may stop the free expansion of the adjacent line at 'L' bend location.
- Anchors on the racks are to be provided on the anchor bay if the concept of anchor bay is adopted. Otherwise anchors shall be distributed over two to three consecutive bays.
- Anchors shall be provided within unit on all hot lines leaving the unit.
- Process lines crossing units (within units or from unit to main pipe way) are normally provided with a block valve, spectacle blind and drain valve. Block valves are to be grouped and locations of block valves in vertical run of pipe are preferred. If the block valves have to be located in an overhead pipe way, staircase access to a platform above the lines shall be provided.
- All small-bore piping shall be designed in a way so as to ensure adequate supporting from adjacent large bore lines to minimize the requirement of intermediate beams in the pipe rack.

4.2.3 Vessel Piping / Control valves:-

- Piping from vessel shall preferably drop or rise upon leaving the nozzle and run parallel as close as practicable to column to facilitate supports from vessel.
- Piping shall be grouped as far as possible for the ease of supports and shall run on the rack side of the vessel.
- Manholes shall be kept on the road side of the vessel and approachable from the platform. Platform width shall be such that minimum 1M space is available beyond manhole for movement.
- Piping shall be supported from cleats welded on the vessels as far as possible. Supports from welded platforms need to be avoided as far as possible.
- Proper guides at intervals shall be provided for long vertical lines.

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- Access platforms/ladders shall be provided along the vessel for valves and instruments. Minimum width of platform shall be 750mm clear.
- For ease of operation and maintenance, vessels, which are grouped together, shall have their platforms at the same elevation interconnected by walkways. However each vessel shall have an independent access also.
- Vessel platforms should be designed in such a way that all the nozzles shall be approachable from platforms.
- Unless specifically indicated in P&IDs control valves shall preferably be kept at grade instead of platform.
- Piping support cleats for safety valve shall be independent & shall be designed considering impact loading during popping off.
- Davit cleat should not foul with nozzles / manhole opening.

4.2.4 Pump Piping:-

- Pump drives shall have clear access.
- Pump suction piping shall be as short as possible & shall be arranged with particular care to avoid vapour pockets.
- Reducers immediately connected to the pump suction shall be eccentric type flat side up to avoid the accumulation of gas pocket. For slurry lines reducers will have flat side bottom.
- For side suction pumps elbows shall not be directly connected to the suction flange. A straight piece minimum 3 times the line size shall be provided at the suction nozzle.
- Pump discharge check valve if installed in vertical lines shall be fitted with a drain connection as close as possible downstream of the valve.
- When a suction vessel operates under vacuum, the vent connection of the pump has to be permanently connected to vapour space of the suction vessel to allow possible filling of the pump with liquid before it is started.
- Unless otherwise specified T-type strainer shall be used on pump suction piping for sizes 2" & above.
- Y- type strainer to be used for all sizes in steam services and for pump suction lines 1 1/2" and below.
- All small-bore piping connected to pump (drain to OWS & CBD, seat and gland leak drain) shall have provision for break up flanges for removal of pumps.
- Piping shall be so arranged that forces and moments imposed on the pump nozzle do not exceed the allowable values.

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- Pump discharge should preferably be routed away from the pump rather than towards the motor side.
- Pump cooling water connection shall be taken from the top of circulating cooling water header.
- Pump suction and discharge block valves shall be located such that both the valves can be operated from the same place.
- Elevation of pump foundation should be decided in such a way that suction piping bottom should be 500mm above grade level. In case of jacketed pipe it shall be 600mm above grade level.

4.2.5 Compressor Piping:-

- Suction lines shall be as short as possible.
- Suction piping shall have adequate flanged joints for ease of erection and maintenance.
- Tube bundle removal space shall be provided for lube oil coolers.
- All operating valves on main suction and discharge piping shall be lined on one side as far as possible.
- A minimum straight length of suction pipe is to be provided as per manufacturer's recommendation.
- Piping shall be designed so that forces & moments imposed on the compressor do not exceed the manufacturer's recommendation.
- Compressor suction lines between the knockout drum and the compressor shall be as short as practicable.
- Where the line between knockout drum and the compressor cannot be routed without pocket, low point drain shall be provided to remove any possible accumulation of liquid.
- Low points in the discharge line from an air compressor shall be avoided because it is possible for lube oil to be trapped and subsequently ignited. If low points are unavoidable, they shall be provided with drains.
- In case of reciprocating compressor, piping shall be suitably supported to avoid vibrations due to pulsation flow. Unless specific requirements of no pocket is there from the licensor, all the piping shall run at 500mm above grade level so that supports can be provided from grade independent of structure to minimize vibrations. Analog study shall be carried out for complete compressor piping including suction / discharge piping as per P&IDs and the study recommendations if any, shall be implemented.

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- Independent supports from grade shall be provided for reciprocating compressor piping. Supports from compressor shed /platform structure shall be avoided.

4.2.6 Relief system / Blow down system piping:-

- Wherever the inlet line size is higher than the safety valve inlet size, reducer shall be installed adjacent to inlet of safety valve.
- Relief valve discharging steam, air or other non-flammable vapour or gas directly to atmosphere shall be equipped with drain and shall be suitably piped to prevent accumulation of liquid at valve outlet.
- Liquid-phase blow down system piping connected to a closed system shall be self-draining to the blow down drum. Closed blow down header shall be sloped towards the CBD drum to assure free drainage.
- Liquid vapour phase relief valves shall discharge into the flare header at an angle 45 degrees in the direction of header flow, to minimize the effect of kinetic energy and to avoid accumulation of liquid.
- Pockets in the flare header and blow down system shall be prohibited.
- Relief valve discharge piping to atmosphere shall be taken to safe location as per the following:
- Inlet and outlet piping of pressure relief valve shall be adequately supported to take care of the thrust induced by the relief valve during popping.
- Reaction forces including both momentum & static pressure effects due to safety valve popping shall be ascertained in the connected piping according to API RP 520 (part-II). The effect of these forces on the piping supports and the anchors of the piping system shall be calculated to ascertain that the allowable limits at these locations are not exceeded. The supporting structure also shall be adequately designed so that when subjected to these reaction forces the supporting elements connected to piping as well as the basic supporting structure i.e. structure members etc. are capable of withstanding them. System stresses in the inlet and outlet piping portions at safety valves also shall be kept within the allowable limits, inclusive of the distribution branching points in the inlet portions. These reactive forces shall not lead to any leakage at the flanged joints present in the system. To ascertain these, necessary calculations for checking leakage at the flanged joints shall be performed.
- Relief discharge valve position shall be as per OMR'84 & API RP 520.

4.2.7 Utility Stations:-

Requisite number of utility stations shall be provided throughout the unit for the utility requirement. Utility stations shall have two connections one for Plant Air (AP), and one for Service Water (WS) each of 1" unless otherwise specified in P & ID. Air and water

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lines shall have quick type hose connection. All connections shall be directed downwards. All connections shall have globe valve for isolation purpose or as per client requirement. Inert gas hose, when required, shall have built-in non- return valve in quick connection coupling of piping end.

Number of utility stations shall be such that the related equipments shall be approachable from at least one utility station. The reach of utility station shall be considered 15M all around the station location. The utility stations shall generally be located adjacent to pipe-rack column. The utility stations shall also be provided on elevated structures like technological structure, operating platforms of vertical equipments etc. Columns/towers shall be provided with utility service (air).

4.3 Flare Piping:-

Flare header shall be sloped towards flare knockout drum. Only horizontal loop shall be provided as per requirement to accommodate thermal expansion. The desired slope shall be ensured throughout including flat loop. Flare header shall be supported on shoe of height ranging from 100mm to 300mm.

Proper thermal analysis temperature shall be established including the possibility of temperature gradient along the line before providing expansion loops. Efforts shall be made to minimize the number of loops.

Flare line between knockout drum and water seal drum shall be designed for pressure fluctuations and adequately supported to avoid vibrations.

4.4 Flexibility Analysis and Supporting:-

4.4.1 Pipe supporting Criteria & General Guidelines:-

Piping System shall be properly supported taking into account the following points:-

- Load of bare pipe + fluid + insulation (if any).
- Load of bare pipe + water fill.
- Load of valves and online equipment and instruments.
- Thermal loads during operation.
- Steam-out condition, if applicable.
- Wind loads for large diameter piping at higher elevation, e.g. transfer lines, column over headlines, flare headers etc.
- Forced vibration due to pulsating flow.
- Vibration due to two-phase slug flow.
- Loads due to internal pressure.
- Any external loads / concentrated loads and cold loads of springs.

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Pipe supporting shall preferably follow the basic span as given in Annexure–A except for flare line in offsite on trestles, in which case the basic span shall preferably be restricted to maximum 18.0 meters. For sizes not covered in Annexure-A, basic span shall be established based on project requirement. For piping on rack or sleeper, as a minimum, providing resting support on every grid of pipe rack / sleeper is mandatory. Depending on the pipe size, as a rule, guides shall be provided on straight run of pipes at intervals as specified in Annexure–C, unless specifically becomes non-viable due to flexibility problems.

Additional supports, guides, anchors, special supports like spring supports and sway braces shall be provided after detailed analysis of piping system to restrict the forces experienced on nozzles of critical items like pumps, compressors, turbines, exchangers, air fin coolers etc. For lines which do not need any support otherwise but become unsupported by opening of flange, etc. during maintenance and thereby may transfer the total load on a small branch or other equipment nozzle, a permanent support shall suitably be provided which may be a spring support also.

Horizontal bare pipes of size 2" and above shall be provided with wear pad at support points.

Adequate care shall be taken for small (1½" and below) branch from piping. As a rule for all lines of 600# & above classes, with two phase or pulsating flow such as discharge of reciprocating compressors & reciprocating pumps, all small bore branches of size 1½" and below, e.g. vents, drains, orifice taps, pressure tapping, temperature trappings, sample connections, PSV inlet, TSV inlet and small bore line etc. shall be provided with 2 number stiffeners at 90° to each other from the main pipe to impart adequate stiffness to the branch connection. The stiffeners shall be made of 6mm thick flats of material equivalent to the pipe material. Further irrespective of line rating, the stiffeners shall be provided for all orifice taps, all small bore tapping from PSV inlet / outlet lines and all small bore tapping's from Control Valve manifolds. For pulsating flow lines, detailed thermal and vibration analysis by analog study shall be done to decide on location of anchor supports and guides etc. Wherever two-phase flow in piping is expected, piping design shall be checked by dynamic analysis to prevent vibrations.

Pipe support design shall be such that deflection in piping systems due to sustained loads shall not exceed 15mm (max.), in any case between two adjacent supports.

As far as possible long trunion types of supports (more than 0.5 M.) are to be avoided. In case long trunion support is unavoidable in straight length of pipe, trunion height is to be restricted to 0.5M and balance height to be made up by providing extended structure.

In the heaters, where steam air decoking is there, the main lines and the decoking lines should be supported in a way that either of the lines should not be in the hanging position while connected to other one.

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Piping passing near RCC/Steel column should have adequate clearance to avoid restriction of line movement during thermal expansion. The gap should take care of thermal expansion along with insulation thickness.

High-density PUF blocks shall be considered for cold piping supports. Use of wood blocks shall be minimized.

All pipe supports shall be so designed that there is no undue loading on equipment flanges.

4.4.2 Flexibility Analysis Criteria & General Guidelines:-

Piping shall be analysed for expansion, contraction, differential settlement, relief, valve reaction and effects mentioned in CL 3.2.6.

- The design of piping systems shall take into account the different conditions expected during operation, start up, shut-down, cold branch in case of stand by pump, tracing etc. Hydrocarbon lines shall be designed for steam-out conditions, if specified in line schedule.
- System where combination of different conditions is envisaged shall be analyzed for all possible combinations.
- The use of expansion joints shall be considered only when space or pressure drop limitation does not permit pipe bends. Expansion joint of axial type shall generally be avoided.
- Forces and moments due to weight, thermal loads and other imposed loads on the equipment nozzle must not exceed the allowed loads for the equipment. Refer JPEC specification for Stress analysis (FGGS-BJN-PIP-SPC-5010).
- In case of special requirement, surge effects (loads generated by overpressure in pipes due to water hammer effect) will be analyzed based on process data. An equivalent static stress analysis will be performed in which the force due to pressure surge will be applied at appropriate locations (changes of direction). Supports (piping supports and structures) will be designed to withstand these loads. Force spectrum dynamic analysis will be performed when high surge pressure fluctuations and high stress level or high loads on supports are obtained from the static stress analysis. Concerned lines will be identified on Piping Line List by Process Group.
- Pipe subjected to slug flow shall be identified by Process Group and indicated on Piping Line List. Slug force will be applied at changes of direction to determine stresses and pipe support loads. Supports (piping supports and structures) will be designed to withstand these loads. First natural frequency of such piping shall be kept in the range of 4 to 8 Hz.

4.4.3 Method of Analysis:-

Following lines shall be considered critical and shall mandatorily require formal analysis. Other lines may also need analysis, if required.

- All process lines to and from fired heaters and steam generators.
- All process lines to and from centrifugal compressors and blowers.

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- All lines to and from turbines.
- All pump lines (6" and above and analysis temp.>600C & less than - 600C).

All lines as below:-

4" to 6"	analysis temp.	above 300°C & less than -100°C
8" to 14"	analysis temp.	above 150°C & less than -80°C
16" & above	analysis temp.	above 80°C & less than -80°C

All other critical lines (connecting to sensitive equipments).

The software used shall be CAESAR II.

All lines shall be analyzed at operating / analysis temperature. In the absence of analysis temperature, lines may be analyzed at design temperature. However in case of wide difference in design and operating temperatures, the temperature for analysis shall be established based on consultation with the process department.(e.g. while doing the analysis of flare line or calculating expansion of long columns.)

All non-critical lines may be analyzed using other methods. Special analysis methods shall be followed for lines involving pulsating flow such as those connected to reciprocating pumps and compressors. Analog and mechanical vibration study of entire system along with piping /equipments will be entrusted to agencies with proven track record.

4.5 Materials:-

Basic material selection of particular line depending on its service temperature and corrosivity shall be spelt in process package.

For additional technical requirements refer Annexure–D.

4.6 Painting:-

4.6.1 Scope of Painting:-

4.6.2 The following surfaces and materials shall require painting:-

- All uninsulated C.S & A.S piping, fittings, valves, columns, vessels, drums, storage tanks, heat exchangers etc. including identification marks on insulated lines.
- Identification colour bands on all piping as required including insulated aluminium clad, galvanized, SS and non-ferrous piping.
- Pipes, fittings & valve surfaces under insulation of carbon steel and alloy steel insulated piping system.
- Pipes, fittings, valve surfaces under insulation of stainless steel insulated piping system.
- All structural steel works, supports, walkways, handrails and platforms.

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4.6.3 The following surfaces and materials shall not require painting:-

- Uninsulated austenitic stainless steel and higher alloy piping.
- Plastic and plastic coated materials.
- Non-ferrous material like aluminium galvanized steel, brass, bronze piping etc.

4.6.4 Colour Coding:-

All painting and colour coding shall be as per JPEC Specification (FGGS-BJN-PIP-SPC-5004), which is as per codes followed by OIL. For clarification reference code is IS: 2379.

4.6.5 Surface Preparation:-

All surfaces to be painted shall be blast cleaned either by air blasting or water blasting using steel grit to finish SA 2.5 as per SIS –055900 / ISO-8501-1. Only repair painting of shop primed piping shall be done with mechanical tools to surface finish ST-3 as per SIS-055900 / ISO- 8501-1.

4.6.6 Painting Application:-

- All blast surfaces shall be primed within four hours upon completion of blasting.
- No surface shall be coated in rain, wind or in environment where injurious airborne element exists, where surface temperature is below 50F above dew point, where relative humidity is greater than 90% and temperature is below 400F.
- No coat shall be applied unless the preceding coat is dried. Forced drying shall be avoided to avoid cracks, wrinkles and blister formation.
- Paint application shall follow the strict instruction of the paint manufacturer whose paint is being employed.
- All procedures from surface preparation to finish painting, including testing shall be well documented through a quality procedure approved by engineer-in-charge.

4.7 Welding:-

4.7.1 Applicable Codes & Standard:-

All welding works, equipments for welding , heat treatment , other auxiliary functions and the welding personnel shall meet the requirements of the latest editions of the following accepted standards and procedures.

a) Process Piping -ASME B 31.3

In addition, the following codes and specifications referred in the code of fabrication shall be followed for the welding specifications, consumable qualifications and non-destructive test procedures.

- i. Welding & Brazing Qualifications - ASME Sec.IX

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ii. Non-Destructive Examination –ASME Sec.V

iii. Material Specifications: Welding rods, electrodes and filler metals- ASME Sec II- Part C.

The additional requirements mentioned in this specification, over and above those obligatory as per codes, shall be followed wherever specified.

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ANNEXURE-A

Table of Basic Span
Part - I

Nom. Pipe Size (Inch)	SCH/ THK (Inch)	PIPE-VAPOUR INSULATION			PIPE-LIQUID INSULATION			BARE PIPE EMPTY		BARE PIPE WATERFILLED		Nom. Pipe Size (Inch)
		BASIC SPAN (L) M			BASIC SPAN (L) M			Up to 175°C		Up to 175 °C		
		Up to 175°C	176°C to 315°C	316°C to 400°C	Up to 175°C	176°C to 315°C	316 °C to 400°C	SPAN (L) M	Weight (kg/m)	SPAN (L) M	Weight (kg/m)	
¾"	SCH40	3.5	3.5	2.5	3.5	3.0	2.0		1.68	4.0	2.04	¾"
1"	SCH40	4.5	4.0	3.0	4.5	3.5	3.0	5.0	2.52	4.5	3.07	1"
1½"	SCH40	5.0	5.0	4.5	5.0	4.5	3.5	6.0	4.08	5.0	5.4	1½"
2"	SCH40	5.5	5.0	4.5	5.0	4.5	3.5	6.5	5.47	5.5	7.65	2"
2 ½"	SCH 40	6.5	6.0	5.0	6.0	5.5	4.5	7.5	8.7	6.5	11.79	2 ½"
3"	SCH40	7.5	6.5	5.5	6.5	6.0	5.0	8.0	11.35	6.5	16.15	3"
4"	SCH40	8.0	7.5	6.5	7.5	7.0	6.0	9.0	16.2	7.5	24.45	4"
6'	SCH40	10.0	9.5	8.5	9.0	8.0	7.5	10.5	28.3	9.0	46.7	6'
8"	SCH40	12.0	11.0	10.0	10.0	10.0	9.0	12.0	42.84	10.0	75.22	8"
10"	SCH40	13.5	13.0	12.0	11.5	10.5	10.5	14.0	60.74	11.5	111.9	10"
12"	3/8" w	14.5	13.5	13.0	12.0	11.5	11.0	15.0	74.40	12.0	147.5	12"
14"	3/8" w	15.0	14.5	13.5	12.0	12.0	11.5	16.0	82.5	12.5	172.05	14"
16"	3/8" w	16.0	15.5	14.5	13.0	12.5	12.0	17.0	94.5	13.0	213.15	16"
18"	3/8" w	17.0	16.5	15.0	13.5	13.0	12.0	18.0	106.5	13.5	258.3	18"
20"	3/8" w	18.0	17.5	16.0	14.0	13.5	12.5	19.0	118.5	14.0	307.5	20"
24"	3/8" w	20.0	19.0	17.5	14.5	14.5	13.0	21.0	142.5	15.0	418.2	24"

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Part- II

Nom. Pipe Size (Inch)	SCH / THK (Inch)	PIPE-VAPOUR INSULATION			PIPE-LIQUID INSULATION			BARE PIPE EMPTY		BARE PIPE WATERFILLED		Nom Pipe Size (Inch)
		BASIC	SPAN (L) M		BASIC	SPAN (L) M		Up to 175 °C		Up to 175°C		
		Up to 175°C	176°C to 315°C	316 °C to 400°C	Up to 175°C	176°C to 315°C	316°C to 400°C	SPAN (L) M	Weight kg /m)	SPAN (L) M	Weight (kg /m)	
¾”	SCH 80	3.5	3.5	2.5	3.5	3.0	2.0	4.5	2.20	4.0	2.49	¾”
1”	SCH 80	4.5	4.0	3.0	4.5	3.5	3.0	5.0	3.25	4.5	3.72	1”
1 ½”	SCH 80	5.0	5.0	4.5	5.0	4.5	4.0	6.0	5.45	5.0	6.60	1 ½”
2”	SCH 80	6.0	5.0	4.5	5.5	5.0	4.0	6.5	7.53	6.0	9.45	2”
2 ½”	SCH 80	6.5	6.0	5.5	6.0	6.0	5.0	7.5	11.49	6.5	14.25	2 ½”
3”	SCH 80	7.5	6.5	6.0	6.5	6.5	6.0	8.0	15.37	7.0	19.66	3”
4”	SCH 80	8.0	8.0	7.0	7.5	7.5	6.5	9.0	22.47	8.0	29.94	4”
6”	SCH 80	10.5	10.0	9.0	9.5	9.0	8.5	10.5	42.90	9.5	59.85	6”
8”	½” w	12.0	11.5	10.5	10.5	10.0	10.0	12.0	65.10	11. 0	94.8	8”
10”	½” w	13.5	13.0	12.0	11.5	11.5	10.5	14.0	82.20	12.0	130.69	10”
12”	½” w	14.5	13.5	13.0	12.5	12.0	11.5	15.0	98.13	13. 0	168.64	12”
14”	½” w	15.0	14.5	13.5	13.0	12.5	12.0	16.0	108.5	13. 5	194.4	14”
16”	½” w	16.0	15.5	15.0	13.5	13.0	13.0	17.0	124.2	14.0	240.0	16”
18”	½” w	17.5	17.0	16.0	14.5	14.0	13.5	18.0	140.25	14.5	286.64	18”
20”	½” w	18.0	17.5	17.0	15.0	14.5	14.0	19.0	157.5	15.0	341.8	20”
24”	½” w	20.0	19.0	18.5	16.0	15.0	15.0	21.0	188.25	16.0	458.44	24”

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Part- III

Nom. Pipe Size (Inches)	SCH/ THK (Inches)	PIPE-VAPOUR INSULATION			PIPE-LIQUID INSULATION			BARE PIPE EMPTY		BARE PIPE WATERFILLED	
		BASIC SPAN (L) M			BASIC SPAN (L) M			Up to 175°C		Up to 175°C	
		Up to 175°C	176°C to 315 °C	316°C to 400°C	Up to 175°C	176°C to 315°C	316°C to 400°C	SPAN (L) M	Weight(kg /m)	SPAN (L) M	Weight(kg /m)
1"	10 S	4.0	3.5	3.0	4.0	3.0	2.5	4.5	2.08	4.0	3.01
1 ½"	10 S	5.0	4.5	3.5	4.5	4.0	3.0	5.5	3.12	5.0	4.57
2"	10 S	5.0	4.5	3.5	4.5	4.0	3.0	6.0	3.94	5.5	6.33
2 ½"	10 S	6.5	5.5	4.0	5.5	5.0	4.5	7.0	5.26	6.0	8.85
3"	10 S	7.0	6.0	5.0	6.0	5.5	5.0	7.5	6.45	6.0	11.91
4"	10 S	7.5	7.0	6.0	6.5	6.0	6.0	8.0	8.34	7.0	17.67
6"	10 S	9.5	9.0	8.0	8.0	7.5	7.5	10.0	13.82	8.5	34.54
8"	10 S	11.0	10.5	10.0	9.5	9.5	8.5	11.5	19.94	10.0	55.5
10"	10 S	12.5	12.0	11.0	10.5	10.0	9.5	13.0	27.83	11.0	83.4
12"	10 S	14.0	13.0	12.0	11.0	11.0	10.0	14.5	36.00	11.5	114.6
14"	10 S	14.5	14.0	13.0	11.5	11.0	11.0	15.5	41.18	11.5	132.6
16"	10 S	16.5	14.5	14.0	12.0	11.5	11.5	16.5	47.33	12.5	172.2
18"	10 S	16.5	15.5	14.5	12.5	12.5	11.5	17.5	53.18	13.0	212.1
20"	10 S	17.5	16.5	15.5	13.0	13.0	12.0	18.5	68.50	13.0	264.5
24"	10 S	19.0	18.0	17.0	14.0	13.5	12.5	20.5	94.37	14.0	376.8

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ANNEXURE-B
Accessibility for valves and instruments

Valves, Instruments, equipment to be operated	Centerline of item to be operated, located less than 3.6 m above grade, less than 2.75 m above floor / platform or less than 1.8 m above wing platform	Centerline of item to be operated, located more than 3.6 m above grade, more than 2.75 m above floor/platform or more than 1.8m above wing platform
Exchanger heads	Nil	Platform
Manually Oper.Valves 2" & smaller	Fixed ladder	Fixed ladder
Manually Oper.Valves 3" & above	Platform	Platform
Motor operated valves	Platform	Platform
Control valves	Platform	Platform
Relief valves 2" & smaller	Fixed ladder	Fixed ladder
Relief valves 3" & above	Platform	Platform
Block valves 2" & smaller	Portable ladder	Platform
Block valves 3" & above	Platform (Note-1)	Platform (Note-1)
Battery limit valves	Platform	Platform
Pressure instruments	Fixed ladder if above 2.2m height	Fixed ladder
Temperature instruments	Fixed ladder if above 2.2m height	Fixed ladder
Sample points	Platform	Platform
Gauge glasses	Fixed ladder	Fixed ladder
Level controllers	Platform	Platform
Process blinds and spades 2" & smaller	Portable ladder / platform	Platform

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Process blinds and spades 3" & above	Platform	Platform
Man ways / manholes	Platform	Platform
Hand holes / inspection holes	Platform	Platform
Nozzles	No access required (Note-2)	No access required (Note-2)
Vessel vents	Portable ladder	Fixed ladder
Line drains & vents	Portable ladder	Portable ladder
Orifice flanges	Portable ladder	Portable ladder

Notes:-

1. Centerline of block valves located above 2.0 meter from the operating floor, which are required for normal operation, shall be provided with portable platform or chain for operation of valves.
2. Temporary arrangement for access should be feasible.

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ANNEXURE – C
Vertical and Horizontal Guide Spacing

Nom. Pipe size (Inches)	Guide spacing (in meters)	
	Horizontal (Note –2,3)	Vertical
1	12	5
1½	12	5
2	12	6
2 ½	12	6
3	12	6
4	18	6
6	18	8
8	18	8
10	18	10
12	24	10
14	24	12
16	30	12
18	30	14
20	36	14
24	36	16

Notes:-

1. The guide spacing given in the above table are indicative only.
2. The above spacing is valid for all lines unless otherwise specified by stress group.
3. For horizontal straight runs of pipe inside units, guide all 2" & below lines on every support & all lines 3" to 8" inclusive on alternative supports. Lines 10" & above need not be guided unless required by stress group.
4. These spacing may be varied to suit column spacing of rack.

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ANNEXURE – D

Technical Requirements of Piping Material

Ends:-

Unless otherwise specified, the end shall be to the following standard:-

SW / SCRD	;	ASME B16.11
BW	;	ASME B16.25
FLANGED	;	ASME B16.5 and ASME B 16.47 SERIES'B'
THREADING	;	ASME B1.20.1 (NPT, Taper threads)

Face Finish:-

This shall be to MSS-SP-6 / ASME B 46.1/ASME B 16.5. The interpretation shall be:-

Stock Finish	:	250 -1000 microns in AARH
Serrated Finish	:	125 - 250 microns in AARH
Smooth Finish / 125 AARH	:	63 - 125 microns in AARH
Extra Smooth Finish/ 63 AARH	:	32 - 63 microns in AARH

Austenitic Stainless Steel:-

All items / parts shall be supplied in solution-annealed condition.

- For all Austenitic Stainless Steels, Intergranular Corrosion (IGC) Test shall be conducted as per following:
 ASTM A262 Practice 'B' with acceptance criteria of 60 mils /year (max.) for casting.
 ASTM A262 Practice 'E' with acceptance criteria of 'No cracks as observed from '20 X Magnification' & microscopic structure to be observed from '250 X magnification' for other than casting.
- For IGC test, two sets shall be drawn from each solution annealing lot; one set corresponding to highest carbon content and other set corresponding to the highest rating / thickness.

ITEM SPECIFIC NOTES:-

Pipes:-

- Unless specifically exempted, welded pipes shall be acceptable only with longitudinal weld made employing automatic welding.
- Double seam 180 deg. apart is allowed for sizes 36" and larger only.

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- Galvanized Pipes shall be only Hot Dip galv. to ASTM A53.

Fittings:-

- All fittings shall be seamless in construction unless otherwise specified.
- For reducing BW fittings having different wall thickness at each end, the greater one shall be employed and the ends shall be matched to suit respective thickness.
- All welded fittings shall have maximum negative tolerance equivalent to pipe selected.
- All welded fittings shall be double welded. Inside weld projection shall not exceed 1.6mm, and the welds shall be ground smooth at least 25mm from the ends.
- For fittings made out of welded pipe, the pipe itself shall be of double welded type, employing automatic welding with the addition of filler material.
- All welded fittings shall be normalized for CS, normalized & tempered for AS, and 100% radio graphed for all welds made by fitting manufacturer as well as for welds on the parent material.
- Bevel ends of all BW fittings shall undergo 100% MP/DP test.

Flanges:-

- For Ring Joint Flanges, Blanks and Spacers, the hardness shall be as follows:-

Flange Material	Min. Hardness of Geove (BHN)
Carbon Steel	120
1 Cr to 5 Cr, ½ Mo	150
9 Cr, 1 Mo	215
Type 304, 316, 347	180
Type 304L, 316L	140

- For RTJ flanges, blinds & spacers, the hardness of the groove shall be specified on the test report.
- Bore of weld neck flange shall correspond to the inside diameter of pipe for specified schedule/thickness. Ends shall be beveled to suit the specified schedule/thickness.
- For RTJ flanges, only octagonal section ring joint flanges shall be used.

Valves:-

- Valves of class 900 & above shall be pressure-sealing type. Threaded and seal welded or welded bonnet may be employed up to sizes 1½".

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- All flanged valves (except forged) shall have flanges integral with the valve body.
- Valve Castings / Forgings purchased from India or Indian vendors shall be from approved foundries / forging shop.
- Yoke material shall be at least equal to body material.
- Forgings are acceptable in place of Castings but not vice-versa.
- No Cast Iron valves to be used in firewater or any other service except in drinking water service.

Valve Standards:-

Following API standard (Latest edition) for valve shall be applicable:-

- API 6D: Specification for Pipe line Valves (Gate, plug, Ball & check valves).
- API 6FA: Fire test for valves.
- API 598: Valve inspection & testing.
- API 600: Steel gate valve flanged and butt weld ends.
- API 602: compact carbon steel gate valve.
- API 607: Fire test for soft seated quarter turn valve.

Valve standards are also mentioned in 'Piping material specification' as well as 'Valve material specification' for this project.

Dimensions:-

Face-to-Face / End-to-End dimension shall be as per ASME B 16.10. In case the same is not covered under B16.10, the dimension shall be as per BS 2080 / Manufactures Std.

- Valve under cryogenic service (temp. below – 45°C) shall be as per BS6364 and shall be procured from prequalified vendor.

Operation:-

Generally the valves are hand wheel or lever operated. However, suitable gear operator in enclosed gear box shall be provided for valves as follows:-

VALVE TYPE	CLASS	FOR SIZES>=
GATE /GLOBE	150	12"
	300	12"
	600	10"
	900	6"
	1500	3"
	2500	3"

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Y GLOBE / STOP-CHECK	900	6"
	1500	3"
	2500	3"

BALL/PLUG (other than PBPV)	150	6"
	300	6"
	600	4"
	900	3"
	1500	3"
	2500	3"

BUTTERFLY	150	6"
	300	6"

- Hand wheel diameter shall not exceed 750mm and lever length shall not exceed 500mm on each side. Effort to operate shall not exceed 35 kgf at hand wheel periphery. However, failing to meet the above requirement, vendor shall offer gear operation.
- Quarter-turn valves shall have "open" position indicators with limit stops.

By Pass:-

- A globe type valve (size as per ASME / ANSI B 16.34) shall be provided as by-pass for the following sizes of gate valves:-

CLASS		SIZE
150	-	26" & above
300	-	16" & above
600	-	6" & above
900	-	4" & above
1500	-	4" & above
2500	-	3" & above

- By-pass Piping, Fitting and valves shall be of compatible material and design. Complete fillet welds for by-pass installation shall be DP / MP tested. NDT of by-pass valve shall be in line with main valve.

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Radiography of Cast Valves:-

The minimum requirement of radiography shall be as under:-

CLASS	SIZE	QTY.
150	26" & above	100%
300	18" & above	100%
600	All	100%
900 & Above	All	100%

Additional radiography requirement for casting sizes for special / critical piping classes [Over and above the requirements covered in clauses (a) above] shall be as follows:

I. For hydrogen / hydrogen bearing, oxygen, NACE, stress relieved amine services:-

CLASS	SIZE	QTY
150	Upto 24"	50%
300	Upto 16"	50%

II. For LT / CRYO services:-

CLASS	SIZE	QTY
150	Upto 24"	20%
300	Upto 16"	20%

III. For alloy steel & stainless steel castings [Not covered in para's a, b (i) & b (ii)]

CLASS	SIZE	QTY
150	Upto 24"	10%
300	Upto 16"	10%

- Radiography procedure, areas of casting to be radiographed, and the acceptance criteria shall be as per ASME / ANSI B 16.34.
- All casting in Class 300 & below shall be of radiographic quality. This requirement is to be ensured by sample radiography before proceeding with the actual production.

Ball/Plug/Butterfly Valves:-

Each valve shall be supplied with a lever / wrench except for gear operated / motor operated valves.

- Soft- seated Ball, Plug & Butterfly valves shall be supplied with antistatic devices.
- The ball of Ball valves shall not protrude outside the end flanges.

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- Ball valves shall be floating ball type/ trunion mounted type as per following:-

Class	Floating Ball	Trunion Mounted Ball
150	8" & Below	10" & Above
300	4" & Below	6" & Above
600 & Above	1½" & Below	2" & Above

- Use of soft-seated Ball/Plug/Butterfly valves shall be suitably selected based on temperatures handled.
- Butterfly valves shall be suitable for throttling application.

Strainer:-

- Allowable pressure drop when specified shall be certified by vendor along with the offer. If asked specifically, vendor shall furnish pressure drop calculations.
- All 2" & higher sized Y type strainers shall be provided with ¾" threaded tap and solid threaded plug as drain connection. For less than 2", this shall be ½" size.
- For fabricated strainers, all BW joints shall be fully radiographed and fillet welds shall be 100% DP / MP checked.
- All the strainers shall be hydrostatically tested at twice the design pressure, subject to flange rating limitations.

Traps:-

Vendor shall also furnish the performance curve indicating the capacity in mass/hour at various differential pressures across the trap.

- Parts subject to wear and tear shall be suitably hardened.
- Traps shall function in horizontal as well in vertical installation.
- Trap shall have integral strainers.
- All traps shall be hydrostatically tested to twice the design pressure.

Hoses:-

- Manufacturer shall guarantee suitability of hoses for the service and working conditions specified in the requisition, if the material is not specified in the Material Requisition for any particular service.
- All hoses shall be marked with service and working pressure as a minimum at both ends clearly.
- Hoses shall be resistant to ageing, abrasion and suitable for outdoor installations.

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- Complete hose assembly shall be tested at least two times the design pressure.

Expansion joints:-

- The applicable codes are ASME B 31.3 and EJMA (Expansion Joint Manufacturer's Association).
- Bellows shall be formed from solution annealed sheet conforming to the latest ASTM Spec. Any longitudinal weld shall be 100% radio graphed. The finished longitudinal weld must be of the same thickness and same surface finish as the parent material. Circumferential welds are not permitted. Bellows are to be hydraulically or expansion (punched) formed. Rolled formed bellows are not acceptable. Noticeable punch or die marks resulting from expansion operation are not acceptable.
- No repairs of any kind are allowed on the bellows after forming. Deep scratches and dents are not acceptable.
- The out of roundness shall be limited to + / -3mm. This is the max. Deviation between the max. & min. diameter.
- The actual circumference of the welding end shall be maintained to + / - 3mm of the theoretical circumference.

Apart from the usual requirements, the vendor shall also furnish:-

- Design calculations to justify stiffness and fatigue life.
- Axial, lateral stiffness, angular stiffness, effective pressure thrust area. Installation/ maintenance manual.

Supports & Spring Assemblies:-

- The Material, Design, Manufacture and Fabrication shall be generally as per MSS-SP-58 / MSS-SP-89 and / or BS 3974.
- Testing of springs shall be as per BS 1726.

Gaskets:-

- Asbestos filler for spiral wound gasket shall not be used.
- Full-face gaskets shall have bolt holes punched on it.

Non- metallic ring gaskets as per ASME / ANSI B16.21 shall match flanges to ASME / ANSI B16.5 upto 24", and ASME / ANSI B 16.47 or AWWA for sizes greater than 24' unless otherwise specified.

Spiral wound gaskets as per ASME B 16.20 shall match flanges to ASME / ANSI B 16.5 up to 24", and ASME B 16.47 series "B" for sizes >24" unless otherwise specified.

Inner rings requirements for spiral wound gaskets shall be as given below: Inner ring shall be provided for the following:-

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- As per code (B 16.20) requirement.
- For sizes 26" & above in all classes.
- For vacuum, cryo and hydrogen service.
- For SS 321, SS 347 and H-grade SS classes.
- For classes where temperature is higher than 427°C.
- For 900# rating and above classes.

In case of RTJ gaskets, only octagonal section ring gaskets shall be used and shall have proper marking stamped. Material certificate shall be available for the gasket. Hardness of RTJ gaskets shall be 20 BHN (min.) less than the corresponding flange groove hardness.

Stud, Bolts, Nuts and Jack Screws:-

- All bolting shall be as per ASME / ANSI B 18.2.1 for Studs, M/C Bolts and Jack Screws, and ASME/ ANSI B 18.2.2 for nuts.
- Threads shall be unified (UNC for ≤ 1" dia. and 8UN for > 1" dia.) as per ANSI B 1.1 with class 2A fit for studs, M/C Bolts and Jack Screws and class 2B fit for nuts.
- Stud bolts shall be full threaded full length with heavy hex nuts. Length tolerance shall be in accordance with the requirement of table F2 of Annexure F of ASME B 16.5.
- The nuts shall be double chamfered, semi-finished, heavy hexagonal type and shall be made by the hot forged process.
- The length of the studs / bolts should be such that minimum two threads should be out of the nut on either side.
- All the stud / bolt should have metallurgical certificates in case of alloy / SS metallurgy with identified colour marking at the stud ends / bolt side face.
- In corrosive atmosphere like acid chemical storage area, cooling towers area, where SS flanges are provided, fasteners should also be SS.
- Heads of jackscrews and M/C bolts shall be heavy hexagonal type. Jackscrew end shall be rounded.
- Wherever bolt tensioning is specified, stud bolt length shall be longer by minimum one diameter to suit bolt tensioner. Excess threads shall be protected by a threaded cap.

Special Service Requirements:-

NACE & Sour Service:-

- For items under this category, NACE MR-0175 and / or any other applicable standards shall also be followed. Hardness shall be below BHN 200 for C.S material. Carbon Equivalent (CE) shall be limited to 0.43.

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CRYO & Fire Safe:-

- For items to be used under cryogenic conditions, temperature below – 45°C and those required to be fire safe, special designs and tests would be applicable. Pre-qualification criteria need to be specified before execution of job.

Impact Tests:-

- Welded Pipes and Fittings used below temp. –29°C shall be impact tested as per requirement of ASME B31.3.

Hydrogen & other demanding services:-

- Vendor quality plan shall include the special quality checks and inspection requirements of these services.
- Impact Test and normalizing of CS/ AS materials shall be prescribed.

Inspection & Testing:-

- All items and their parts shall be subjected to all mandatory as well as supplementary (wherever specified) tests and checks called for in the respective codes/ standards / datasheets.
- All critical service valves shall be hydro tested at site for leak test before installation. All facilities for testing shall be arranged by the contractor.
- The examining personnel shall have the requisite qualification and experience.
- Client and its authorized representative reserve the right to vet and suggest changes in vendor's procedures.
- Vendor's works and facilities shall be accessible to the Client / Representative at all reasonable times.
- Test reports for all mandatory as well as supplementary tests wherever specified shall be furnished.
- All items of low alloy, alloy and exotic material shall be subjected to Positive Material Identification (PMI) Test before despatch as well as at site before fabrication / erection.

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ANNEXURE– E

Clearances

Overhead Clearances

Equipment, Structure, Platforms, Piping & its Supports shall be arranged to provide the following clearances overhead:-

1	Over rail tracks, top of rail to bottom of any obstruction	7 m
2	Over Plant roads for major mobile equipment	7 m
3	Over secondary roads (Bottom of pipe) access ways for mobile equipment	5 m
4	Over grade and bottom of pipe (inside battery limit)	3.0 m
5	Over walk-ways, pass-ways & platforms to nearest obstruction and inside building	2.2 m
6	Over Exchangers at Grade, shell cover channel end	1.5 m

Horizontal Clearances:-

1	Between Exchangers	0.9 m clear aisle or 2 m centre to centre whichever is higher
2	Around pumps (Aisles between piping)	0.9 m
3	Fired heaters to pumps handling flammable stock	16 m
4	Fired heaters to other flammable containing equipment not closely associated with heaters	16 m
5	At driver ends of pumps where truck access is required	3 m
6	At driver ends of pumps where truck access is not required	1.8 m
7	At shell cover end of exchangers at grade, for access way	1.3 m
8	Between shells of adjacent horizontal vessels	2.0 m or 0.9 m clear aisle whichever is higher

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Equipment Spacing:-

1	Small Pumps (3.7 KW & less)	Mount on common foundations with suitable centre to centre distance
2	Middle Pumps (22.5 KW & less)	900 mm clear Aisle beyond associated piping
3	Larger Pumps (Above 22.5 KW)	900 mm clear Aisle beyond associated piping
4	Exchangers and other equipments on structures	900 mm clear Aisle beyond associated piping

Platforms:-

TOWERS, VERTICAL & HORIZONTAL VESSELS:

1	Distance of platform below centerline of manhole flange-side platform	750mm – 1050mm
2	Width of manhole platform from manhole cover to outside edge of platform	1000mm
3	Platform extension beyond centerline of manhole-side platform	1000mm
4.	Distance of platform below underside of flange – head platform	175mm
5.	Width of platform from three sides of manhole-head platform	750mm

Horizontal Exchanger:-

1	Clearance in front channel or Bonnet flange	1300mm
2.	Heat exchanger tube bundle removal space	Bundle length+1.5 m
3	Min. clearance from end of flanges	100mm

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Vertical Exchanger:-

1	Distance of platform below top flange of channel on bonnet	1500mm

Furnaces:-

1	Width of the platform at side of horizontal and vertical tube furnace	2000mm (min.)
2.	Width of the platform at ends of horizontal tube furnace	2000mm (min.)

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MECHANICAL DESIGN BASIS

0	Issued for ITB	01-07-19	RS	SN	CK	
A	Issued for Review/ Approval	14-03-19	RS	SN	CK	
REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

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1.0 INTRODUCTION

M/s OIL India Ltd (OIL) is a Navaratna Company under the Ministry of Petroleum and Natural Gas, Govt of India. As an integrated upstream company with pan India presence and overseas wings spreading over different parts of the globe, OIL is engaged in exploration, production and transportation of crude oil and natural gas and production of LPG with its headquarter at Duliajan, Assam. In line with OIL's strategy for balanced growth, an ambitious plan for development of non-associated gas fields is presently underway in OIL's Upper Assam operational area. As a part of this development scheme, OIL desires to construct a modular Field Gas Gathering Station (FGGS) for augmenting natural gas production facility at Baghjan field in Upper Assam, India.

Jayathe Petrotech Engineers and Consultants (JPEC) has been awarded the contract for Engineering and Project Management Consultancy for developing the engineering and managing project execution.

1.1 PROJECT OBJECTIVE

The Baghjan field is having huge amount of Non-Associated Gas (NAG) potential and the expected gas production from this area in 7.5 MMSCMD. To explore these resources one modular Field Gas Gathering Station (FGGS) having the facilities for production of natural gas is to be created. The proposed FGGS shall have Non-Associated Gas (NAG) processing facility for 5.0 MMSCMD (2 trains x 2.5 MMSCMD) and provision to feed Associated Gas (AG) of 0.5 MMSCMD along with the NAG to a Glycol based Dehydration facility (5.0 MMSCMD) for achieving water dew point less than or equal to (0) Zero Deg C. The facility shall include Production and Test Manifolds, Gas /Condensate/Water Separators, Gas Dehydration, Flare system and Effluent Treatment and disposal system along with all the required utilities and auxiliary systems. Space provision will be made within the plant to augment its capacity by installing one more train of 2.5 MMSCMD in future.

2.0 PURPOSE

This document describes basis of design for the mechanical equipment for the Field Gas Gathering Station at Baghjan, Upper Assam. This design basis along with the Codes & Standards mentioned herein and the Project specifications defines the minimum requirement for the design of the Static Equipment, Rotating Equipment, and Packaged Equipment associated with the Project.

3.0 CODES & STANDARDS

The design, manufacture, inspection, testing and supply of equipment shall as a minimum comply with the requirements specified in the following International Codes, Standards and Practices as amended/supplemented by Project Specifications/ Standards.

Table 3.1 Codes and Standards

ASME CODES	TITLE
ASME B1.1	Unified Inch Screw Threads
ASME B16.5	Pipe Flanges and Flanged Fittings NPS ½ Through NPS 24

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ASME B 16.9	Factory Made Wrought Steel Butt Welding Fittings
ASME B 16.20	Metallic Gaskets for Pipe Flanges Ring-Joint, Spiral-Wound and Jacketed
ASME B 16.21	Non-metallic Flat Gaskets for Pipe Flanges
ASME B 16.25	Butt Welding Ends
ASME B16.47	Large Diameter Steel Flanges NPS 26 Through NPS 60
ASME SEC II PART A, B, C, D	Boiler and Pressure Vessel Code – Material Specifications and Properties
ASME SEC V	Non-Destructive Examination
ASME SECT VIII, DIV 1	Boiler and Pressure Vessel Code – Rules for Construction of Pressure Vessels
ASME SECT VIII, DIV 2	Boiler and Pressure Vessel Code – Alternative Rules for Construction of Pressure Vessels
ASME SEC IX	Welding, Brazing and Fusing Qualifications
API CODES / STANDARDS	TITLE
API 12 F	Specification for Shop Welded Storage Tanks for Storage of Production Liquids
API 12 J	Specification for Oil and Gas Separators
API 12 K	Specification for Indirect Type Oil-field Heaters
API 500	Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2
API STD 520, PART 1	Sizing, Selection, and Installation of Pressure-Relieving Devices—Part I—Sizing and Selection
API RP 520, PART 2	Sizing, Selection, and Installation of Pressure-Relieving Devices—Part II—Installation
API 521	Pressure – Relieving and Depressuring Systems
API 526	Flanged Steel Pressure-Relief Valves
API 537	Flare Details for Petroleum, Petrochemical, and Natural Gas Industries
API 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
API 620	Design and Construction of Large, Welded, Low-Pressure Storage Tanks
API 650	Welded Tanks for Oil Storage
API 660	Shell-and-Tube Heat Exchangers
API 661	Air-Cooled Heat Exchangers for General Refinery Service
API 662 / ISO 15547 PART 1	Plate Heat Exchangers for General Refinery Services – Part 1: Plate and Frame Heat Exchangers
API 670	Machinery Protection System
API 671	Special-Purpose Couplings for Petroleum, Chemical and Gas Industry Services
API 674	Positive Displacement Pumps- Reciprocating

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API 675	Positive Displacement Pumps- Controlled Volume for Petroleum, Chemical and Gas Industry Services
API 676	Positive Displacement Pumps- Rotary
API 682	Shaft Sealing Systems for Centrifugal and Rotary Pumps
API 2000	Venting Atmospheric and Low-Pressure Storage Tanks

OTHER STANDARDS	TITLE
ANSI/ASME B73.1	Specification for Horizontal End Suction Centrifugal Pumps
ANSI/ASME B73.2	Specification for Vertical In-Line Centrifugal Pumps
AWS D1.1	Structural Welding Code — Steel
BS 3692	ISO Metric Precision Hexagon Bolts, Screws and Nuts – Specification
BS 4190	ISO Metric Black Hexagon Bolts, Screws and Nuts – Specification
BS 4320	Specification for Metal Washers for General Engineering Purposes Metric Series
BS: 5514/ ISO: 3046	Gas/Diesel Engine
IS 875	Code of Practice for Design loads (Other than earthquake) for Building & structures
IS 1893	Criteria for Earthquake Resistant Design of Structures.
IS 10000	Methods of Tests for Internal Combustion Engines
IS 12065	Permissible Limits of Noise Level for Rotating Electrical Machines
IS 12469	Specification for Pumps for Fire Fighting System
ISO 281	Rolling Bearings-Dynamic Load Ratings and Rating Life
ISO 1940-1	Mechanical Vibration- Balance Quality Requirements for Rotors In a Constant (Rigid) State- Part 1: Specification and Verification of Balance Tolerances
ISO-2954	Mechanical Vibration of Rotating and Reciprocating Machinery - Requirements for Instruments for Measuring Vibration Severity
ISO 5199	Technical Specification for Centrifugal Pumps
ISO 9000	Quality Management Systems - Fundamentals and Vocabulary
ISO 9001	Quality Management Systems – Requirements
ISO 9004	Quality Management Systems - Guidelines for Performance Improvements

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ISO 10474	Steel and Steel Products — Inspection Documents
ISO 14847	Rotary Positive Displacement Pumps- Technical Requirements
NFPA 20	Installation of Stationary Pumps for Fire Protection
NFPA 22	Standard for Water Tanks for Private Fire Protection
OISD 116	Fire protection Facilities for Petroleum Refineries & Oil/Gas Processing Plants
OISD 118	Layouts for Oil and Gas Installations
OISD 119	Selection, Operation and Maintenance of Pumps
OISD 120	Selection, Operation and Maintenance of Compressors
OISD 125	Inspection and Maintenance of Mechanical Seals
PD 5500	Specification for Unfired Fusion Welded Pressure Vessels
TEMA	Standards of the Tubular Exchanger Manufacturers Association
WRC BULLETIN 107 (537)	Local Stresses in Spherical and Cylindrical Shells due to External Loadings
WRC BULLETIN 297	Local Stresses in Cylindrical Shells due to External Loadings on Nozzles- Supplement to WRC Bulletin No. 107

Table 3.2 Project Specifications

PROJECT SPECIFICATIONS	TITLE
FGGS-BJN-MEQ-SPC-4007	Equipment Noise Level
FGGS-BJN-MEQ-SPC-4009	Specification for Storage Tanks
FGGS-BJN-MEQ-SPC-4012	Specification for Pressure Vessels
FGGS-BJN-MEQ-SPC-4017	Specification for Centrifugal Pumps
FGGS-BJN-PIP-SPC-5004	Specification for Painting
FGGS-BJN-PIP-SPC-5009	Specification for Hot Insulation
FGGS-BJN-PIP-SPC-5010	Piping Stress Analysis Guide
FGGS-BJN-ELC-SPC-6005	Specification for Electrical Motors Rated Up to 200kW
FGGS-BJN-ELC-SPC-6011	Specification for Hazardous Area Classification
FGGS-BJN-INT-DBM-7000	Instrumentation Design Basis
FGGS-BJN-CIV-DBM-8000	Architecture/Civil/Structural Design Basis

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4.0 ABBREVIATIONS / DEFINITIONS

4.1 ABBREVIATIONS

Table 4.1.1 Abbreviations

ABBREVIATIONS	DESCRIPTION
ANSI	American National Standards Institute
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BJN	Baghjan
CPCB	Central Pollution Control Board
DB	Design Basis
EPCC	Engineering, Procurement, Construction and Commissioning
FGGS	Field Gas Gathering Station
F&G	Fire & Gas
FRP	Fiberglass Reinforced Plastic
JPEC	Jayathe Petrotech Engineers and Consultants Pvt Ltd
KCAL	Kilo Calories
KOD	Knockout Drum
LPG	Liquefied Petroleum Gas
MH	Manhole
NFPA	National Fire Protection Association
NPS	Nominal Pipe Size
NPSHA	Net Positive Suction Head -Available
NPSHR	Net Positive Suction Head -Required
OEM	Original Equipment Manufacturer
OISD	Oil Industry Safety Directorate

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ABBREVIATIONS	DESCRIPTION
PFD	Process Flow Diagram
P&ID	Piping and Instrumentation Diagram
WN	Weld neck
WRC	Welding Research Council

4.2 DEFINITIONS

Table 4.2.1 Definitions

NOMENCLATURE	DESCRIPTION
Company	Oil India Limited (OIL)
Consultant	Jayathe Petrotech Engineers & Consultants (JPEC)
Project	Field Gas Gathering Station, Baghjan (FGGS-BJN)
Vendor/Manufacturer/Supplier	The person, firm, Company or Corporation including their assignees who supplies the equipment/materials required for the project
EPC	Engineering, Procurement & Construction
Shall	Indicates mandatory requirements
Should	Indicates strong recommendations to comply with the requirements of this document

5.0 GENERAL DESIGN REQUIREMENTS

a) Specific design requirements pertaining to individual equipment are identified in individual equipment specifications/ data sheets. The following general considerations are to define engineering aspects to be built into the design and procurement engineering activities:

- ◆ Reliability in Service.

Assessment from Supplier's experience list and industry feedback for operation reliability and suitability of offered model / package for required duty conditions.

- ◆ Compliance with OISD, National and International Rules, Regulations, Codes & Standards.

- ◆ Equipment Maintenance:

Adaptability of maintenance features for ensuring safety, operation and maintenance ease and higher availability of equipment.

- ◆ Standardisation of Components, where feasible.

- ◆ Equipment / Package suitability for facility Layouts.

b) Design pressure shall be as defined in the respective datasheet.

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- c) The metric system of measurement shall be used in all supplier's drawing and calculation notes, except for pipe and pipe fitting sizes, flange ratings and nozzle dimensions.
- d) The supplier's drawings shall be submitted to Company/ Consultant for review. Company/ Consultant's approval is restricted to the general characteristics of the design and to the main dimensions. As a general rule, supplier's drawing shall incorporate any information or data indicated in Company/ Consultant's datasheet / drawings. Company/ Consultant's comment /approval does not absolve Supplier of meeting all the Purchase Order requirement.
- e) The supplier is fully responsible for design and fabrication of the equipment in accordance with the relevant code and standards.
- f) The supplier shall provide specific procedures for the shipping, lifting, storage and erection of equipment in order to maintain the mechanical guarantees as required in the purchase order.
- g) Modular design: All the equipment, to the extent feasible, shall be designed and supplied as pre-fabricated skids sized to enable transportation to site in standard sized containers. The skids assembly shall be complete with all associated facilities such as piping, fittings, valves, instrumentation and controls, electrical items, cabling up to the skid edge junction box, etc.

5.1 DESIGN LIFE

Design service life for the Mechanical Equipment and packages shall be 30 years.

5.2 SITE DATA

Design ambient temperature Maximum, °C	40
Design ambient temperature Minimum, °C	7
Dry bulb temperature Maximum, °C	36
Dry bulb temperature Minimum, °C	8
Average Rainfall (in full monsoon)	194.2 cm
Average Rainfall (in 24 hours)	15.9 cm
Wind velocity at 10m height	50 m/s
Maximum relative humidity	93%

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6.0 LOADS COMBINATION

6.1 EQUIPMENT STABILITY

Unless otherwise specified, the stability of all vessels (including columns, reactors, horizontal / vertical drums, air coolers and other heat exchangers) and their supports shall be checked under the following combinations of loads: (☒: Applicable).

	Pressure	Temp	Weight (2)	Wind (1)	Earthquake (1)	Scaffolding
Erection (uncorroded)	☐	T_{amb}	☒	☒	☒	☒
Normal operation (corroded)	P_{Design}	T_{Design}	☒	☒	☒	☐
Hydrostatic Test (3)	P_{Test}	T_{amb}	☒	30 %	☐	☒
Shutdown condition (corroded)	☐	T_{Design}	☒	☒	☒	☐
Lifting (uncorroded)	☐	T_{amb}	☒	☐	☐	☐

1) Whichever is greater (wind and earthquake shall not act simultaneously).

2) Refer to weight combinations below.

3) For vertical vessels, calculation shall be performed for horizontal and vertical positions.

The following weights combination shall be used:

- ♦ Erection: Vessel complete with platforms, ladders, attached piping, all welded internals, insulation and fireproofing without any removable internal; atmospheric pressure and ambient temperature.
- ♦ Normal Operation: Vessel complete with platforms, ladders, attached piping, insulation, fireproofing, all internals and liquid at maximum operating levels, at design pressures (or vacuum) and temperatures.
- ♦ Shut down: Same as normal operation except no pressure and no liquid in vessel.
- ♦ Hydrostatic test: Vessel full of water including all attachment at test pressure and ambient temperature.
- ♦ Lifting: Vessel complete without any removable internals, platforms, ladders, attached piping, insulation and fireproofing, atmospheric pressure and ambient temperature.

6.1.1 For horizontal equipment, the stresses induced by the supports on the shell shall be checked in accordance with the applicable Codes. In case the Codes do not cover this calculation the L.P. Zick method in PD 5500 shall be applied.

6.1.2 The thickness of cladding and weld deposit shall not be considered in any of stability calculation.

6.1.3 The thickness added as Corrosion Allowance shall not be considered in the stability calculation under the following condition:

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- ◆ Normal Operation.
- ◆ Shut-Down.
- ◆ Hydrostatic Test (when made in operating position to allow further Hydrostatic Test during the life of the vessels).

6.1.4 Vertical vessels with H/D ratios exceeding 15, where H is the height of the vessel from the point of support to the top tangent line and D is the average diameter in the top third of the vessel, shall be checked for vortex shedding vibrations from wind to insure structural stability.

6.1.5 For columns having trays the maximum allowable top deflection shall not be greater than 1/200 of the total height unless otherwise required.

6.1.6 Under hydrostatic test condition, the main induced stresses shall not be greater than 90% of the specified minimum yield strength of the materials.

6.2 DEAD AND LIVE EXTERNAL LOADS DEFINITION

6.2.1 Under all conditions, the calculated weight of the equipment shall be based on using the uncorroded thicknesses and including cladding.

6.2.2 Wind and earthquake loadings, whichever is greater shall be considered for calculation. Wind and earthquake loadings shall not to be considered to act simultaneously.

6.2.3 Under hydrostatic test condition, 30% of the wind pressure shall be considered. No earthquake load shall be taken into account.

6.2.4 The total moment due to wind and earthquake shall be increased to consider the eccentric loads from overhead vapor line and heavy equipment attached to the vessel.

6.2.5 Calculation of wind exposed surface and weights

The following components shall be taken into account for wind and earthquake design.

a) Platforms

- ◆ Solid wall with 1 m height and L width (L is 1700mm, unless otherwise specified):
- ◆ Angle < 120°: projected area = (1.0 x L) m²
- ◆ Angle ≥ 120°: projected area = 2 x (1.0 x L) m²
- ◆ Head platform: projected area = ((2 x 1.0 x L) + vessel diameter) m² (L is 1400mm, unless otherwise specified)
- ◆ Estimated weight of platforms shall also be considered, based on 250 kg/m²

b) Ladders

- ◆ Solid wall with 330mm width, length of 8m, applied at all the 8m from base plan
- ◆ Estimated weight of ladders, based on 40 kg/m shall also be considered

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c) Fireproofing

- ◆ Projected area = (2 x Thickness x Section height)
- ◆ The fireproofing thickness is 50 mm, unless otherwise specified
- ◆ Estimated weight of fireproofing, based on 160 kg/m² (equivalent to 3200 kg/m³ for 50 mm thick) shall also be considered

d) Insulation and insulation supports

- ◆ Projected area = (2 x Thickness x Section height); insulation thickness is specified on vessel data sheet.
- ◆ Insulation thickness shall be determined according to insulation specification.
- ◆ Estimated weight of insulation supports is 2.42 kg x circumference of vessel (m) at each 2.85 m. The weight of insulation shall also be considered.

e) Piping

- ◆ Head line is taken into account. The load is applied 1 m below the upper tangent line (it is assumed that the line is connected to the vessel at this point)
 - Projected area = piping outside diameter x (vessel height with skirt – 10 meter)
 - Thickness and weight of insulation (if any) shall also be considered
- ◆ Other nozzles with piping

Weight due to piping (insulation included, if any) shall be considered. The load is applied 1 m below the nozzle level, length to be considered is up to the base of vessel plus 1 m.

6.2.6 The equipment and relevant lifting accessories such as tailing lugs, trunnions and lifting lugs shall be designed to withstand the equipment lifting weight considering a dynamic factor of 2.

The design shall be performed considering the equipment in horizontal and vertical position. The lifting weight is defined as shop weight plus insulation, ladders, platforms, main pipelines and trays. The internal packing is excluded in lifting weight.

7.0 SHELL AND TUBE HEAT EXCHANGERS

7.1 FIXED TUBE SHEET DESIGN CONDITIONS

In addition to the design conditions, if the controlling condition is not specified on exchanger data sheets/drawings, the following operating conditions shall be considered:

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Condition	Shell Pressure	Shell Metal Temp.	Tube Pressure.	Tube Metal Temp.
Shell start up	P Design Shell	T Shell in	0 or FV	T Shell in
Tube start up	0 or FV	T Ambient	P Design Tube	T Tube in
Normal operation	P Design Shell	(T Shell In + T Shell Out)/2	P Design Tube	(T Shell In +T Shell Out +T Tube In +T Tube Out)/4
Shell shut down	0 or FV	(T Shell In + T Shell Out)/2	P Design Tube	(T Shell In +T Shell Out +T Tube In +T Tube Out)/4
Tube shut down	P Design Shell	(T Shell In + T Shell Out)/2	0 or FV	(T Shell In +T Shell Out +T Tube In +T Tube Out)/4

$T_{\text{Shell In}} / T_{\text{Shell Out}}$

Inlet/ outlet shell side operating temperature

$T_{\text{Tube In}} / T_{\text{Tube Out}}$

Inlet/ outlet tube side operating temperature

T_{Ambient}

Ambient temperature

FV

Full vacuum –only when specified by datasheet

$P_{\text{Design Tube}}$

Design pressure on tube side

$P_{\text{Design Shell}}$

Design pressure on shell side

- ♦ If required by the equipment data sheet, any other special condition, such as steam out, shall also be considered.

8.0 EXTERNAL LOADS AND CLIMATIC CONDITIONS

8.1 WIND LOAD

Wind loads shall be as per IS: 875 (Part 3)

Design wind pressure P_z in N/m^2 at height “z” shall be calculated as follows

$$P_z = 0.6 \times V_z^2 \text{ (IS: 875, Clause 5.4) (Part – 3),}$$

Where,

$$V_z = \text{design wind velocity in m/s at height “z”}$$

$$= V_b \times k_1 \times k_2 \times k_3 \text{ (IS: 875, Clause 5.3) (Part – 3),}$$

Where, V_b = Basic wind speed = 50 m / sec As per IS: 875, (Part 3)

k_1 = Risk coefficient

k_2 = Terrain, height and structure size factor

k_3 = Topography factor

The values of coefficients k_1 , and k_3 (as in IS: 875, Part 3) shall be as given below:

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STRUCTURE	k1	k3
Process Columns, Stacks and Stack like structures	1.08	1

Design wind pressure at different heights for terrain category 2 are as given below:

H (m)	k2 Category 2		
	Class A	Class B	Class C
10 or less	1.00	0.98	0.93
15	1.05	1.02	0.97
20	1.07	1.05	1.00
30	1.12	1.10	1.04
50	1.17	1.15	1.10
100	1.24	1.22	1.17

A force coefficient (Cf) of 0.7 shall be followed for stacks and stack like structures.

To allow for surface area of piping, platforms and other attachments fixed to the equipment, the surface area exposed to the wind shall be increased as defined in section 6.2.

Total Wind Load (F) on the equipment shall be
 $F = C_f \times A_e \times P_d$ (As per Clause No. 6.3 of IS:875, Part-3)
 Where,
 C_f = Force coefficient (As specified above)
 A_e = Effective area of the object normal to the wind direction
 P_d = Design wind pressure

8.2 EARTHQUAKE LOAD

Seismic forces shall be evaluated as per IS: 1893(latest), Zone V

Wind and seismic forces shall not be considered to act simultaneously.

8.3 LOCAL LOADS

Unless otherwise specified, all forces and moments act on the intersection of the axis with the mid-thickness of the shell or head plates.

8.3.1 PRESSURE EQUIPMENT

Local stress in vessel wall resulting from nozzles or attachment loads shall be determined by applying one of the following methods:

- ♦ WRC Bulletins 107 (537) and 297. The resulting stresses shall be evaluated using the allowable stress criteria of Part 5 of ASME Code, Section VIII, Division 2.
- ♦ Finite Element Analysis (FEA). The resulting stresses shall be evaluated using the allowable stress criteria of Part 5 of ASME Code, Section VIII, Division 2.

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The minimum nozzle loads to apply on nozzles shall be as per APPENDIX 1.

8.3.2 SHIPPING LOADS

The vessel, its supports and hold-down bolting or attaching welds shall be designed to withstand shipping loads, whichever are the greater of:

- ♦ Pitch (long) = $0.22 * g$
- ♦ Heave (vertical) = $1.27 * g$

OR

- ♦ Roll (transversal) = $0.51 * g$
- ♦ Heave (vertical) = $1.27 * g$

8.3.3 AIR COOLED HEAT EXCHANGER (API 661)

- ♦ The nozzles and headers shall withstand twice the forces and moments indicated on API 661 Figure 6 and Table 4.

8.3.4 PLATE AND FRAME HEAT EXCHANGER (API 662 / ISO 15547 – Part 1)

- ♦ The nozzles and headers shall withstand twice the forces and moments indicated in API 662 / ISO 15547 – Part 1. Unless otherwise indicated, severe service nozzle loading (Table 2) shall be used.

9.0 DESIGN CRITERIA

9.0.1 General

The equipment design in general shall primarily fulfil the desired service requirements and maximum equipment availability for a minimum service life of 30 years. All rotating equipment shall be designed for uninterrupted operation of three years without any major overhaul.

The basic design for Pressure Vessels, Heat Exchangers and Atmospheric Tanks shall conform to all applicable clauses of the respective design code requirements and all specified standard constructional requirements, quality details, and other specific job requirements.

All pressure vessels, shell & tube heat exchangers, air-cooled heat exchangers, and plate & frame heat exchangers designed as per ASME Sec. VIII Div.1 or Div.2 shall be code stamped.

The rotating equipment and packaged equipment shall be of proven design and performance conforming to the respective design code and standards and Vendor's standard design (proprietary in nature) fulfilling the experience and qualification requirements as specified in respective Purchase specifications.

Vendor's scope shall include supply of spare parts for start-up and commissioning. Unless otherwise specified in the purchase requisition, Vendor's scope of supply shall also include spares for two years normal operation.

9.0.2 Order of Precedence

Order of precedence for various documents is as follows:

- National or local regulatory standards
- Purchase Order

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- Equipment Data Sheets
- Project Specifications and Standards
- International Codes and Standards.

In the event of any conflict/ contradiction/ discrepancy/dispute between the above documents, the same shall be referred to the Company for clarification. The Company's decision shall be binding on the LSTK Contractor/ Vendor. The most stringent requirement shall apply unless otherwise approved by Company in writing.

9.1 Static Equipment (Tanks, Vessels, Exchangers & Indirect Water Bath Heaters)

9.1.1 PRESSURE VESSELS

Pressure Vessels shall be designed in accordance with ASME SEC VIII, DIV 1 or 2 as specified in respective datasheet, and the project Specification FGGS-BJN-MEQ-SPC-4012. All pressure vessels shall be ASME code stamped.

The minimum shell and head thickness for carbon steel pressure vessels, including corrosion allowance shall be 6.0 mm.

The minimum corrosion allowance for carbon steel and low alloy steel shall be 3.0 mm unless specified otherwise in the datasheets. The minimum corrosion allowance shall be added to both sides of non-removable carbon steel internals when exposed to corrosive fluid or vapour. Removable carbon steel internal parts shall be provided with corrosion allowance equal to half the specified value on each surface exposed to corrosive fluid or vapour.

All vessel nozzles connections are to be flanged type. Nozzles on pressure vessels shall not be less than 2" NPS. Minimum size of hand holes shall be 6" NPS and for manholes 18" NPS unless otherwise mentioned. Nozzles shall be set-in type with full penetration weld construction.

Manholes, hand holes, and end flanges shall be provided as required for operation and maintenance to meet code requirements for inspection.

Dished ends shall be 2:1 ellipsoidal unless otherwise specified in vessel data sheet. Construction shall be seamless up to 2000 mm diameter. Larger dished ends shall have one weld seam or shall be of crown and petal construction. The weld seams shall be fully radiographed.

Vessel size and type shall be as per data sheet. Process internals of proprietary nature shall be procured by LSTK Contractor from reputed process internals suppliers.

Flanges shall be of Weld Neck Type, as per ASME B16.5/ B16.47 as applicable.

Long weld neck Nozzles may be used up to 2" NPS in high-pressure service. Manhole (MH) shall be provided with davit & jack screw.

9.1.2 MATERIAL SELECTION

All the materials of construction shall be conforming to ASME specification. Internal cladding / lining is to be provided when specified in equipment datasheet. Material for

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non-pressure parts welded to vessel shall be compatible with the material to which they are welded.

♦ PLATES

The carbon content of carbon steel plates shall be restricted to 0.23% maximum, and the Carbon Equivalent (CE) shall be 0.43% maximum.

♦ PIPES

The carbon content of carbon steel pipes shall be restricted to 0.23% maximum, manganese to 1.20% maximum, and the CE shall be 0.43% maximum.

♦ FITTINGS

The carbon content of carbon steel fittings shall be restricted to 0.23% maximum.

♦ FORGINGS

The carbon content of carbon steel forgings SA 105 and SA 350 Gr. LF2 shall be restricted to 0.25% maximum and 0.23% maximum respectively.

Unless otherwise specified, where vessel internals are in stainless steel, bolts and nuts shall also be of stainless steel.

All materials used for fabrication/ construction shall be new. Material certification is required as per ISO 10474 type 3.1 for all wetted and pressure parts and type 2.2 for non-pressure parts. Positive Material Identification (PMI) reports shall be required for High Alloy parts and welds.

9.1.3 LOADINGS

The vessels shall be designed considering all the loads including wind load during operation and hydrostatic test conditions and also shall be designed for seismic, transportation and erection loads.

Dynamic/ static loads imposed by pumps mounted on pressure vessels are to be considered wherever applicable and adequate stiffening and reinforcement is to be provided in the nozzle and shell.

Lifting lugs / lifting trunnions shall be provided on the vessel and shall be designed for a single point lift. They shall be designed with an impact factor of 2.0

Design for External Forces

- Full wind loads shall be considered, applicable during erection and operating conditions.
- 30% wind load shall be considered during hydrostatic test.
- Additional loads during transportation of the equipment through road/sea shall be considered.

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- Seismic loads
- Local Loads on nozzles due to piping reactions

Nozzles other than Instrument nozzles, manholes, and inspection openings, shall be designed for piping loads and moments specified in APPENDIX 1 in accordance with WRC 107 (537) / WRC 297.

9.1.4 LOCAL LOADS

Local load analysis shall be carried out for equipment support to shell joints of legs/lugs/ brackets.

External loads due to structural and piping supports must be considered. External loads due to lifting shall also be considered.

9.2 WELDED STEEL TANKS

The design, materials, fabrication, erection, inspection & testing of welded cylindrical vertical storage tanks shall be in accordance with API-650, or API 620 (as specified in the data sheet) and the applicable project specification FGGS-BJN-MEQ-SPC-4009.

Allowable nozzle loads shall be calculated in accordance with criteria given by API 650.

Rectangular tanks, if any, shall be designed in accordance with "Roark's Formulas for Stress and Strain" published by the author Warren C. Young or similar structural design practice.

Material classification shall be in general as per Process/ Mechanical Data Sheet. Manholes shall be provided with hinge / davit.

9.3 AIR COOLED HEAT EXCHANGERS

Air cooled heat exchangers shall comply with the following requirements:

The design, materials fabrication, inspection, testing, code stamping and preparation for shipment of air-cooled heat exchangers shall be based on ASME VIII Div. 1 or 2 (as specified in respective datasheet), API 661, and the applicable Project specifications.

At least two fans shall be provided for each bay. Forced or Induced draft requirement shall be as per individual datasheets. For nozzle loads and moments, two times API 661 values shall be used. The design of the tube bundles and headers shall comply with applicable Code and shall be code stamped.

An air cooler is to be ordered as total package. Such a package shall consist of, but not be limited to fin tube bundles including header boxes, louvers, actuators and positioners where required, protection screens for safety purposes, plenum chambers, fans, fan rings with supports, electric motors (single speed/ two-speed / variable speed as specified in data sheet), transmissions with supports, steel support structure, vibration switches, walkways, cage ladders, sliding plates, cable tray supports, etc., under one contract. The delivery of the air coolers to site shall be in fully assembled condition.

9.4 GROUND FLARE SYSTEM

The flare unit shall be of enclosed ground flare type designed as per API Standard 537 and the applicable Project specifications.

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The flare system shall include burners, risers, manifolds, refractory/ceramic fibre lined enclosure, ignition and monitoring system, all required instrumentation & controls etc.

High Energy Ignition (HEI) type ignition system shall be provided for the pilot burners and duplex K-type thermocouple for pilot flame monitoring.

The enclosure height shall ensure there is no visible flame above it during maximum flaring load.

9.5 INDIRECT WATER BATH HEATER

Each indirect water bath heater shall have independent heat transfer coils to handle two well streams at a time. Each well stream shall pass through a pre-heat coil section and an expansion coil section. A suitable positive choke valve to be provided in between the pre-heater section outlet and the expansion coil inlet.

The water bath heaters shall be procured from reputed Vendors. Water bath heater coils shall be made of seamless pipes. Corrosion allowance shall be considered for the heating coil as specified in water bath heater datasheet. The heater design shall generally comply with API 12K.

9.6 ROTATING EQUIPMENT (COMPRESSORS & PUMPS)

- For all rotating equipment, the main equipment together with its driver, auxiliaries and accessories will be purchased through one vendor (Compressor/ Pump Supplier) who shall be responsible for the performance of complete unit.
- The noise level for equipment and packages shall not exceed 85 dBA when measured at 1-m distance from the equipment surface in any direction without acoustic treatment. Noise level for DG set shall comply with Project Specification FGGS-BJN-ELE-SPC-6001 (Specification for Diesel Generator).
- Equipment nozzles especially at customer interface shall be as per the piping specifications and sizes. Where the use of non-standard nozzles cannot be avoided, the companion flanges along with the gaskets and fasteners shall be procured from the equipment vendor.
- Pumps and compressors shall be selected from standard series in such a way so as to have maximum interchangeability between components to minimize inventory cost.
- Couplings shall be of spacer type for ease of maintenance. Guards for all moving part. i.e. coupling guards, belt drive, etc shall be of non-sparking material and shall be provided with hole for visual inspection of coupling.
- Performance & Complete unit test of critical equipment shall be witnessed by Company representative at Vendor's premises.

9.6.1 CENTRIFUGAL PUMPS

The selection of API centrifugal pump type and specification shall be based on Project specification FGGS-BJN-MEQ-SPC-4017, which is an overlay to API 610. Pumps in water service may comply with ANSI/ASME/ISO standards if specified in datasheet. Fire water pumps shall comply with IS: 12469 and NFPA-20.

External loads on pump nozzles shall be twice the loads and moments specified in API

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610.

Unless other specified, all pumps shall be electric motor driven.

The margin on motor nameplate rating over the pump power requirement shall be as per Table-12 of API 610, but not less than maximum BkW at any point on pump performance curve from shut off to end of curve for rated impeller. For the rating of diesel engine for fire water pumps, IS: 12469 shall be complied with.

The available NPSH shall be at least 1m of liquid column higher than the required NPSH provided by the pump manufacturer. In case higher margin is required, data sheet will govern. In case of pump operating at the end of curve, positive NPSH margin shall be available at the end of curve.

All horizontal centrifugal pumps shall have back pull out design.

Fire water pumps shall be of axially split casing type with back pull out facility.

Suction specific speed for all centrifugal pumps shall be limited within 8500 (USCS unit).

Mechanical seals and seal flush systems plan shall be in accordance with API 682 latest edition (Shaft Sealing Systems for Centrifugal and Rotary Pumps) and FGGS-BJN-MEQ-SPC-4017. Qualification test results of each seal shall be furnished during detail engineering for review.

Pumps fitted with inducers are not acceptable unless approved by Company.

9.6.2 METERING PUMPS

The metering pumps, for example chemical injection pumps, shall be according to API 675, single head plunger / single diaphragm type. Double diaphragm type with diaphragm rupture detection system shall be provided for dosing toxic chemicals.

The capacity control and turn-down for these pumps shall be based on manual stroke adjustment.

The scope of supply of metering pumps shall also include appurtenances such as pulsation dampeners, calibration pots, filters, and strainers. Pumps shall be provided with full flow relief valves at discharge, upstream of any pump's isolation valve. PRV shall be designed as per API 520 & 526.

9.7 PACKAGED EQUIPMENT

The following Packaged Equipment units are envisaged for the Project:

- a. Gas Dehydration Package
- b. Water Treatment Package
- c. Effluent Treatment package

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- d. Instrument Air Package
- e. Chemical Injection Package
- f. Flare System

- The packaged equipment shall comply with the respective data sheets, applicable codes, standards, project specifications and the requirements stated in this design basis.
- The package design shall be of proven one and the supplier shall have references of similar installations in satisfactory operation for at least five years.
- Package battery limits shall be as per P&IDs for respective package. P&IDs for package equipment shall be further developed by Vendor and submitted for review and approval by Company/ Consultant.
- All piping, fittings, valves, instruments, panels, junction boxes, platforms, ladders, lifting provisions etc shall be provided within the package skid.

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APPENDIX 1- NOZZLE LOADS ON PRESSURE VESSELS AND SHELL & TUBE HEAT EXCHANGERS (2 SHEETS)



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NOZZLE SIZE	OUTSIDE DIAMETER	PRESSURE VESSEL AND SHELL AND TUBE HEAT EXCHANGER ALLOWABLE FORCES & MOMENTS FOR ASME VIII Div 1 or Div 2																																		
		150 LB & 300 LB FLANGE RATING							600 LB FLANGE RATING							900 LB FLANGE RATING							1500 LB FLANGE RATING							2500 LB FLANGE RATING						
		FORCES KN			MOMENTS KNm				FORCES KN			MOMENTS KNm				FORCES KN			MOMENTS KNm				FORCES KN			MOMENTS KNm				FORCES KN			MOMENTS KNm			
IN.	mm	VL	P	VC	MC	MT	ML	VL	P	VC	MC	MT	ML	VL	P	VC	MC	MT	ML	VL	P	VC	MC	MT	ML	VL	P	VC	MC	MT	ML					
2	60.33	3,3	3,3	2,5	0,4	0,6	0,5	3,8	3,8	2,9	0,5	0,7	0,6	7,2	7,2	5,4	0,7	1,1	0,9	12,0	12,0	9,0	1,2	1,8	1,6	13,2	13,2	9,9	1,3	2,0	1,7					
3	88,9	4,9	4,9	3,7	0,9	1,3	1,1	5,6	5,6	4,2	1	1,5	1,3	10,8	10,8	8,1	1,6	2,4	2,1	18,0	18,0	13,5	2,7	4,1	3,5	19,8	19,8	14,9	3,0	4,5	3,9					
4	114,3	6,3	6,3	4,7	1,4	2,1	1,8	7,2	7,2	5,4	1,6	2,4	2,1	14,4	14,4	10,8	2,9	4,3	3,7	24,0	24,0	18,0	4,8	7,2	6,2	26,4	26,4	19,8	5,3	7,9	6,9					
6	168,28	9,3	9,3	7	3,1	4,6	4	10,6	10,6	8	3,5	5,3	4,6	21,6	21,6	16,2	6,5	9,7	8,4	36,0	36,0	27,0	10,8	16,2	14,0	39,6	39,6	29,7	11,9	17,8	15,4					
8	219,08	12,1	12,1	9,1	5,2	7,8	6,8	13,8	13,8	10,4	6	8,9	7,7	28,8	28,8	21,6	11,5	17,3	15,0	48,0	48,0	36,0	19,2	28,8	25,0	52,8	52,8	39,6	21,1	31,7	27,5					
10	273,05	15,1	15,1	11,3	8,1	12,1	10,5	17,2	17,2	12,9	9,2	13,9	12	36,0	36,0	27,0	18,0	27,0	23,4	60,0	60,0	45,0	30,0	45,0	39,0	66,0	66,0	49,5	33,0	49,5	42,9					
12	323,85	17,9	17,9	13,4	11,4	17,1	14,8	20,4	20,4	15,3	13	19,5	16,9	43,2	43,2	32,4	25,9	38,9	33,7	72,0	72,0	54,0	43,2	64,8	56,2	79,2	79,2	59,4	47,5	71,3	61,8					
14	355,6	19,6	19,6	14,7	13,7	20,6	17,8	22,4	22,4	16,8	15,7	23,5	20,4	50,4	50,4	37,8	35,3	52,9	45,9	84,0	84,0	63,0	58,8	88,2	76,4	92,4	92,4	69,3	64,7	97,0	84,1					
16	406,4	22,4	22,4	16,8	17,9	26,9	23,3	25,6	25,6	19,2	20,5	30,7	26,6	57,6	57,6	43,2	46,1	69,1	59,9	96,0	96,0	72,0	76,8	115,2	99,8	105,6	105,6	79,2	84,5	126,7	109,8					
18	457,2	25,2	25,2	18,9	22,7	34	29,5	28,8	28,8	21,6	25,9	38,9	33,7	64,8	64,8	48,6	58,3	87,5	75,8	108,0	108,0	81,0	97,2	145,8	126,4	118,8	118,8	89,1	106,9	160,4	139,0					
20	508	28	28	21	28	42	36,4	32	32	24	32	48	41,6	72,0	72,0	54,0	72,0	108,0	93,6	120,0	120,0	90,0	120,0	180,0	156,0	132,0	132,0	99,0	132,0	198,0	171,6					
24	609,6	33,6	33,6	25,2	40,3	60,5	52,4	38,4	38,4	28,8	46,1	69,1	59,9	86,4	86,4	64,8	103,7	155,5	134,8	144,0	144,0	108,0	172,8	259,2	224,6	158,4	158,4	118,8	190,1	285,1	247,1					
26	660,4	36,4	36,4	27,3	47,3	71	61,5	41,6	41,6	31,2	54,1	81,1	70,3	93,6	93,6	70,2	121,7	182,5	158,2	156,0	156,0	117,0	202,8	304,2	263,6	171,6	171,6	128,7	223,1	334,6	290,0					
28	711,2	39,2	39,2	29,4	54,9	82,3	71,3	44,8	44,8	33,6	62,7	94,1	81,5	100,8	100,8	75,6	141,1	211,7	183,5	168,0	168,0	126,0	235,2	352,8	305,8	184,8	184,8	138,6	258,7	388,1	336,3					
30	762	42	42	31,5	63	94,5	81,9	48	48	36	72	108	93,6	108,0	108,0	81,0	162,0	243,0	210,6	180,0	180,0	135,0	270,0	405,0	351,0	198,0	198,0	148,5	297,0	445,5	386,1					
32	812,8	44,8	44,8	33,6	71,7	107,5	93,2	51,2	51,2	38,4	81,9	122,9	106,5	115,2	115,2	86,4	184,3	276,5	239,6	192,0	192,0	144,0	307,2	460,8	399,4	211,2	211,2	158,4	337,9	506,9	439,3					
34	863,6	47,6	47,6	35,7	80,9	121,4	105,2	54,4	54,4	40,8	92,5	138,7	120,2	122,4	122,4	91,8	208,1	312,1	270,5	204,0	204,0	153,0	346,8	520,2	450,8	224,4	224,4	168,3	381,5	572,2	495,9					
36	914,4	50,4	50,4	37,8	90,7	136,1	117,9	57,6	57,6	43,2	103,7	155,5	134,8	129,6	129,6	97,2	233,3	349,9	303,3	216,0	216,0	162,0	388,8	583,2	505,4	237,6	237,6	178,2	427,7	641,5	556,0					
38	965,2	53,2	53,2	39,9	101,1	151,6	131,4	60,8	60,8	45,6	115,5	173,3	150,2	136,8	136,8	102,6	259,9	389,9	337,9	228,0	228,0	171,0	433,2	649,8	563,2	250,8	250,8	188,1	476,5	714,8	619,5					
40	1016,0	56,0	56,0	42,0	112,0	168,0	145,6	64,0	64,0	48,0	128,0	192,0	166,4	144,0	144,0	108,0	288,0	432,0	374,4	240,0	240,0	180,0	480,0	720,0	624,0	264,0	264,0	198,0	528,0	792,0	686,4					
42	1066,8	58,8	58,8	44,1	123,5	185,2	160,5	67,2	67,2	50,4	141,1	211,7	183,5	151,2	151,2	113,4	317,5	476,3	412,8	252,0	252,0	189,0	529,2	793,8	688,0	277,2	277,2	207,9	582,1	873,2	756,8					
44	1117,6	61,6	61,6	46,2	135,5	203,3	176,2	70,4	70,4	52,8	154,9	232,3	201,3	158,4	158,4	118,8	348,5	522,7	453,0	264,0	264,0	198,0	580,8	871,2	755,0	290,4	290,4	217,8	638,9	958,3	830,5					
46	1168,4	64,4	64,4	48,3	148,1	222,2	192,6	73,6	73,6	55,2	169,3	253,9	220,1	165,6	165,6	124,2	380,9	571,3	495,1	276,0	276,0	207,0	634,8	952,2	825,2	303,6	303,6	227,7	698,3	1047,4	907,8					
48	1219,2	67,2	67,2	50,4	161,3	241,9	209,7	76,8	76,8	57,6	184,3	276,5	239,6	172,8	172,8	129,6	414,7	622,1	539,1	288,0	288,0	216,0	691,2	1036,8	898,6	316,8	316,8	237,6	760,3	1140,5	988,4					
52	1320,8	72,8	72,8	54,6	189,3	283,9	246,1	83,2	83,2	62,4	216,3	324,5	281,2	187,2	187,2	140,4	486,7	730,1	632,7	312,0	312,0	234,0	811,2	1216,8	1054,6	343,2	343,2	257,4	892,3	1338,5	1160,0					
56	1422,4	78,4	78,4	58,8	219,5	329,3	285,4	89,6	89,6	67,2	250,9	376,3	326,1	201,6	201,6	151,2	564,5	846,7	733,8	336,0	336,0	252,0	940,8	1411,2	1223,0	369,6	369,6	277,2	1034,9	1552,3	1345,3					
60	1524,0	84,0	84,0	63,0	252,0	378,0	327,6	96,0	96,0	72,0	288,0	432,0	374,4	216,0	216,0	162,0	648,0	972,0	842,4	360,0	360,0	270,0	1080,0	1620,0	1404,0	396,0	396,0	297,0	1188,0	1782,0	1544,4					



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MECHANICAL DESIGN BASIS

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NOTES

1. All forces and moments in the above table are positive and sign notation is as per WRC bulletin 107 (537). The most stringent case caused by axial load 'P' acting inward or outward shall be considered.
 2. The Supplier shall ensure that all process nozzles shall be suitable for the nozzle loads shown in the above table and provide the necessary calculations in accordance with WRC Bulletin 107 (537) and 297 and ASME code.
 3. All forces and moments act on the intersection of the axis with the mid-thickness of the shell or head plates.
 4. The Supplier shall notify the Contractor of cases where calculations require an increase in thickness of the reinforcing greater than construction code and/or guide drawing minimum allowable thicknesses.
- In such cases, if notified at the time of quotation, the standard load may be reduced by the Contractor upon written request by the Supplier. Such agreed specific load shall be indicated on the equipment guide drawing.
5. If any nozzle is not covered by this table, the Supplier shall ask the applicable loads to the Contractor.

6. All cost for the above reinforcement must be included in the Supplier's price.

7. LOADING NOMENCLATURE

FORCES

VL= Longitudinal
P= Axial
VC= Circumferential

MOMENTS

ML= Longitudinal
MT= Torsional
MC= Circumferential

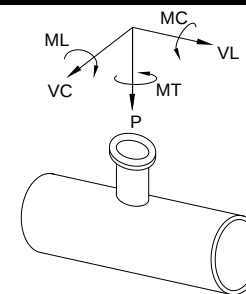
8. FOR SPHERES AND HEADS

Resultant shear force

$$F = \sqrt{VL^2 + VC^2}$$

Resultant bending moment

$$M = \sqrt{ML^2 + MC^2}$$



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REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

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1.0 INTRODUCTION

M/s Oil India Ltd (OIL) is a Navaratna Company under the Ministry of Petroleum and Natural Gas, Govt of India. As an integrated upstream company with pan India presence and overseas wings spreading over different parts of the globe, OIL is engaged in exploration, production and transportation of crude oil and natural gas and production of LPG with its headquarter at Duliajan, Assam. In line with OIL's strategy for balanced growth, an ambitious plan for development of non-associated gas fields is presently underway in OIL's Upper Assam operational area. As a part of this development scheme, OIL desires to construct a modular Field Gas Gathering Station (FGGS) for augmenting natural gas production facility at Baghjan field in Upper Assam, India.

Jayathe Petrotech Engineers and Consultants (JPEC) have been awarded the contract for Engineering and Project Management Consultancy for developing the engineering and managing project execution.

1.1 PROJECT OBJECTIVE

The Baghjan field is having huge amount of Non Associated Gas (NAG) potential and the expected gas production from this area in 7.5 MMSCMD. To explore these resources one modular Field Gas Gathering Station (FGGS) having the facilities for production of natural gas is to be created. The proposed FGGS shall have Non Associated Gas (NAG) processing facility for 5.0 MMSCMD (2 trains x 2.5 MMSCMD) and provision to feed Associated Gas (AG) of 0.5 MMSCMD along with the NAG to a Glycol based Dehydration facility (5.0 MMSCMD) for achieving water dew point less than or equal to (0) Zero Deg C. The facility shall include Production and Test Manifolds, Gas /Condensate/Water Separators, Gas Dehydration, Flare system and Effluent Treatment and disposal system along with all the required utilities and auxiliary systems. Space provision will be made within the plant to augment its capacity by installing one more train of 2.5 MMSCMD in future.

2.0 PURPOSE OF THE DOCUMENT

This document describes basis of design and provides the process design data, codes for process design and criteria that will be used for the design of various process equipment, systems, lines etc. The main objective of the document is to define the inlet compositions, scenarios to be considered, envelope for design of process and utility systems, production rate, product quality etc. for the Field Gas Gathering Station at Baghjan, Upper Assam.

3.0 CODES & STANDARDS

Table 3.1 Codes & Standards

CODES	DESCRIPTION
API 12J	Specification for Oil and Gas Separators
API 14C	Basic Surface Safety Systems
API 520 Part I	Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries
API 520 Part II	Pressure-Relieving Devices Installation

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CODES	DESCRIPTION
API 521	Guide for Pressure-Relieving and Depressurizing Systems
API 526	Flanged Steel Pressure Relief Valves
API 537	Flare Details for General Refinery and Petrochemical Service
API 660	Shell and Tube Heat Exchangers
API 676	Positive Displacement Pumps-Rotary
API 2000	Venting Atmospheric and Low-Pressure Storage Tanks – Non-Refrigerated and Refrigerated
ASME Sec VIII Div I	Rules for Construction of Pressure Vessels
ISO 13631	Packaged Reciprocating Gas Compressors
OISD 116	Standard for Fire Protection for Petroleum Refineries & Oil& Gas Processing Plants
OISD 118	Standard for Layout for Oil & Gas Installations
OISD 189	Standard for Fire Fighting equipment for Drilling Rigs, Work over Rigs and Production Installations.
TEMA	Tubular Exchanger Manufacturers Association Incorporated Standards

4.0 ABBREVIATIONS / DEFINITIONS

4.1 Abbreviations

Table 4.1.1 Abbreviations

ABBREVIATIONS	DESCRIPTION
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
BJN	Baghjan
BWPD	Barrels of Water per day
CBD	Closed Blow Down
CD	Closed Drain
CO ₂	Carbon Dioxide
CS	Carbon Steel
DB	Design Basis
DCS	Distributed Control System

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ABBREVIATIONS	DESCRIPTION
EERA	Escape, Evacuation And Rescue Analysis
EIA	Environmental Impact Assessment
EPCC	Engineering, Procurement , Construction and Commissioning
EPS	Early Production Station
ERA	Environmental Risk Assessment
ESD	Emergency Shutdown
ETP	Effluent Treatment Plant
FFG	Flame Front Generator
FG	Fuel Gas
FGGS	Field Gas Gathering Station
F&G	Fire & Gas
H&MB	Heat & Mass Balance
HAZOP	Hazard and Operability Study
HDPE	High Density Polyethylene
HP	High Pressure
JPEC	Jayathe Petrotech Engineers and Consultants Pvt Ltd
KOD	Knockout Drum
KCAL	Kilo Calories
LP	Low Pressure
LPG	Liquefied Petroleum Gas
MMSCMD	Million Standard Cubic Meter per Day
MOV	Motor Operated Valve
MPFM	Multi-phase Flow Meter
NPS	Nominal Pipe Size
NPSHA	Net Positive Suction Head Available
OISD	Oil Industry Safety Directorate
PFD	Process Flow Diagram
P&ID	Piping and Instrumentation Diagram

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ABBREVIATIONS	DESCRIPTION
PCV	Pressure Control Valve
PIT	Pressure Indicating Transmitter
PMS	Piping Material Specification
ppm	Parts Per Million
PRV	Pressure Relief Valve
PVRV	Pressure Vacuum Relief Valve
PSV	Pressure Safety Valve
QRA	Quantitative Risk Assessment
SCMD	Standard Cubic Meters per Day
SDV	Shutdown Valve
SIL	Safety Integrity Level
TC	Temperature Control
TEG	Tri Ethylene Glycol
TIT	Temperature Indicating Transmitter
WTP	Water Treatment Plant

4.2 Definitions

Table 4.2.1 Definitions

NOMENCLATURE	DESCRIPTION
Company	Oil India Limited (OIL)
Consultant	Jayathe Petrotech Engineers & Consultants (JPEC)
Project	Field Gas Gathering Station, Baghjan (FGGS-BJN)
Vendor	Supplier of Equipment/Package

5.0 DESIGN BASIS

5.1 Station

Field Gas Gathering Station (FGGS) comprising of natural gas production facility including Heaters, test and production manifolds and separators, gas dehydration, dew point correction unit and required auxiliary, safety and utility units like Flare system, Fuel Gas system, Captive Power plant, Effluent Treatment Plant, Water treatment plant, Instrument air system, Chemical dosing system, Firefighting system, Control and Emergency shutdown systems, Telecommunication system etc.

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The entire plant will be modular in structure both in terms of layout and operation to the extent possible. Details of the self-containing, pre-fabricated standard size containers for various units and equipment along with transportation requirement to site in containers and placement at site shall be covered in the other discipline documents.

5.2 Design Capacity

Non Associated Gas : 5.0 MMSCMD (2 X 2.5 MMSCMD with a common standby and with provision for one more train)

Associated Gas from EPS, Baghjan : 0.5 MMSCMD

Gas Dehydration Unit : 5.0 MMSCMD (2 X 2.5 MMSCMD and space provision for 1 X 2.5 MMSCMD in future. Size limitation of the equipment like the inlet KOD, Contactor tower due to remote location of the proposed installation is to be considered and accordingly more equipment units as required shall be provided.)

5.3 Design Life

FGGS shall be designed for a life of 30 years.

5.4 Wells, flow rates and operating/design conditions

Total numbers of gas wells are expected to be 25 nos. Normal Flow rate of each well is expected to be 0.2 MMSCMD (Design flow rate 0.3 MMSCMD). Operating and design conditions are indicated below.

Well Operating Pressure maximum/ minimum, Kg/cm² g	320 / 100
Well Operating Temperature maximum/minimum, °C	20 / 7
Design Pressure, Kg/cm ² g	350
Design Temperature maximum/minimum, °C	100 / - 20

Battery limit conditions of the well fluids are available in clause 7.1

5.5 No. of trains

Manifold

Production : 2 (each having a capacity of 2.5 MMSCMD)

MPFM : 1 (capacity 1.0 MMSCMD common for the two streams)

Gas Dehydration : 2 X 2.5 MMSCMD (Provision for 1X 2.5 MMSCMD in future)

5.6 Turndown and Design Margin

As 50% margin is considered for the well fluids, additional margin in design is not envisaged. Turndown is as follows

Non Associated Gas : 20%

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Associated Gas from EPS : 20%

5.7 No. of stream days per year : 365

5.8 Capacity of Manifolds

Product Manifolds : 2.5 MMSCMD each

5.9 Capacity of Separators

Production Separators : 2.5 MMSCMD (2 working & 1 common standby)

High Pressure Separator : 0.25 MMSCMD (1 No. with op. pr. of 90 KSC)

HP Separator has provision to take input from four heaters.

5.10 Capacity of Flare

a) HP Flare : 3.5 MMSCMD

b) LP Flare : 2.5 MMSCMD

6.0 FEED GAS/ PRODUCT GAS CHARACTERISTICS

6.1 Gas Composition

Feed gas composition based on the analyses provided by OIL(given in Annexure -1) with maximum 2.25% CO₂ and 1000 lbs/mmcf H₂O present in the gas for design has been simulated and the final gas composition used is as follows.

Components	NAG Composition Volume%		AG Volume%
	Well # A	Well # B	Well # C
C ₁	89.90	90.09	90.481
C ₂	4.44	4.41	4.408
C ₃	1.30	1.26	1.339
i C ₄	0.22	0.22	0.240
n C ₄	0.29	0.28	0.330
i C ₅	0.11	0.11	0.120
n C ₅	0.09	0.09	0.110
C ₆	0.13	0.22	0.170

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N ₂	1.26	1.08	0.920
CO ₂	2.25	2.25	1.829
H ₂ O	0.01	0.01	0.054
Gas properties:			
Gas sp. gravity	0.612	0.612	0.607
Gross Calorific value, BTU/SCF	1004.13	1007.72	1014.48
Net calorific value, BTU/SCF	912.42	915.70	921.81
Water Content (Gas), lbs/MMSCF	8.034	8.034	77.58

6.2 Product Characteristics

Product gas specification shall be water dew point : ≤ 0°C (Zero Deg C).

Suspended particle size : <10 microns

7.0 BATTERY LIMIT CONDITIONS

7.1 Feed Well Fluid

Choke valve upstream the Heater is in OIL scope (outside the FGGS-BJN) and reduces the pressure from 320 Kg/cm²g to 200 Kg/cm²g and battery limit condition after pressure reduction is as follows.

Feed stock Pressure, Kg/cm²g : 200 (Process design) / 350 (equipment design)

Feed stock Temperature, °C : -20 to 40 (design) / 10-15 (operating)

Destination point : Inlet of Heaters

For process simulation and design basis, well fluid at 200 KSC and 10°C is used.

7.2 Associated Gas from EPS

Gas Pressure , Kg/cm²g : 23

Gas Temperature, °C : 25

Destination point : Inlet of Dehydration unit

Gas Composition : See Annexure -1

7.3 Product

Description	Pressure, kg/cm ² g	Temperature, °C	Destination
Sales Gas	25.0	20-30	750 mm DN (30"NPS) pipeline.

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HP Gas	90	50-60	Provision for future requirement of gas for gas lift
Condensate	Atmospheric	20 -25	Production Manifold at EPS, specific tie-in to be decided at the time of detailing.

7.4 Oily effluent water quality to ETP

Oil Content (free & emulsified)	-	200 ppm
Salinity	-	3500 ppm

7.5 Treated Effluent

Oil content (free & emulsified)	-	10 ppm
Sludge	-	Nil

8.0 DESIGN CASES

Gas well fluid analysis report has been provided by OIL and analyses of NAG wells are given in Annexure -1. Input fluid composition basis for process simulation and material balance are as given in clause 6.1 above and design case considered is a pressure of 200 KSC and temperature of 10°C minimum. As indicated by OIL, free water of up to 20 KLD is found only in isolated cases from particular well and hence, free water is not considered in the simulation and heater design.

9.0 PIPELINE DATA

9.1 Pipelines

40km long Sales gas pipeline of 750mm (30") NPS is being laid and is excluded from the scope of this project. Provision to transport the sales gas through the existing 400mm (16") NPS sales gas pipeline shall also be made.

9.2 Pigging Facilities

As pipeline is not in the scope, pigging facilities are excluded from the scope of this project.

10.0 FORMATION WATER SPECIFICATION

Formation water analysis report for water from Emulsion- treater water outlet of 2nd chamber and FW disposal pump outlet at the EPS, Baghjan has been provided by OIL and is provided in Annexure 2.

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11.0 UTILITY SPECIFICATIONS AT UNIT BATTERY LIMIT

11.1 Fuel Gas

Fuel Gas (Natural gas) required for the Captive Power Plant generator/ fired heaters will be from the gas from the Gas dehydration Unit. Pressure reduction as required shall be carried out and the gas scrubbed/filtered to remove liquids. For initial start-up, fuel gas shall be sourced from the existing EPS.

11.2 Water

Water for FGGS-BJN will be available from shallow/deep water bore wells to be drilled as part of the project.

Analysis of bore well water of adjacent installation Baghjan – EPS, provided by OIL is given in Annexure 3. Water treatment comprising of pressure sand filtration/ multi-media filtration, iron removal (resin filter), hypochlorite addition and UV sterilization are proposed as part of the water treatment plant for the FGGS.

11.3 Instrument Air

Pressure, kg/cm²g : 8.5

Dew Point, °C : (-) 40 at atmospheric pressure

Instrument Air package with Compressor, Air Dryers and Receiver shall be included as part of the Project to ensure continuous availability of instrument air.

11.4 Power

Power required for the facility shall be generated in the Captive Power Plant. Four nos. (4X 100%) of gas engine-driven Generating sets (three operating and one standby) will be provided to cater to the entire power requirement of the FGGS, Baghjan. Gen set running philosophy shall be 100% running with minimum 100% standby. Fuel gas required for power generation shall be from the fuel gas network. Diesel driven Generating set shall be provided for initial start/ emergency. Diesel shall be from external sources and only day tanks for the diesel engine drives and DG set shall be provided within the FGGS.

12.0 CHEMICALS

Tri-ethylene Glycol : For dehydration of Gas

Anti-foam : if required

Corrosion Inhibitor : Suitable corrosion inhibitor shall be dosed to inhibit corrosion due to carbon dioxide in the fluid

Oxygen Scavenger : Dosing in Effluent treatment plant

Biocides : Dosing in Effluent treatment plant, if required

Hydrate Inhibition : Only provision for hydrate inhibitor injection is to be made. To inhibit hydrate formation, well fluid is heated in Heater before pressure reduction downstream the choke valve.

Methanol : At the outlet line of the HP Separator.

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13.0 FLARE SYSTEM

An enclosed ground flare shall be installed at FGGS, Baghjan, which has burners for flaring HP and LP gases (from both the FGGS and existing EPS, Baghjan) of capacity to flare 3.5 MMSCMD and 2.5 MMSCMD gas respectively. The flare shall be non-luminous type. Existing flare for EPS, Baghjan shall be demolished after the FGGS Flare is on line.

14.0 EFFLUENT TREATMENT SYSTEM

The ETP shall be designed for a capacity to treat 1000 KLPD of effluent in two trains of capacity 500 KLPD each. Effluent water from the existing EPS shall be routed to the FGGS. Three raw water tanks of total capacity 2000 KL (say 700 KL capacity each), one for receipt, one for processing and the third for retention are to be provided. ETP is to be designed based on the philosophy of Zero Liquid Discharge (ZLD) from the installation. Formation water shall be treated to achieve the following limits for the treated water output from the ETP.

Oil content : < 10ppm

Sludge content : NIL.

Treated water from the ETP shall be stored in two tanks of capacity 700 KL each. Treated effluent is to be pumped using Treated Effluent Disposal pump to the water injection well through two manifolds having six take-off points each with valves. All tanks of ETP (raw water and treated water) shall have proper internal coating to store water at 3700 mg/l salinity.

Rain water treatment section shall meet the applicable discharge conditions of Assam State Pollution Control Board. Treated rain water is to be harvested within the plant battery limit and routed to the ground water reservoir. Size will be indicated in the discipline documents

15.0 WATER TREATMENT AND SUPPLY SYSTEM

Source of supply : Deep tube well / shallow tube well

Requirement of water

- Potable water (as per BIS10500) to cater to 80 persons at a time, with required treatment
- Service water required for the plant with iron removal and required treatment
- Fire water for firefighting, which is supplied from the well deep tube well

Two overhead HDPE tanks each for Potable water and Service water tanks of adequate capacity shall be provided.

16.0 WASTE WATER & SLUDGE TREATMENT FACILITY:

Sludge treatment facility for storm water : Required

Storm water system : Closed system.

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Filtered storm water outlet : Ground water reservoir.

Treated water from the ETP is injected into disposal wells. Storm water is to be used within the facility. Provision is also made for routing the water to the canal through a single outlet with sluice gate in case of an emergency.

All tanks in the ETP shall be provided with clean out doors for removal of sludge. OIL shall arrange removal and disposal of sludge to licensed pits where bio-remediation is carried out.

17.0 FIRE FIGHTING & PROTECTION FACILITIES

Firefighting system shall be designed for the worst case scenario. Fire Water ring main pressurized and maintained at 7 Kg/cm²g pressure at the hydraulically remotest point.

Fire Water Pumps : Diesel driven, with a minimum capacity of 410m³/hr

Jockey Pumps: Electric driven with auto start to maintain pressure

The pump will take suction from two above ground fire water tanks to be installed for the purpose. There will be provision for taking suction from ground water reservoir (storm water pond) for continuous fire fighting.

Entire FGGS shall be equipped with firefighting equipment as per OISD - 189. All the firefighting systems/facilities shall conform to NFPA, OMR, BIS, and OISD 117 & 189 whichever is stringent.

18.0 EQUIPMENT DESIGN CONSIDERATIONS

All major equipment shall be skid-mounted so that, in future; relocation to other field is possible in case required. Equipment selection shall be as per the data sheets and in conformity to all applicable codes and standards.

General equipment/package selection criteria used in this project will be as given below;

- Generally a 10% overdesign shall be considered for the design capacity of individual equipment.
- For Pumps, generally a 10% design margin should be considered on the rated capacity over the expected normal flow rate.
- Pump NPSHA shall have a minimum margin of 1 meter above NPSHR.
- Equipment noise level (Driver + Driven equipment train) at 100% operating condition shall not exceed 85 dBA when measured at 1m distance from the equipment surface in any direction.

19.0 DESIGN TEMPERATURE /PRESSURE CRITERIA

A 20°C margin shall be maintained for the design temperature above the maximum operating temperature or maximum ambient temperature (40°C), whichever is higher and below the minimum operating temperature expected. For pressure a minimum of 10% above the maximum continuous operating pressure rounded off appropriately is used.

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For Heaters and piping up to the ESDV, the design pressure shall be 350 KSC and design temperature shall be -20°C and 100°C for equipment design only and not Process design.

20.0 CRITERIA FOR LINE SIZING

Hydraulic study and line sizing shall be performed using ASPEN HYSYS and in-house software. The criteria for sizing of multiphase piping shall be the erosional velocity/ pressure drop limits and noise. Actual velocity shall be kept below the erosional velocity. In general, for gas piping, velocity shall be limited to 30 m/s for over 70 Kg/cm²(g). Lower velocity shall be considered where pressure drop limitations or other process considerations are encountered. For liquid piping, the minimum velocity shall be 0.9m/s and maximum 5m/s. Velocity shall be limited to 1- 2 m/s for pump suction lines and 2-3 m/s for discharge lines.

21.0 INSTRUMENTATION

Mode of Plant Operation : Fully Automatic
Type of Control : DCS
Type of Controllers : DCS
Final control element : Control Valves (Pneumatic)

Status lamps on control

For rotating equipment : Yes (On/Off/Overload)

For shutdown valves : Yes

Safety valve isolation : Yes

Shut-down : Programmable Logic Control based SIS system

Monitoring and control of the operation of the plant is from dedicated DCS located in the Control room within the FGGS. Basic design for Basic Process Control System (BPCS) envisaged for the plant is an integrated system comprising of a DCS for plant control and a PLC for executing shutdown function, dedicated flow computers for custody transfer applications, an addressable fire alarm panel are also provided. Failsafe, redundant automation systems shall be used for process applications. A fully integrated control system which will improve plant productivity and safety shall be provided. Integration of the DCS with ESD PLC, Burner Management PLC, Dehydration unit controls, Flare control PLC, Flow computers, Gas chromatograph shall be carried out. Facilities for on-line trending, historical trending, reports generation, alarms, alarm history, event list etc. are to be provided. For the firefighting system, standalone fire alarm panel shall be installed which take inputs from the heat and smoke detectors and manual shall call points in the field and control room. SIL rating of the control and safety systems shall be finalized after the SIL study.

DCS should have the provision for interfacing FGGS data to ABB SCADA. Availability of FGGS data at the RTU end of Baghjan EPS shall be ensured. Dedicated communication link shall be provided. All instruments shall have the required vent and drain arrangement with isolation valves.

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22.0 SITE DATA

Design ambient temperature Maximum, °C	40
Design ambient temperature Minimum, °C	7
Dry bulb temperature Maximum, °C	36
Dry bulb temperature Minimum, °C	8
Average Rainfall (in full monsoon)	194.2 cm
Average Rainfall (in 24 hours)	15.9 cm
Wind velocity at 10m height	50 m/s
Maximum relative humidity	93%

23.0 FUTURE PROVISIONS

Adequate space provision with required safety distances as per OISD norms are to be kept inside the FGGS boundary for setting up

- Two bath Heaters
- One train of 2.5 MMSCMD Production separator
- Hydrocarbon Dew point reduction facility
- Gas Sweetening Facility in case of a change in gas characteristics over time as a future requirement.

24.0 PROCESS DESCRIPTION

24.1 Heaters and Manifold

Field Gas Gathering Station at Baghjan is designed to receive well fluids from 25 nos. of wells (20 producing wells + 5 future well). 10 Nos. of electric heaters (H-1001 A01 to A10) are provided in the Phase I, each catering to single well and 6 nos Water Bath Heaters (5 working and 1 common standby) (E-1001 A01 to A06) each catering to 2 nos. of wells in Phase II. Flow lines from the wells are connected to the heater inlet through a header. Provision is made for 2 Water Bath heaters (E-1001 A07 to A08) to cater to the future wells. Well fluid is heated from 10oC to adequate temperature so as to maintain a temperature of 15oC after pressure reduction to 25 kg/cm² g which is effected through a

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choke valve downstream of the heater.

Two manifolds are provided at the outlet of the Heaters, namely Test manifold and Production manifold. Electric heaters are provided in Phase I and water bath heaters are provided in Phase II for heating the well fluids to prevent hydrate formation. In Phase I, each well is connected to an electric heater and in Phase II, each Bath heater caters to two wells, with each well connected to one set of preheat and heating coils in the Bath Heater. However, valves and connections shall be provided for feeding the well fluid from one well to one heater and also to one adjacent heater.

Manifolds are designed on modular concept for easy relocation and one module of a manifold caters to 4 nos. of wells. Production manifold is to be designed in two modules (Production Manifold A & B.) Provision is to be made for adding another module of capacity 2.5 MMSCMD to the production manifold in future. Well fluids from the heaters are routed to the Production Separators/HP Separator for production /gas lift and MPFMs for well testing.

24.2 Production and HP Separators

Production Separators (V-1201 A/B/C) are provided to separate the gas, condensate and aqueous phases from the incoming well fluids. Horizontal 3-phase separator of capacity 2.5 MMSCMD each are envisaged. Total 3 Nos. (2 working + 1 standby) Production Separators are provided and are skid mounted for any relocation required later. Gas from the Production Separators is routed to the Dehydration unit through KOD drum for further processing and condensate is sent to the manifold at EPS, Baghjan, while water is routed to the Raw Effluent water tank.

HP separator (V-1203) is provided for separation of the well fluids at high pressure and for using the gas for gas lift. Four heaters (H -1001 A07 to A10) shall be connected to the HP Separator in Phase I.

24.3 Multi-phase Flow Meter

Multi-phase flow meter (MPFM) shall be provided as required by OIL, instead of Test separator for accurate testing of the well fluids. Single MPFM capable of testing well fluids at the rate of 1 MMSCMD is to be provided.

24.4 Dehydration Unit

Gas from the Production separators, as well as the Associated Gas from the existing EPS AT Baghjan is routed to the dehydration unit for removal of moisture to meet the pipeline gas specification. Moisture in the gas is knocked off in the Knock out Drum before the Dehydrating unit based on Tri- Ethylene Glycol (TEG). The system consists of TEG Contactor, Gas /Lean TEG Heat Exchanger, series of Filters, Glycol drain/storage and Transfer System.

In the Contactor tower, mass transfer of water takes place from the gas flowing up which comes into contact with the glycol flowing down the Contactor. Gas leaves the Contactor from the top through a mist extractor located at the top of the tower to remove entrained glycol in the gas.

Glycol from the bottom of the Contactor is preheated in the Glycol Still overhead condenser and passes into the Glycol flash tank where the pressure is reduced. Sufficient glycol retention time is provided to ensure degassing of the glycol and

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removal of any liquid hydrocarbon. Rich glycol is then filtered in a series of filters to remove solids and entrained hydrocarbons respectively. Rich glycol is heated using the lean glycol leaving the regenerator in the Rich/Lean exchanger. Degassed, filtered and preheated rich TEG is piped to Glycol Still column placed above the direct fired heater based Reboiler which together makes up the Regeneration Unit. Water and TEG are separated by fractional distillation to 99 wt % TEG. Water vapour leaves the top of the column and the rich glycol entering the column is progressively heated by the Reboiler. Concentrated TEG is further stripped using gas to 99.5% concentration. Hot Lean Glycol which leaves the tower flows by gravity through the Rich/Lean glycol exchanger cooling it while preheating the rich glycol feed. Lean TEG from the Regenerator is recycled back to the TEG Contactor via Rich/Lean exchanger, Glycol Surge Drum and Gas /TEG exchanger.

Outlet gas from the unit shall meet the specification indicated in 2.2 above and is metered and fed to the FGGS Delivery Gas (Sales gas) pipeline.

24.5 Fuel Gas System

Fuel Gas (Natural gas) required for the Captive Power Plant generator/ fired heaters will be taken from the outlet of the Scrubber of the Gas dehydration Unit. Pressure reduction as required shall be carried out and the gas filtered. For initial start-up, fuel gas shall be sourced from the existing EPS.

24.6 Effluent Treatment

An ETP of capacity 1000 KLPD is to be installed in the FGGS in 2 trains of 500 KLPD each. The ETP shall be designed on the philosophy of zero discharge from the installation. Formation water shall be treated to achieve the following limits for the treated water output from the ETP.

Oil content	: < 10 ppm
Sludge content	: Nil

The water separated out in test and production separators are received in Raw Effluent Tank. Oily wastewater from the tank is pumped to the Effluent Treatment Package for treatment. Formation water from existing EPS shall be treated in the ETP. The package will comprise of corrugated plate interceptor, induced gas floatation unit, and filter. De-oiled water from IGF is sent to the nutshell filter to meet the required sludge content and oil-in-water specifications and taken to the treated effluent water storage tank to be disposed of in the injection wells with high pressure treated water disposal pumps. Separated oil will be routed to the CBD vessel from where it is pumped to the EPS.

24.7 Flare system

The flare system shall receive PSV discharges and blow down from equipment and inlet manifolds. Condensate in the flare gas is collected in the LP and HP flare KODs which is pumped using the respective KOD pumps to an underground Closed Blow down (CBD) vessel and the gas is routed to the non-luminous enclosed ground flare system.

The enclosed ground flare system shall also receive LP and HP flare gases from existing EPS facility at Baghjan. Baghjan EPS flare gas headers of suitable sizes with input points to hook up flare lines from existing HP Flare and from the existing LP Flare, VLP

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Flare and PSV discharge shall be provided. Additional points are also to be included for future provision.

Enclosed Ground Flare Package is sized for 3.5 MMSCMD gas and 2.5 MMSCMD for HP and LP gases respectively from FGGS-BJN and EPS and shall include dedicated PLC based burner management systems, knock out drums, water seals etc.

24.8 Closed Blow Down System

Oil drains from the separators, flare KODs and other process equipment are routed to the Closed Blow down Vessel located below ground. A submersible pump is provided inside the vessel to recycle the collected oil to EPS for reprocessing.

24.9 Water Treatment and Supply

Water for Baghjan FGGS available from deep water/shallow water bore wells to be dug in the area is to be treated and used for firefighting, drinking and as service water. Sufficient water storage capacity has to be provided at station. Bore well water is pumped to the FGGS, treated through Pressure Sand Filter/ Multi-media Filter for turbidity and iron removal and used as service water. Two, overhead, HDPE, Service Water Storage tanks with adequate storage capacity shall be provided and service water is distributed by gravity through the service water header.

Filtered water is further chlorinated and/ UV treated for use as potable water. Potable water is stored in two, overhead, HDPE Potable Water tanks from where it is distributed by gravity.

24.10 Instrument Air and Nitrogen

Instrument air requirement of the FGGS-BJN is met by an Instrument Air Package, which includes Instrument Air Compressor, Plant Air Receiver, Air Pre-filter, heatless type Air Dryer and After-filter. Instrument air from the dryer package is received in Instrument Air Receiver and send to Instrument Air header. Nitrogen required for purging the gas systems for maintenance/start-up shall be sourced in tankers or cylinders.

24.11 Contaminated Rain Water System

Since the site falls in a heavy monsoon felt area, during extreme rainy season, the excess rain water from the storm water drain need to be accommodated in the ground water reservoir. Storm water will be collected in a pit before pumping to the Ground Water Reservoir which will be sized based on the rainfall data and reported in the discipline design basis. A single outlet for the water collected in the Ground water reservoir to the canal outside the battery limit of FGGS is also provided which is to be used only in case of emergency.

25.0 FIRE FIGHTING & PROTECTION FACILITIES:

Firefighting systems shall be provided for FGGS, Baghjan conforming to OISD Std. 116 and 189. Fire Water network shall have the ring main pressurized at 7 Kg/cm² g residual pressure using Diesel pumps conforming to BIS standard. Capacity of the diesel pump shall be for 4 hours continuous fire fighting requirement considering double fire scenario. The entire fire system shall be in auto mode.

All the pumps shall operate in auto mode. The ring main shall have water cum foam

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monitors & hydrants at a regular spacing as per the norms with necessary hose boxes along with type 'B' synthetic hoses and nozzles. The entire fire water ring main shall be maintained at 7 Kg/cm² pressure at the hydraulically remotest point with the help of automatic electrical motor driven jockey pump. FGGS shall be covered with fire detection and alarm system addressable at control room with manual call points at strategic locations. Automatic fire detection and alarm system shall be provided for control room. The foam system shall be SS.

26.0 SAFETY STUDIES

The following studies are to be carried out and necessary documentation/reports generated. Approval from OIL and other statutory bodies are to be obtained.

26.1 HAZOP Study

HAZOP study shall be carried out on the P&IDs of the main process units, utility and auxiliary systems handling hydrocarbons with the aim to check the adequacy of the instrumentation and safety provisions and to identify any operation related problems/hazards.

26.2 QRA Study

Quantitative risk assessment of the entire FGGS-BJN facility and surrounding is to be carried out and report shall be submitted to OIL for approval.

26.3 ERA Study:

Risk to plant personnel within the FGGS facility in terms of number of fatalities per year of Potential Loss of Life for the plant as a whole is to be evaluated. Risk to environment shall also be evaluated and presented.

26.4 SIL study

Detail SIL (Safety Integrity Level) study based on the HAZOP and Risk analysis study results/data has to be carried out to comply with IEC61511 & IEC61508 standard requirements. The SIL study should determine all the safety functions that will be required to achieve risk reduction to "ALARP" (as low as reasonably practicable level) and then the requisite SIL level should be assigned to each safety function. The SIL study should determine the safety requirement specifications (SRS) for the proposed safety instrumented system for the entire FGGS-BJN facility.

26.5 EERA Study

An escape, evacuation and rescue analysis shall be carried out considering the method of escape and evacuation which shall not expose the evacuees to a higher level of risk than the emergency situation and should enable the rescuers to search locate and remove persons from the plant and its neighborhood to a place of safety without causing injuries or worsening any injuries already sustained.

26.6 DMP and EIA Study

Disaster Management Plan for the installation shall be developed and Environmental Impact Assessment (EIA) study shall be carried out for the FGGS –BJN facility.

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ANNEXURES

ANNEXURE -1

COMPOSITIONS OF INLET GAS & ASSOCIATED GAS

Components	NAG Composition Vol%		AG
	Well # A	Well # B	Well # C
C ₁	90.26	91.09	90.53
C ₂	4.46	4.46	4.41
C ₃	1.31	1.27	1.34
i C ₄	0.22	0.22	0.24
n C ₄	0.29	0.28	0.33
i C ₅	0.11	0.11	0.12
n C ₅	0.09	0.09	0.11
C ₆	0.13	0.22	0.17
N ₂	1.27	1.09	0.92
CO ₂	1.86	1.17	1.83
O ₂	0	0	0
Gas properties:			
Gas sp. gravity	0.627	0.6213	0.6278
Gross Calorific value, Kcal/SCUM	9423.9	9525.2	9492.7
Net calorific value, Kcal/SCUM	8507.0	8598.9	8570.0
Water Content (Gas), lbs/mmcf	620	600	750

Note: For design case, maximum 2.25% CO₂ and 1000 lbs/mmcf water content in the gas is taken as worst case scenario.

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ANNEXURE -2

ANALYSIS OF FORMATION WATER

Characteristic	Unit	Sample 1	Sample 2	Test method/Instrument
Appearance	-	Turbid	Turbid	Visual
pH	-	7.1	7.2	Metrohm pH meter
Salinity NaCl	mg/l	3400	3400	Titration with silver nitrate
Carbonate as CO ₂	mg/l	Nil	Nil	Titration with Hydrochloric acid
Total dissolved solids	mg/l	2470	2510	Gravimetric method
Suspended solids	mg/l	2178	2248	Gravimetric method
Oil and Grease	mg/l	73.6	10.8	Horiba oil content analyser

Note: For design of ETP oil in inlet water of 200 ppm and salinity of 3500mg/l be shall considered.

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ANNEXURE -3

BORE WELL WATER ANALYSIS

Characteristic	Unit	Acceptable limit as per IS 10500-2012	Sample 1 Raw	Sample 2 Filtered	Sample 3 I.M. Office (Tube well Water)	Test method/Instrument
Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	By sniffing
pH	-	6.5-8.5	6.7	6.8	6.5	Metrohm pH meter
Turbidity	NTU	1.0(max)	82.6	21.1	95.6	Hach turbidity meter
Chloride (as Cl)	mg/l	250(max)	8	9	11	Titration with silver nitrate
Total hardness (as CaCO ₃)	mg/l	200(max)	76	58	74	Titration with EDTA
Iron (as Fe)	mg/l	0.3(max)	2.7	0.72	2.0	Spectrophotometer
Total dissolved solids	mg/l	500(max)	89	81	60	Gravimetric method
Alkalinity(as Ca CO ₃)	mg/l	200 (max)	85	75	90	Titration with Hydrochloric acid
Mineral Oil	mg/l	0.5 (max)	Nil	Nil	Nil	Horiba oil content analyser

Note

Water treatment plant shall be designed for 5ppm (max) iron and 100ppm (max) turbidity in the inlet water.

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0	Issued for ITB	17-07-2019	RJ	RV	CK	
E	Issued for Approval	25-05-2019	RJ	RV	CK	
D	Issued for Approval	14-05-2019	RJ	RV	CK	
C	Issued for Approval	25-04-19	RJ	RV	CK	
B	Issued for Approval	09-04-19	RJ	RV	CK	
A	Issued for Review/Approval	15-03-19	RJ	RV	CK	
REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

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1.0 INTRODUCTION

M/s OIL India Ltd (OIL) is a Navaratna Company under the Ministry of Petroleum and Natural Gas, Govt of India. As an integrated upstream company with pan India presence and overseas wings spreading over different parts of the globe, OIL is engaged in exploration, production and transportation of crude oil and natural gas and production of LPG with its headquarter at Duliajan, Assam. In line with OIL's strategy for balanced growth, an ambitious plan for development of non-associated gas fields is presently underway in OIL's Upper Assam operational area. As a part of this development scheme, OIL desires to construct a modular Field Gas Gathering Station (FGGS) for augmenting natural gas production facility at Baghjan field in Upper Assam, India.

Jayathe Petrotech Engineers and Consultants (JPEC) have been awarded the contract for Engineering and Project Management Consultancy for developing the engineering and managing project execution.

1.1 PROJECT OBJECTIVE

The Baghjan field is having huge amount of Non Associated Gas (NAG) potential and the expected gas production from this area in 7.5 MMSCMD. To explore these resources one modular Field Gas Gathering Station (FGGS) having the facilities for production of natural gas are to be created. The proposed FGGS shall have Non Associated Gas (NAG) processing facility for 5.0 MMSCMD (2 trains x 2.5 MMSCMD) and provision to feed Associated Gas (AG) of 0.5 MMSCMD along with the NAG to a Glycol based Dehydration facility (5.0 MMSCMD) for achieving water dew point less than or equal to (0) Zero Deg C. The facility shall include Production and Test Manifolds, Gas /Condensate/Water Separators, Gas Dehydration, Flare system and Effluent Treatment and disposal system along with all the required utilities and auxiliary systems. Space provision will be made within the plant to augment its capacity by installing one more train of 2.5 MMSCMD in future.

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2.0 ARCHITECTURE

2.1 GENERAL

2.1.1 Scope

- This documents covers the general requirements for the Design of Buildings, Sheds, (not limited to the buildings types, covered in this specification) so as to provide enough space for operation, maintenance of machinery and provide for the plant workers good and safe environment.
- The design shall be based on Local Statutory requirements.

2.1.2 Codes and Standards

The Indian codes and standards are applicable, unless otherwise specified. The codes and standards to be followed are as under:

- National Building code of India

2.1.3 Related Engineering Specification

All engineering specifications.

2.1.4 Units

Unless otherwise specified MKS units shall be applied as the measurement system to the Drawings and Documents.

2.1.5 Priority of Requirements

In case of any discrepancy among the Codes / Standards, related Design Specification and this document (Design Basis), the priority order shall be as under:

- This Document
- Related Design Specification
- Codes and Standards

2.2 MATERIALS

2.2.1 General:

All buildings shall be aesthetically designed with modern materials. Materials requirements unspecified in Engineering Specifications shall conform to manufacturer's standards. There will be limited building construction work at site. Only three building are to be constructed at site .There are

1)Operators accommodation - RCC structure

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2)Security barrack -RCC column with steel roof structure

3)Administration building -RCC column with steel structure roof

All these buildings should be aesthetically designed and should have a modern look.

2.3 PLANNING

2.3.1 Layout and Elevation

2.3.1.1 Layout of Buildings / Sheds shall be simple rectangular shape in general. Spacing of columns shall be unified as far as practicable and shall be determined in consideration of material of construction viz. R.C.C. or Steel.

2.3.1.2 Requirements of ceiling height shall be as per functional requirements and applicable factory rules.

The height shall be determined considering the clearance from equipment, bus Duct, HVAC duct, piping features etc.

However for some of the building areas the following minimum ceiling height requirements shall be followed.

Table - 1 – Ceiling Height

Sr. No.	Description	Minimum Ceiling Height*
1	Minimum height of any habitable room	3000 mm

*All height dimensions are to be underside of ceiling/beams, whichever is lower.

The height shall be determined considering the clearance from equipment, bus duct and lighting fixtures etc.

2.3.1.3 Width of stair shall be 1000mm minimum, unless otherwise specified.

2.3.2 Building Plinth Height

Building Plinth Height shall be minimum +450mm from FGL.

The minimum height of outdoor and indoor pedestals (supporting structures) shall be 300mm and 200mm respectively above the highest paving level/ floor finish level whichever is higher. The projection of pedestals for staircase/ ladder shall be 200mm.

2.3.3 Main Construction

2.3.3.1 Main Structural Construction of buildings, such as R.C.C., Steel, combined R.C.C. / Steel and masonry shall be properly selected by confirming to B.I.S. (Bureau Of Indian Standards).The building construction work will be limited. Only three main buildings will be constructed at site. Most of the other facilities like substation, switch

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gear room, control room, laboratory instruments and mechanical workshops, ware house etc. should be containerized type. These containerized units will be supported directly on RCC grade slab. All the process units (manifold, heaters, vessels, KOD) should also be supported directly on grade slab. Foundations are to be provided only for very heavy equipments or vibrating equipments which cannot be placed directly on grade slab without foundations. Grade slab for placing the containerized unit should be raised up above the surrounding area.

2.3.3.2 Typical main construction of buildings are given in the following table.

Table – 2 – Typical Main Construction Of Buildings

Building	Main Structural Construction	Remarks
Control room building /Substation	Containerized	Cover shed to be provided over these for protection from rain.
Security barrack	RCC columns. structural steel truss roof	Precoated GI roof sheeting
Guard room	Containerized	
Compressor sheds/Other sheds	Steel structure	Prefabricated steel structure with precoated GI sheet roofing.
Operators accommodation	RCC structure	
Administration building	RCC columns. structural steel truss roof	Precoated GI roof sheeting

All steel structure platforms, sheds etc. shall be prefabricated at shop and assembled at site. All prefabricated parts should be sized so as to fit in to standard size containers.

2.3.3.3 All structural steel shall be prefabricated where ever possible. Connections shall be Bolted. Welding at site has to be avoided. Site work shall be minimised to the maximum possible extent. The purpose of this is to speed up the work and complete it within the assigned time and also due to other environmental issues.

Tall sheds with structural steel columns and trusses (or steel beams for small spans) with colour coated roofing sheets will be erected over the containerized units for protection from sun and rain. These sheds shall be prefabricated and assembled/erected at site. All welding for these structures shall be done in fabrication shop and only bolted connections will be allowed at site. These sheds should be sized so as to cover as many containerized units as possible.

Another major work at site will be earth filling, levelling and grading. FGL shall be .5m above existing well plinth at location TP (BGN#2). The FGL should have a uniform

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gradient from the middle of the site. It should be 1:500 in longer direction and 1:400 in shorter direction. Filled up earth should be compacted to 95% proctor density up to FGL.

Pipe racks and pipe bridges shall be prefabricated structural steel. These are to be assembled/erected with bolted connections at site. All roads, approaches, footpaths, walkways, culverts, parking, piping manifold area, storm water drains etc. shall be RCC.

2.4 BUILDING ELEMENTS

2.4.1 Roof

2.4.1.1 In case of reinforced concrete framed building, the roof shall be made of cast-in situ reinforced concrete and shall be made completely waterproof. Proper slope shall be given towards outlets for drainage purpose. The roof for the administration building/office building and the security barrack may be colour coated roofing sheet with aesthetic design.

2.4.2 Wall

2.4.2.1 Internal / partition walls shall be made of common bricks and shall be of minimum 115 mm thick. Surfaces of common bricks shall be finished by cement mortar.

2.4.2.2 The external / load bearing wall shall be made of common bricks and shall be of Minimum 230 mm thick.

2.4.2.3 Fire walls (around transformers) shall be minimum 350 mm thick made of fire bricks.

2.4.3 Floor

2.4.3.1 Floor on grade

Type wise floor on grade to be adopted shall be as below:

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Table - 3 - Types of Floor on grade

Sr. No.	Facility Name	Type Of Construction
1	Containerized building resting on grade slab	-150 mm thick concrete slab (M15) with layer of 8 mm dia. Tor reinforcement bar @ 200 mm c/c (both ways) top & bottom. -50 mm thick Levelling Concrete (1:5:10) below concrete slab. -150 mm thick compacted sand below Levelling Concrete.
2	For Non-Plant Buildings like Administration Building/office building/Security barrack/Operators accommodation	-The buildings floor shall be ceramic tiles finish. -100 mm thick concrete slab (M15) -Construction - 50 mm thick Levelling Concrete (1:5:10) below concrete slab -150 mm thick compacted sand below Levelling Concrete.

Note: - Structural concrete slab shall be cast in alternate panels and no dimension of the panel shall exceed 7.5 m.

Toilets, Kitchens, pantry & dining shall be ceramic tiles finish.

2.4.4 Damp Proof Course

Plain cement concrete of mix 1: 1 1/2: 3 of minimum 40 mm thickness (using 100 mm & down size graded aggregates) shall be provided as damp proof course at plinth level of all masonry walls.

Waterproofing compound shall be added to the damp proof course to prevent Percolation of water to superstructure.

2.4.5 False Ceiling

2.4.5.1 False ceiling shall be provided in areas wherever air conditioning is required.

2.4.5.2 False ceiling shall be of 84C aluminium pre coated.

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2.4.5.3 Suitable space shall be kept to enable suitable arrangement of service duct cable, piping and lighting fixtures.

2.4.6 Doors / Windows / Ventilators

Following general guidelines shall be applied:

- (1) External doors shall be made to open outwards.
- (2) Wooden windows / ventilators shall not be used.

2.4.6.1 Room-wise requirement of door is stated as in the following table.

Table – 4 – Doors-Non Containerized Building

Sr. No.	Room / Area	Finish
1.	Main Entrance Door	Collapsible steel gate
2.	Toilet, Drinking Water Area, Pantry.	Single Shutter PVC Panelled door with Aluminium Frame.
3.	Office, Cabins.	Single Shutter Anodized Aluminium Glazed door & frame.

2.4.6.2 Pressed Steel Doors

The pressed steel doors shall conform to IS: 4351.

2.4.6.3 Aluminium Doors

All aluminium doors shall be glazed anodized aluminium doors with closing devices.

Doors shall have heavy duty locks and vertical Venetian blinds.

2.4.6.4 Windows / Ventilators

All windows / ventilators for buildings shall be Anodized Aluminium windows / ventilators of industrial type conforming to IS: 1038 / IS: 1285.

2.4.6.5 Requirement for windows / ventilators is as stated below :

Table – 5 – Windows / Ventilators

Sr. No.	Room / Area	Finish
1.	Windows and Ventilators.	Anodized Aluminium Windows / Ventilators

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	with 5.5mm thick toughened glass.

2.4.6.6 Fly mesh shutters shall be provided for Kitchen, Pantry, Dining hall windows / ventilators.

2.4.6.7 Rolling Shutters

- (1) Rolling shutters shall be provided wherever area requirement of open able shutters exceed 2500 mm x 2500 mm.
- (2) For opening width from 2500 mm to 3000 mm, it shall be manually operated if the opening height is less than or equal of 2500 mm. In case opening height is more than 2500 mm, mechanically operated rolling shutter shall be used.
- (3) For opening sizes more than 9 m² (or opening width more than 3000 mm), it shall be mechanically operated type, irrespective of the height of the door.

2.4.6.8 Partitions :

Glazed aluminium partitions shall be provided for Console Area, Rack Room, EC/PLC Room, and Operator Room etc. The partition shall be consisting of Anodized aluminium sections for framework and both side laminated (1 mm thick) MDF board (12 mm thick) lower panels up to 900-1000 mm.

Partitions for office areas shall be of 18 SWG MS framework of 52 mm x 38 mm sections @ 600 mm both ways & 12 mm thick Gypsum board panels on both sides finished with plastic emulsion paint.

2.4.6.9 Glazing

All glazed partitions, doors, windows / ventilators shall be provided with 5.5 mm thick toughened glass.

Toughened tinted glass (5.5mm thick) shall be provided for Doors/ windows in Administration building.

Front Facia of Administration Building shall be provided with 12mm thick Toughened Tinted Glass

2.4.7 Hardwares

All hardware fittings and fixtures for doors, windows and louvers (e.g. hinges, bolts, locks, latches, stays, door-stops, door closers, floor springs) shall be heavy type matching to the size and weight of the door/ window/ ventilator shutters. Fittings should operate without jamming, require nominal maintenance and should be durable under prevailing/weather conditions.

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2.4.8 Steps / Ramps

Steps / Ramps shall be provided for access to buildings, sheds for pedestrian / vehicular, equipment entry. Minimum 1000 mm wide platform shall be provided between Entrances door and ramps. Following dimensions of steps / ramps shall be followed :

- (a) Tread.....: 250 mm (Minimum)
- (b) Riser.....: 150 mm (Maximum)
- (c) Slope of ramp.....: Not steeper than 1:6
- (d) Ratio of tread and riser
 - (i) Non-plant buildings.....: Riser + tread = 420 to 450 mm
 - (ii) Other buildings.....: 2 Riser + tread = 600 to 648 mm
- (e) Minimum width of steps / ramp.....: 1000 mm

All the flat roofs shall be accessible either by ladder or staircase for maintenance.

2.4.9 Canopy / Overhangs / Shading Devices:

2.4.9.1 Canopy / Overhangs:

Canopy / overhangs shall be provided at all entries and exits for rain and sun protection as per following requirements.

- (a) Canopy shall be provided to all the entrance of administration building ,Security barrack, Operators accommodation building.
- (b) Size of canopy / overhang shall be decided based on vehicle parking, covered access to buildings / sheds, movement around the vehicle and aesthetics of building / shed.
- (c) Overhangs shall be provided over all exits. Minimum 900 mm overhang shall be provided.

2.4.9.2 Shading Devices

Shading devices over windows / ventilators such as chajja shall be provided for rain / sun protection. These devices shall be in the form of horizontal projection, vertical projected fins or combination of both as per building facade treatment. Minimum projection of chajja shall be 600mm.

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2.4.10 Parapet

Parapets shall be minimum 300 mm high for non-approachable roof and 900 mm high for approachable roof. Parapet up to 600 mm high shall be of R.C.C. In case of future expansion, GI/MS removable railings shall be provided.

2.4.11 Plinth Protection

All buildings / sheds shall be provided with 1000 mm wide plinth protection (100 mm thick concrete of grade M15 over 150 mm thick compacted sand layer) all around buildings/sheds.

2.4.12 Roof gutter

Roof gutter with rain water pipes shall be provided for RCC buildings and sheds, shelters for roof water drainage. Gutters shall be of R.C.C. or MS sheet metal type depending on type of structure.

2.4.13 External Finishes

(1) Plastering

External surfaces of brick walls shall receive 16 mm thick (1:6) sand faced cement plaster.

(2) Painting

External plastered surface of buildings shall be painted with cement based paint (SNOWCEM or equivalent)

(3) Portico Columns in Administration building and control Room shall be covered with black granite cladding.

2.4.14 Internal Finishes

(1) Painting

All internal plastered surfaces shall be painted with plastic emulsion paint.

Note:

1. 100 mm high skirting shall be provided in all areas.
2. Cement plaster skirting shall be provided in areas having cement concrete, granolithic / heavy duty flooring.
3. For other areas, skirting shall be provided of same material as that of flooring.

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2.5 PLUMBING

2.5.1 Materials

2.5.1.1 Water Supply :

UPVC pipes and fittings conforming to IS: 4985 :2000 shall be used for water supply.

2.5.1.2 Rain water pipes:

Rain water pipes shall be provided to drain off the rain water accumulating on roof efficiently. Nos. and dia. shall be decided on area of roof, slope and rainfall intensity. Rain water down take pipes shall be of UPVC (Class -1, IS 4985 :2000). Rain water pipes shall be embedded in concrete /brick for administration building, Security barrack, Operators accommodation. For other building rain water pipe may be exposed.

2.5.1.3 Sewage System:

- (1) UPVC pipes (type B, IS 13592 : 2013 shall be used for sanitary / sewage above and below ground.
- (2) Domestic sewer collected from buildings shall be directed towards septic tank for treatment. Treated water from septic tank shall be discharged to soak pit. Number and capacity of septic tank and soak pit shall be decided based on number of users. Flow from one or more buildings may be combined to common septic tank and soak pit.

2.5.1.4 Drainage System

Rain Water from the buildings shall be discharged into the storm water drain through roof gutters and down take pipes.

- (1) Unless otherwise specified, the oil contaminated water from buildings shall be connected to the oily sewer system of the plant.

2.6 OTHERS

Underground pits, drains, cable & pipe trenches and sewer system shall be made water tight as water table during monsoon rises substantially.

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3.0 GENERAL CIVIL

3.1 Scope

This document covers engineering Design Basis for General Civil Works such as development of plot plan, roads, pavements, storm water drainage, water supply, oily water sewer, tank and other equipment foundations, dykes, site finishing, fencing, miscellaneous civil works such as barricading, pipe sleepers, pipe way bridges etc.

3.2 Codes and Standards

Only latest edition of the codes and standard shall followed. In case of conflict between codes and standards and job specification more stringent requirement shall be prevailed in general. Following codes shall govern:

OISD-118	Layout for oil & gas installation.
OISD-189	Stand on fire fighting equipment for drilling rigs, work over rigs and production installations.
OISD-116	Fire Protection Facilities for Petroleum Refineries and Oil/ Gas Processing Plants
OISD-117	Fire Protection Facilities for Petroleum Depots, Terminals and Pipeline Installations
OISD-164	Fire Proofing in Oil & Natural Gas Industry
OMR	Oil Mines Regulations
IRC-37	Design Code of Flexible Pavement

3.3 Plot Plan

Plot plan shall be developed as per the OISD-118 & OMR. Inter distances between process unit, equipment, storage tanks, buildings, boundary wall, flare (ground) and line of adjoining property shall be considered as defined in the above codes & standards.

3.4 Green Belt

Green belts inside the plant boundary of the area shall be considered based on accepted norms for environmental protection in India.

Fencing to be provided for area demarcation only as shown in plot plan.

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Type of Fencing : Wire chain link type with precast
RCC post, M-15 Foundation block, M-10 for PCC

3.5 Roads

RCC roads shall be provided around (all side) the process area for access & approached for fire fighting (in the event of blockage on one route). Road width, gradient & turning radii at junctions shall be followed as below to facilitate movement of the largest fire fighting vehicle.

Road Width

Location	Road way	Carriage way
1. Main roads for Product movement & Approach to Site.	8.5 M	5.5 M +1.5m wide shoulders on either side
2. Other Roads	6.5 M	4.5 M +1.0m wide shoulders on either side
3. Foot path	1.0 M	

Design Parameters

Camber : 1 in 50

Radius of curve : 13.0 m for 6.5 m roadway

Ruling Gradient : 1 in 30 (in plain terrain)
1 in 20 (in hilly terrain)

Design of Road crust thickness : As per IRC-37, 2001 for 2.0 msa

Finish : Bituminous carpet with seal coat of minimum 50 mm thickness.

Road level above FGL : Min. 0.6 M above F.G.L.

3.6 RCC Pavements

Pavement Slope : 1 in 100

Type Vehicular movement area: Type-I (200 mm thick RCC);

Non vehicular movement areas: Type-II (150 mm thick RCC);

Offsite pumps station : Type-III (100 mm thick RCC).

Refer standard : Pavement shall be constructed in panels with provision of construction, expansion / contraction

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and sealing joints.

3.7 Site Finish

Site grading to be done to obtain on FGL which is 0.5m above existing well plinth at location TP (BGN#2) . The FGL will have on uniform gradient from the middle of the site and it will be 1:500 in longer direction and 1:400 in shorter direction.

Area as given below shall be provided with top finish.

Area type	R.C.C	Asphalt	PCC	Gravel or stone chips	Compacted earth surface	Stone pitching
Operating area (units)				*		
Non-operating area (units)				*		
Road	*					
Approaches	*					
Footpath	*					
Tank farm					*	
Between unit & roads					*	
Parking	*					
Piping manifold	*					
Road slope						*
Pipe ways						
Open storage/Main areas	*		*			
Sphere area(with kerb wall)	*					

3.8 Storm Water Drains

STORM WATER DRAINAGE

Storm water drains shall be of RCC. Storm water drain shall be sized for the higher discharge arising out of rain water. The design intensity of rainfall shall be 100 mm per hour.

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Rain water run-off shall be computed by the formula-

$$Q = KIA/360$$

K is run-off coefficient given below,

A is area (hectares) contributing to drain,

I is rainfall intensity (mm/hr),

Q is the discharge.

Design of drains shall be computed by the formula-

$$V = R^{2/3} S^{1/2} / n$$

V is velocity of flow m/s,

R is hydraulic radius m,

S is slope,

n is roughness coefficient taken as 0.013 for plastered surfaces, 0.015 for cast-in-concrete 0.017 for brick lined.

The following parameters shall be ensured while sizing:-

Minimum velocity of drains : 0.6 m/s

Maximum velocity of drains : 2.4 m/s

Minimum depth of drains : 300 mm

Minimum width of rectangular drains: 300 mm (for depth < 500 mm)

Minimum width of drains :500 mm (depth >500 mm)

Run off co-efficient 'K'

a. Paved area Concrete : 1.0

Bituminous : 0.9

b. Unpaved areas : 0.7

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c. Unusable areas like Green belt : 0.4

Drain details

Drain section : (i) Rectangular type covered by hot dipped galvanized MS gratings in and around units.

(ii) Rectangular type without cover at other places i.e. road side around building etc.

Material of construction: Brick work with cement plaster.

Culverts

Storm water drains shall cross the road by suitable pipe culverts or box culverts. Design of culverts shall be for heavy crane loads on crane movement roads. Material of construction of culverts shall be as below:

Pipe culverts : RCC pipe class NP3 as per IS:458. Minimum Size-350 mm) (Encasement shall be provided if clear cover over pipe from road top is less than 600 mm.)

Box culverts : RCC construction. (Minimum M20 Type)

The culverts shall be designed running 2/3 full conditions with minimum velocities as 0.6 m/sec. & maximum as 2.4 m/sec. based on Manning formula. The min. cover over culvert shall be 1200 mm. In case of less cover on pipe culverts, pipe encasement shall be provided.

3.9 Pipe Way Bridges

RCC pipe way bridges shall be provided for crossing of process pipelines under the roads and the width of crossing shall be based on pipe ways. Selection of the type and the size of bridge shall be based on number of pipe & wheel load on slab.

Design Loads: As per relevant IRC loads for roads or expected crane wheel loads whichever is more.

Material of construction

Foundations & walls : RCC M30 grade

Precast cover : RCC M35 grade

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Cross section : As per standard

3.10 Pipe rack

Pipe racks shall be designed for the loads given by piping. Thermal loads due to constraint and frictional forces of piping and equipment shall be considered as follows,

1. A minimum of 10% of the gravity load on pipe racks carrying 5 or more lines, at each level.
2. A minimum of 30% of the gravity load on pipe rack carrying less than 5 lines at each level.

If the horizontal loads provided by piping stress analysis is greater than the above, then the higher values are to be used.

Pipe racks shall be moment resisting frames in transverse direction. Cross bracing may be provided along longitudinal direction for stability.

3.11 Sleepers

The RCC sleepers for process piping and fire water lines shall be designed based on soil investigation report and the horizontal/vertical loads of the pipes running full. The sleeper shall conform to standard (minimum requirement). Firewater piping sleepers shall be independent of process piping sleepers. Design of sleepers shall be done taking into account soil conditions as per soil investigation to be carried out.

3.12 Electrical / Instrumentation Cable Road Crossing

ERC/IRC road crossing : PVC pipe conformed to IS: 4998 encased in concrete as per STEP standard

RCC / brick masonry cable trenches shall be with pre cast cover designed to sustain the maximum load envisaged. Buried cable trenches shall be made, as per electrical / instrumentation standards. At crossings electrical trenches shall be made below the instrumentation trenches. Wherever, storm water drains crosses the trenches, cable shall be taken below drains with RCC duct.

The cable crossing at roads & pipe way shall be either with group of PVC pipes (Min. dia. 150 mm encased with PCC M15) or RCC ducts. Clear cover over top of PVC pipe shall be 1200 mm. In case of less cover, RCC encasement shall be provided.

3.13 Drinking Water System

General

Drinking water shall be provided in the toilet blocks, kitchens, offices and drinking

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water points at some specified location (to be defined at detailed engineering stage) from the deep tube well with pumping arrangement & overhead tank on roof.

Source : Taping from nearest existing water header. Co-ordinates of tapings as per site location. Water header will feed the water from deep tube well after the treatment of water if required.

Distribution Network : Drinking water piping network shall be laid U/G in a closed Loop wherever possible. Isolation valves shall be provided at Junctions Valve pit shall be provided for valves in under ground drinking pipes.

Min. Clear Cover : 600 mm in open areas. 1200 mm below road crossings.

Design Data

Water demand Plant Service: 270 Litres/capita/day

Materials

Pipes (up to 150 mm NB) : G.I. as per IS: 1239, heavy

Valves : C.I. gate valve as per IS: 780 Gun metal valves as per IS: 778

Drinking Water Header

Drinking water header shall be provided by the EPC contractor and providing drinking water post including internal plumbing, piping, fittings, design, testing & commissioning as per relevant IS codes & specifications.

Underground GI piping shall be minimum dia 2". The line inside unit boundaries shall be either laid above ground on pipe rack. Drinking water posts at suitable locations. Drinking water headers on rack shall be insulated.

Water treatment shall be based on tube well water quality and suitable to provide potable water with chlorination. Additionally UV type water purifier shall be provided at all drinking water coolers/points.

3.14 Sewer System

Underground sewer system shall be as per following categories:

Sanitary sewer system

Oily waste sewer

3.14.1 Sanitary Sewer System Source

Sanitary sewer system shall collect waste from all toilet facilities provided in various

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plant and non-plant buildings & discharge to septic tank & soak pit. Size of septic tank for 80 person shall be considered.

Acids, caustics, hydrocarbons, rain water or other chemical waste shall not be discharged into the septic tank if any.

Estimate of Quantity

The flow shall be based on the following guidelines:

- No. of users. -Average daily consumption of water.
- Any exceptional requirement due to simultaneous use of fittings in buildings.
- Generally 90% of water supply may be expected to reach the sewer.

The sewers should be designed for minimum of 240 litres per capita per day considering 270 litres per capita day water consumption.

Cover

The minimum cover over top of sewer pipes shall be 600 mm. Under road, the sewers shall have a minimum cover of 1200 mm and shall be enclosed in cement concrete.

Sewer Design

i) Flow

The sewers shall be designed to a capacity of 3 times the average daily flow. From the consideration of ventilation in waste water sewer it shall be designed to run half full up to 400 mm diameter, 2/3rd full from 401 mm to 900 mm diameter and three fourth full for diameter greater than 901 mm at peak flow.

ii) Velocity

Sewers should be designed for a minimum velocity of 0.75 m/sec.at peak flow. The maximum velocity in the sewers should be restricted to 2.4 m/sec.

iii) Minimum Size

The minimum size of sewer shall be 150 mm for one building (Toilet Blocks) and 250 mm for two or more buildings (Toilet Blocks).

Manning's Formula as given below shall be used for sizing of sewers.

$$V = 1/n \times (R)^{2/3} \times (S)^{1/2}$$

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V = Velocity in m/s

n = Manning's Coefficient

R = Hydraulic mean depth (m)

S = Hydraulic Gradient

iv) **Manholes**

Spacing

Dia. Of sewers (mm)	Max. spacing of manholes on straight reaches (m)
Up to 300	30
301 to 500	45
551 to 900	60
901 and above	as per local conditions.

Apart from manholes on straight runs these shall be provided at:

- Starting of sewers
- Junction of sewers -Change of direction
- Change of gradient or invert level of sewer
- Change of size -Dead ends of mains.

v) **Drop Manholes**

These shall be provided when the difference in elevation of the invert level of the incoming and outgoing sewers of a manhole is more than 200 mm drop from larger to smaller diameter shall not be made. The crowns of the sewers should be kept continuous. In no case the hydraulic flow line of the larger outgoing sewers shall be higher than the incoming one.

vi) **Material**

Sewer up to the first manhole shall be CI (IS: 3989 with concrete encasing) pipes.

3.14.2 Oily Waste Sewer (wherever applicable)

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This covers the basic design parameters of oily waste sewer in offsite and tank farms. Oily waste shall be collected and stored in a sump and subsequently pumped to the Central Static Sump.

Sewer Design

Design of sewer of gravity flow shall be as per as given below:

$$V = 1/n \times R^{2/3} \times S^{1/2}$$

V = Velocity m/s

N = Manning's Coefficient

R = Hydraulic men depth (m)

S = Hydraulic gradient

Sewers shall be designed as flowing full with peak flow taking future requirements or flowing 2/3 full without considering expansion. Minimum size of sewer shall be 150 mm.

Minimum velocity at half full shall be 0.6 m/sec. If sewage consists of large quantities of sediments the minimum velocity shall be 1.0 m/sec. subject to a maximum of 2.4 m/sec.

Sewers shall be designed for the sum of rain water and process water or fire water and process water whichever is more. Storm water quantities within tank farm areas shall not be included.

Fire Water Quantities

Sewers which are to drain fire water shall be designed for the following capacities:

- i) 2250 litres / minute entering first catch basin.
- ii) 1125 litres / minute entering each of subsequent catch basin.
- iii) 4500 litres / minute maximum carried by a lateral sewer.
- iv) 9000 litres / minute maximum carried by main sewer.

Minimum Sewer Sizes

Sewer lines serving equipment shall be sized for the anticipated flow with following minimum sizes:

- i) Lines serving a single discharge point and less than 10 m long shall be 100 mm

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- ii) Lines serving two or more points or over 10 m long shall be minimum 150 mm dia.

Cover

Minimum cover over sewer shall be 600 mm, however the sewer shall have cover of 1200 mm under the roads. In case of less cushion, the pipe shall be encased with 150 mm concrete encasing all-round.

Sewer Appurtenances

i) Manholes

The manholes shall be spaced as per IS: 1742 and IS: 4111 part I and generally as given below:

For sewers up to 300 mm diameter maximum spacing will be 45 m. For sewers up to 01-500 mm diameter, max. spacing will be 35m. For sewers above 900 mm dia. spacing depends on local condition.

ii) Location of Manholes

Manholes shall be Located at Junction of sewers Dead end of mains Change of grade or size of mains.

iii) Location of Sealed Manholes

Sealed manholes shall be provided on oily sewers at the following location.

-At connection manhole of branch sewers to main sewers to isolate each facility, contributing oily waste, from the risk of fire. Such connections may be from unit, tank farms, offsite, pump stations, compressor house etc.

-On main oily sewer lines at suitable points so as to provide fire barriers for segregation of vital hazardous installations from each other, along the sewer alignment.

-All sealed manholes shall have air tight covers and vents.

Sewer in Tankage Areas

Storm water shall be controlled by valve outside the dyke. Water draw off from crude oil slopes of storage tanks shall be through an underground sewer system controlled by valve just outside the dyke. Storm water from above areas shall be led to sand trap. The discharge from the sand trap shall be connected to the oily waste sewer (if it

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contains oil or other contaminants) or to an open drain outside the dykes (if the rain water is uncontaminated) through individual valves on the pipes. For diversion of uncontaminated water to storm water drain, bypass arrangement shall be provided with a valve. Minimum size of sewer carrying rain water shall be 200 mm dia and that carrying draw off from tanks shall be 150mm dia.

Material of OWS Sewer CS pipes confirming to piping class A3A.

3.14.3 OILY WATER SEWER (OWS)

Waste from equipment drains etc. shall be collected in funnel points and shall be drained through OWS, while uncontaminated areas (normally at periphery of the unit) shall be drained through ditches covered with Hot Dip Galvanised grating. Oily water sewer shall also collect oily waste / drain from pump, equipment through funnel points and shall be drained through OWS. OWS shall consist of underground carbon steel sewer with corrosion protection tape coating, funnel points, clean out, RCC manholes, vent pipes, flame arrestor etc. Open ditches of units shall have a bypass either to the OWS or to storm water drains of offsite.

Discharge Data Design discharge shall consist of:

- i) Process flow
- ii) Fire water or rain water whichever is more.

Normal design flow shall be 1.1 times of maximum of above two combinations. The normal flow shall be equal to average process flow. After the design flows shall be identified, sewer shall be designed for running full. Velocity at minimum flow shall not be less than 0.3 m / Sec.

Sewer Size

OWS sizes shall generally be governed by firewater flow or rain water flow. For first catch basin the sewer size shall be 200 mm. This is based on a fire water flow of 144 cum / hr. Similarly the min. sewer size from the subsequent catch basins shall be 300 mm based on fire water flow of 216 cum / hr. Each lateral sewer serving 4 or more catch basins shall be based on flow of 288 cum / hr. and the sewer size shall be 300 mm. The main sewer size for one unit shall be based on firewater flow of 600 cum / hr. based on unit of one hectare area.

For larger units, the design shall be accordingly established for sewer sizing. If rain water flow exceeds this flow rate, the sewer size shall be decided based on increased flow rate.

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All funnel drain shall be of minimum pipe size 100 mm dia. When 2 or more funnels join together, the OWS size shall be 150 mm.

The main oily waste sewer header shall not be less than 200 mm dia. All connections from funnel points shall be fire sealed.

Velocity

The slopes shall be provided so as to have the following velocities with sewers running full.

Minimum velocity 0.6 m / sec.

Maximum velocity 2.4 m / sec.

Cover

The maximum cover over pipes in unit areas shall be as below:

- i) 300mm : For the sewer of sizes up to 150 mm from equipment drain points to nearest main header or manhole.
- ii) 450mm : For main headers having size 150 mm and above, when located such that there is no chance of truck movement or crane movement over then.
- iii) 750mm : For headers in open paved areas when crane or truck movement can be expected. (Pipes shall also be encased with 150 mm thick concrete in this case).

Vent Pipes

Vent pipes shall be located along pipe rack columns or building columns and shall be provided 2 m above the building parapet or top layer of pipe rack.

Requirement of sealed manholes

Sealed manholes shall be provided in the following positions.

- On unit oily sewer / contaminated area sewer at the unit battery limit so that unit area is cut off from any fire in offsite area / sewer.
- Within the unit area, sealed manholes shall be provided in such locations so that each sub-unit within the unit is isolated from the other areas. In case this demarcation is difficult, one sealed manhole for every 30 m length of main sewer in the unit shall be provided.

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- At change of direction of the line.
- At entry of branch line to manhole or mainline.

Sealed manhole (with vent pipe) shall be used for CS pipes up to 400 mm diameter. For CS pipes greater than 400 mm diameter double compartment type manhole shall be used.

Future Requirement

During erection of main underground headers, two dummy points with caps shall be left in between two manholes / catch basin for joining left over / future connections.

Material

OWS - CS pipe confirming to piping specification with corrosive protection with coating and wrapping suitable for working temperature.

Manhole - RCC (M-20), with manhole, vent pipe, rungs etc.

Discharge from the catch basin (CB) shall be conveyed to a manhole.

3.15 Fire Proofing

Fire proofing shall be provided as per guidelines laid out in OISD-164 (Fire proofing in Oil & Natural Gas industry).

3.16 Barricade

Barricading shall be provided near construction area to prevent damage to existing facilities. The barricade shall be within the plot plan. The height of the barricade shall be; minimum two meters above the highest point of active work.

Barricading sheets shall be 150 mm below existing ground level. The barricade shall be properly designed/ constructed as per BIS codes. The barricade shall be made out of steel framework with galvanized iron sheets. Steel framework and its foundations shall be properly designed/ constructed as per BIS codes. The barricade shall also be provided with suitable piping arrangement to be connected to a pressurized water source to provide necessary water curtain. Any hot work above the point of barricade shall be done after getting the approval from OIL INDIA. After completion of the work, barricading including its foundations shall be removed and the site made good.

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4.0 STRUCTURAL

4.1 GENERAL

4.1.1 Scope

This design basis is intended to be an overview of information for the preparation of designs and detailed drawings of all relevant structural works.

All designs shall be carried out as per Job Specifications, Engineering Design basis, Standard Specifications, Standard Drawings and IS Codes / Statutory regulations.

4.1.2 Brief Description Of Some Of Works / Structures

In general, most of the superstructures will be made of prefabricated type wherever possible. Site work to be minimised and in order to speed up the work and complete it within time.

4.1.2.1 Compressor house

The air compressor will be a containerized unit and separate shed is not required. It will be within the same roof structure where the other containerized units will be placed. Size of the shed shall be as per approved equipment layout.

4.1.2.2 Equipment Foundations

All Equipment foundations shall be in RCC construction. Foundations for fabricated equipment (Horizontal vessels / Exchangers) shall be designed for water full condition (hydro test) with 50% wind load. For stacks, vertical vessels 25 % wind load shall be considered for test/ hydro test condition.

4.1.2.3 Substation Building

Substation building shall be completely containerized. Substation shall have either all or some of unit like Switchgear Room, Cable Cellar Room, Pressurization Plant Room, Battery Room, UPS Room, Staircases, Passage and storeroom, Toilets, Transformer Bays, and Hardware Room, cellar and access staircases, as per requirement. Some units like switch gear room, UPS room ,batter room ,toilet etc. may come as separate containers.

4.1.2.4 Security barrack

The security barrack will be RCC type for 30 persons. However, instead of one dormitory, 2 dormitories may be provided. There will be separate rooms for Officer-in-charge (with attached bathroom), one office room, one strong room, dining area & kitchen for the entire security team, one recreation room and lavatory. The fuel used

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in the Kitchen will be natural gas available at site. The dining space shall be furnished with Desk and Bench. The dormitories shall be furnished with beds (preferably metallic), cupboards, table-chairs etc. Also, Table, chairs etc. are to be placed in the office room & recreation room. Number of Bath rooms/ lavatory should be adequate. Provision for some open bathing/ washing area may be provided. Wash basins shall be placed separately (not in bath rooms). All rooms shall have adequate numbers of lights and fans.

4.1.2.5 Operator's room accommodation

The Operator's accommodation shall be RCC(double storied building) work and should accommodate 30 persons. There should be 6 single bed rooms, two room of four beds and two rooms of eight beds. Adequate dining area & kitchen for the entire team, one recreation room and lavatory shall be provided. The fuel used in the Kitchen will be natural gas available at site. The dining space shall be furnished with Desk and Bench. The dormitories shall be furnished with beds (preferably metallic), Table-chairs etc. Also, good quality Plastic Table, chairs etc. are to be placed in the recreation room. Number of Bath rooms/ lavatory should be adequate. Provision for some open bathing/ washing area may be provided. Wash basins shall be placed separately (not in bath rooms). All rooms shall have adequate numbers of lights and fans.

4.1.3 Site Information

4.1.3.1 Wind Data

BASIC WIND SPEED - AS PER IS: 875-1987-(PART-3)
Wind direction - As per Wind Rose.

4.1.3.2 Seismic Loads

Seismic forces shall be as per IS: 1893 –2002 (Part-1) for building & other Structures, Seismic zone -V.

4.1.3.3 Geotechnical Data

The foundation type and depth shall be as mentioned in the geotechnical investigation report which is available.

4.1.3.3.1 Foundation Type And Depth

This will be furnished once after the Geo-technical Investigation report is available.

4.1.3.3.2 Maximum allowable settlements for foundations shall be as follows:

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- a) Foundations in unit areas, utility areas
and foundation for plant buildings - 25 mm
- b) Foundations supporting non plant- buildings - 40 mm
- c) Foundation for oil storage tanks - 150 mm (Edge settlement)
- d) Machine foundations and critical equipment - 25 mm With interconnected piping

4.1.3.3.3 Coefficient of friction

Steel on steel: 0.3 Steel on PTFE: 0.08 Concrete on soil: 0.4

4.2 DESIGN LOADS

Design loads shall be considered as per IS: 875

4.2.1 DEAD LOAD

4.2.1.1 Weights Of Specific Material And Construction:

In estimating dead loads for purpose of design, the actual weights of materials and construction shall be used. Unless noted otherwise, unit weight shall be taken as follows:

Unit Weights

- a) Backfill Soil (above GWT) : 1800 Kg/ m³
- b) Backfill Soil (below GWT). : 800 Kg/ m³
- c) Reinforced cements concrete: 2500 Kg/ m³
- d) Plain concrete : 2400 Kg/ m³
- e) Brick masonry : 2000 Kg/ m³
- f) Structural steel : 7850 Kg/ m³
- g) Cement mortar/screed : 2100 Kg/ m³
- h) False Ceiling : 60 Kg/ m²
- i) Heavy duty tar felting : 30 Kg/ m²
- j) Staircase (steel) : 140 Kg/ m²
- k) Ladder : 40 Kg/ m²
- l) Operating floor with grating : 100 Kg/ m²

4.2.2 LIVE LOAD

4.2.2.1 LIVE LOAD ON FLOORS:

Live load on floors shall comprise of all loads other than dead loads. The minimum live loads on floors for different uses as applicable shall be as given in Table-1. The loads specified in Table-1 are uniformly distributed static loads in KN/m² on plan area and provide for normal effects of impact and acceleration. Flat roofs, sloping roofs and curved roofs shall be designed for live loads as given in ITB document / IS: 875, (Part II).

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TABLE – 1

Sl.No.	Occupancy or Use (Types of Floor)	Live Load KN/m ²	Remarks
1.	Compressor House (Optional item)		
a	Operating Area	7.5	
b	Maintenance Area	7.5	
c	Ground Floor	10.0	
2.	Substation/Control Room		
	Panel floor	10.0	
	Miscellaneous partition	1.0	
	Other areas	5.0	
3.	Roof (Flat, Sloping with slopes up to and including 10 degrees)		See Note 2 below
	Access provided	1.5	
	Access not provided except for maintenance	0.75	
4.	Services supported from below the floor	1.0	

Notes:

1. Live loads on floors other than those mentioned above, shall be as per IS: 875 (Part-2).
2. For sloping roof with slope greater than 10 degrees, the live load of 0.75 KN/m² less be reduced by 0.02 KN/m² for every degree increase in slope over 10 degrees.
3. 1.0 KN/SQ.M allowance shall be made for services supported from below the floor.

4.2.2.2 Reduction in floor live loads for design of foundations shall be in accordance with relevant clause of IS: 875 and IS: 1893.

4.2.3 Static Equipment Loads

a) Empty Weight

The self-weight of equipment including fireproofing, piping, internals, insulation and platforms supported from equipment.

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b) Operating Weight

The operating weight shall be empty weight (as defined above) plus weight of operating fluid.

c) Test Weight

The test weight shall be the empty weight (as defined above) plus the weight of water, which can completely fill up the equipment.

When piping weight is not included in the weight of the equipment, 10% weight of the equipment shall be considered as piping weight.

The equipment loads are considered for the design of the members supporting the equipment. In the case of small equipment, the equipment load shall be considered in addition to the live load. However, in the case of large equipment / vessels, live load in the area occupied by the equipment / vessel shall not be considered along with the equipment load.

SPECIAL CONSIDERATION

4.2.3.1 Thermal Expansion

Horizontal force due to thermal expansion of horizontal vessels/ exchangers shall be relieved by using slotted holes and slide plates and remaining force derived from the product of the sliding saddle ' gravity load ' and the coefficient of friction shall be applied on each support

4.2.3.2 Non-Static Loading

Foundations and structures supporting vessels subject to surge loading such as Deaerators shall be designed to resist a notional horizontal forces of 10 % of Vessel's operating weight or the given surge load whichever is greater. The force shall be applied at the vessel's C.G. and acting longitudinally/ transversely.

4.2.4 Mechanical Equipment Loads

Complete loading data of mechanical equipment such as Pumps, Compressors, Turbines, Motors, and Engines etc. shall be considered as furnished by Vendor.

4.2.5 Impact And Vibratory Loads

In general, machine foundation will be designed Clause. No:3.7.1, Structures subjected to impact or vibratory loads shall be designed as per the provisions of IS: 875 & IS: 2974. The following minimum dynamic factors (multiplying factor for calculating equivalent static load) shall be considered for the static design of structure supporting the under mentioned equipment. However, if the manufacturer's

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specifications / foundation design input indicate higher factor or actual load (static & dynamic) disposition, the same shall be adopted.

pump / motor -3

Reciprocating Equipment -3

Crane -As per IS: 875 or as specified by the Manufacturer whichever is maintained.

The above provisions are for the design of such equipment supporting structures only. For independent foundations of these equipment the provisions of IS: 2974 and Job Specification shall be followed.

4.2.6 Wind Loads

Wind loads shall be as per IS: 875 (Part III)

Design wind pressure P_z in N/m² at height “Z” shall be calculated as follows

$$P_z = 0.6 \times V_z^2 \text{ (IS: 875, Clause 5.4) (part – III),}$$

Where

V_z = design wind velocity in m/s at height “z”

$V_z = V_b \times k_1 \times k_2 \times k_3$ (IS: 875, Clause 5.3)(part – III),

Where,

V_b = Basic wind speed = 50 m / sec As per IS: 875, (Part 3)

K_1 = Risk coefficient

K_2 = Terrain, height and structure size factor

K_3 = Topography factor

The values of coefficients k_1 , Terrain Category, and k_3 (as in IS: 875, Part 3) shall be as given below:

Type of Structure Terrain category	K1	K3
• Open structures	1	1
• Enclosed RCC/Clad	1	1
• Partially closed/clad	1	1
• Sheds with monitors	1	1
• Process Columns, Stacks and Stack like structures with height more than 30m	1.08	1
• Elevated water tanks	1	1

Note – louvers to be considered as fully clad.

Design wind pressure at different heights for terrain category 2 are as given below:

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H (m)	K2 Category 2		
	Class A	Class B	Class C
10 or less	1.00	0.98	0.93
15	1.05	1.02	0.97
20	1.07	1.05	1.00
30	1.12	1.10	1.04
50	1.17	1.15	1.10
100	1.24	1.22	1.17

Following force coefficients (C_f) shall be adopted

Type of Structure	Pressure Coefficient
➤ Open Structures	
• Roof	As per Table 7 to Table 14
• Shielding effect	As per Table 29
➤ Clad / Partially clad structures	
• One side open	
-Internal pressure	As per Figure 3
-External pressure	As per Table 4
• Buildings with medium and large openings	
-Internal pressure	As per Clause 6.2.3.2
-External pressure	As per table 4
• Roof	As per Table 5 & 6
• Skylight / Monitor	As per Table 20
Stacks and stack like structure with height more than 30 m	As per table 23(dynamic effects shall also be examined)
Open Structures	As per table 26
Parapet Walls and fascia	1.3

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To allow for surface area of piping, platforms and other attachments fixed to the equipment, the surface area exposed to the wind shall be increased by 20%. Wherever applicable, frictional drag shall be considered in calculation of wind force.

Total Wind Load (F) on the building / Structure as a whole

$$F = C_f \times A_e \times P_d \quad (\text{As per Clause No. 6.3 of IS:875, (Part-III)})$$

Where,

C_f = force coefficient (As specified in the table above)

A_e = Effective area of the object normal to the wind direction

P_d = Design wind pressure

4.2.7 SEISMIC LOADS

Seismic forces shall be as per IS: 1893 -2002 (Part-1) for building & other Structures and min mass participation should be 90%.

Whenever STAAD-Pro software is used, mass will be lumped in such a way that c.g. of the mass remains unchanged in STAAD-Pro modelling.

4.2.7.1 SRSS method will be used in STAAD-Pro with sufficient nos of mode shapes so that mass participating percentage is greater than or equal to 90% in X and Z direction. In absence of vendor data, C.G. of the equipment will be considered at 2/3rd height from base.

4.2.7.2 Wind and seismic forces shall not be considered to act simultaneously.

4.2.7.3 Appropriate ductility details shall be provided for steel structures and reinforced concrete structures. Ductile detailing of steel structures shall be carried out as per the provisions of IS: 4326-1993 and IS: 1893-2002. Ductile detailing of reinforced concrete members shall be carried out as per the provisions of IS: 13920-1993.

4.2.8 BLAST FORCE

Where required as per OISD – STD-163 / IS: 4991 provisions, structures subjected to blast forces generated due to accidental blasts from hydrocarbon ignitions shall be designed to withstand a minimum pressure of 2.1 T /m² (3 psi).

4.2.9 Contingency Loads

4.2.9.1 RCC Structures

All floor slabs and beams shall be designed for a concentrated load of 1 ton acting simultaneously with the uniform live load but not with actual concentrated loads from equipment, piping etc. This load shall be placed to result in maximum moment and / or maximum shear. It shall not be considered for the design of columns, foundations and in overall frame analysis. For floor slab, the load shall be considered to be distributed over an area of 0.75m x 0.75 m

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4.2.9.2 Structural Steel

For process plants, the following contingency additional loading shall be applied to individual beam elements; these shall be applied as point loads to produce worst shear and bending stresses:

Platform Walkways 3 kN

Secondary Floor Trimmers 5 kN

Primary beams 10 kN.

4.2.10 Load Combinations

Design shall be done to resist the worst combination of the loads

4.2.10.1 Building

Load combination for buildings shall be as follows:

CASES:

DL - Dead load

LL - super imposed loads/live loads

WL1 – Wind load (in longitudinal direction)

WL2 – Wind load (in transverse direction)

SL1 – Seismic load(longitudinal direction)

SL2 - Seismic load (transverse direction)

LOAD COMBINATIONS

DL+LL

DL+LL± WL1

DL+LL± WL2

DL+LL±SL1

DL+LL±SL2

DL±WL1 or SL1

DL±WL2 or SL2

Note: Live load in combination with seismic will be same as considered in seismic

load ,as per IS: 875 –1987 (Part-V)

4.2.10.2 Foundation for stacks, columns towers & vertical vessels

- Self weight of equipment & foundation including fire proofing, piping, all loose internals, Insulation, platforms supported from the Equipment = Empty Weight = a
- Operating weight of equipment as per above (1) including weight of Operating fluid =Operating Weight = b
- Test weight of equipment as per above (2) except full of water instead of operating

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fluid = Test Weight = c

- Live Load (L.L) – On platforms, for first two Platforms consider 50% L.L. on each platform. For rest of the platforms consider 25% L.L. on Each platform = d
- Wind Load (100 %) = e
- Wind Load (25 %) = f
- Seismic Load = g
- Erection Load– Temporary loads and Forces caused by erection where specified = h
- Dynamic loads = i (if any)
- Thermal loads = j (if any)
- Pipe stress loading = k (if any)

	operating			erection	Test/stability	
	without	with	with	With	without	with
	wind	wind	E.Q	wind	wind	wind
Combination no.	1	2	3	4	5	6
Dead load a				x		
Operation load b	x	x	x			
Test c					x	
Live load d	x		X1			
Wind load e		x		x		x
30%wind load f					x	
Earth quake load g			x			
Erection h				X		
Dynamic I	X	X	X			
Thermal j	X	X	X			
Pipe stress k	X	X	X			

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Note:

X =Indicate applicable load case

X1=live load as appropriate to seismic

4.2.10.3 Shed type building with crane loads

- A) For design of roof trusses
 - 1) DL+LL on roof
 - 2) DL+WL
- B) For design of roof of portals
 - 1) DL+LL on roof+crane load+surge
 - 2) DL+WL
- C) For design of roof leg
 - 1) DL+LL+surge
 - 2) DL+LL+surge+WL(50%)
 - 3) DL+LL(50%)+surge(50%)+WL
- D) For design of columns and foundations
 - 1) DL+LL+surge
 - 2) DL+LL+surge+WL(50%)
 - 3) DL+WL(50%)

Where

DL =Dead load

LL =Live load

WL =Wind load

4.2.10.4 Earth/liquid retaining structures

EARTH/LIQUID RETAINING STRUCTURES BELOW GROUND

Earth retaining structures such as retaining walls,dry basements etc. shall be checked for the following combinations

- 1) DL+LL+static earth pressure+pressure due to ground water
- 2) DL+uplift due to ground water (where applicable).(90% of the dead load shall be considered while checking uplift/overturning)
- 3) DL+LL+lateral pressure due to earth+pressure due to ground water+lateral forces

Under ground liquid retaining structures shall be designed for the following load combinations

- 1) Tank empty and full lateral pressure from outside due to soil surcharge, ground water.
- 2) (a)+earth pressure due to earthquake

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- 3) Tank full with liquid with no relief due to active earth pressure considered.
 - 4) (c)+hydro dynamic pressure due to earthquake
 - 5) For tanks provided with two or more compartments, combinations shall be considered also with one or more compartments only
- In both the above cases, coefficient of earth pressure will be considered as 0.33

4.2.11 Stability Criteria

Factor of safety against sliding shall be 1.5 minimum for operating load case with wind or earthquake (with or without live loads for worst cases) and 1.75 minimum for operating load without wind or seismic load case (plant operating ,with or without live loads ,for worst cases).

Factor of safety against overturning shall be 1.5 minimums for operating load case with wind seismic load case (with or without live loads for worst cases) and 2.0 minimums for operating load without wind and seismic load case (plant operating with or without live loads, for worst cases).

For stability against uplift, the sum of vertically downward loads shall exceed 1.2x sum of all vertically upward loads.

4.2.12 Soil And Hydrostatic Pressure

Pressure on basement walls:-Basement walls and other vertical structures below grade shall be designed for the lateral pressure due to adjacent soil. Due allowance shall be made for possible surcharge from fixed or moving loads. When a portion or whole of the adjacent soil is below a free water surface, computations shall be based on the weight of the soil diminished by buoyancy (submerged weight of the soil) plus full hydrostatic pressure.

Uplift on floors:-Basement floors and other horizontal constructions below grade shall be designed for the upward pressure of water, if any, and the loading shall be taken as full hydrostatic pressure applied over the entire area .The hydrostatic head shall be measured from the underside of the construction. Factor of safety against uplift shall be 1.2.For purpose of calculating downward load due to over burden, the weight for the same shall be calculated for volume over projected plan area only.

4.3 DESIGN METHODS

In general, the design shall conform to the applicable latest Indian codes/standards and shall be in accordance with sound engineering practice. The major applicable Indian standards are listed in ANNEXURE 1

4.3.1 Analysis And Design

- a) In general, analysis and design shall be done using STAAD Pro v8i software for both structural steel and RCC framed structures. Equivalent reinforcement or greater than STAAD Pro output design reinforcement result will be provided during detailing. If required, sample critical members design calculation can be

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furnished for comparison of STAAD Pro design result.

- b) Design reinforced concrete members shall be by limit state method as per IS 456.

Liquid retained structures shall be designed as per IS :3370

- c) Design of structural steel members shall be as per IS 800.

4.4 MATERIALS OF CONSTRUCTION

The requirements of various materials to be used in civil and structural works shall be as per job specification –structural.

4.4.1 Cement

Ordinary Portland cement 43 grade conforming to IS: 8112 shall be used for all concrete works .For masonry application, the use of masonry cement (IS: 3466) may be used.

4.4.2 Reinforcement bars

High strength deformed steel bars of grade Fe500 or Fe500D, conforming to IS:1786 shall be used. All the Re-bars in U/g construction shall be given. Reinforcement steel produced by the following primary producers shall be preferably used.

1. Tata steel
2. SAIL
3. Jindal
4. RINL
5. Shyam steel

4.4.3 Structural steel

Structural steel shall be of yield stress of 250 MPa conforming to grade A of IS:2062.Tubular steel shall conform to IS:1161 of grade Y 240 or higher.

4.5 REINFORCED CONCRETE WORKS

Design of reinforced concrete work shall be as per IS:456-2000 .Reinforced concrete conforming to IS:456-2000 shall be used 20mm and down size graded crushed stone aggregate.

4.5.1 Grade of concrete

The grade of concrete to be used for various types of structural elements shall be as follows:

considering environmental exposure condition as severe as per CL.No.8.2.2 of IS:456-2000

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For all structures and foundations except
Grade slabs/paving

M30($F_{ck}=30\text{N/mm}^2$)

Concrete of ground floor/non –suspended

M30($F_{ck}=30\text{N/mm}^2$)

Concrete for encasing(10mm down aggregate)

M30($F_{ck}=30\text{N/mm}^2$)

Where F_{ck} is the characteristic compressive strength at 28 days of concrete cube specimens as per IS:456-2000.

Below all RCC foundations, 75mm thick lean concrete of grade 7.5 (nominal mix 1:4:8) shall be provided. Below RCC foundations of liquid retaining structures, 100mm thick concrete of mix M10(nominal mix 1:3:6) shall be provided. The lean concrete shall extend 50mm beyond the foundation for normal foundations and 75mm under liquid retaining structures

Plain cement concrete (PCC) of grade M 7.5 (nominal mix 1:4:8) of minimum 150mm thickness shall be provided under all masonry wall foundations.

4.5.2 Minimum cover reinforcement

The minimum clear cover to the steel reinforcement including links for various structural concrete elements shall be as follows unless stated otherwise

Slab (roof & floors, canopy, cantilever, waist slab) 20mm if bar dia. Is less than or Equal to 12mm; 20mm otherwise

Beam (roof, floor & lintel) 45mm or dia of bar
Whichever is greater

Column, pedestal 45mm Above FGL
75mm below FGL

Retaining wall, Basement and Pit wall

- a) Face in contact with earth 75mm
- b) Free face 45mm or dia of bar whichever is greater.

Liquid retaining structure

- a) Face in contact with liquid 30mm or dia of bar whichever is greater
 - b) Face away from liquid but in contact with earth 75mm
 - c) Free face 30mm or dia of bar whichever is greater.
- Foundation slab, base slab, plinth beam 75mm
(top, side & bottom) pile cap

- a) Bottom face 100mm

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b) Top face 75mm

4.5.3 Minimum Thickness Of Structural Concrete Elements

Footing(All type including raft foundations 300mm
Without beams)

(Note: Tapered footing shall not have thickness less than 150mm at the
edges. Minimum average thickness shall not be less than 300mm)

Pile cap 500mm

Slab thickness in raft foundation with 225mm
Beam & slab construction

Basement walls& Base slab 150mm

Floor/Roof slab, walkway, canopy, slab resting 125mm
on beams

Cable/pipe trench/Laundry walls & Base slab 100mm

Parapet, Cantilevered canopy slab 75mm

Louver/fin 50mm

Precast trench cover/floor slab 100mm

Precast floor slab/Louver(in contact with liquid) 100mm

Liquid retaining /leak –proof structure walls& 150mm
Base slab

Underground pit/ Reservoir walls &base slab 250mm
(below ground water table)

Underground pit/ Reservoir walls &base slab 200mm
(Above ground water table)

Ground floor slab (Non suspended) 150mm

4.5.4 Minimum Reinforcement

The minimum diameter of reinforcement bar for slab, beam stirrups and column ties shall be 8mm and for foundation slabs and vertical walls it shall be 10mm. The maximum spacing of these bars shall be as per IS: 456 but shall be restricted to 300mm c/c. For other elements, the minimum reinforcement shall be as per IS: 456.

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4.5.5 Minimum Height Of Pedestals

The minimum projection of pedestals supporting equipment/structures above the highest pavement/finished grade/finished floor level shall be as per requirement.

4.5.6 Anti-termite treatment

All RCC building shall be provided with anti-termite treatment As per IS: 6313.
Material shall be as per IS: 8944.

4.6 STRUCTURAL STEEL WORKS

Design of structural steel work shall be as per IS: 800.

4.6.1 Allowable Deflection Of Steel Structure

The maximum deflections for the structures are limited to the following values:

Gantry girder for electric overhead crane:	Span / 750 (Capacity up to 50 T)
Gantry girder for electric overhead crane:	Span / 1000 (Capacity over 50 T)
Gantry girder for manually operated crane:	Span / 500
Girder beam supporting dynamic equipment hoist:	Span / 450
Grating / Chequered plate:	Span / 200 or 6 mm
Purlins supporting any type of roofing material:	Span / 200 Under (dead load live load) or (dead load-wind load)
Other structural components: As specified in relevant	

IS codes

Note: The limiting permissible horizontal deflection for multi storied steel structure / building frame shall be height / 325

4.6.2 Slenderness Ratio Of Compression Members

Slenderness ratio of members shall be as per IS: 800.

4.6.3 Permissible Stresses

The permissible stress shall be as per relevant IS codes.

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4.6.4 Bolts

Minimum size of bolts shall be 16mm. (10mm & 12mm can be used for misc. structures)

Minimum centre-to-centre distance of bolts shall be 2.5 times nominal diameter.

Minimum distance from the centre of the bolt to the edge of the plate is given below:

Diameter of Fastener (mm)	Sheared or Manual flame cut edges	Rolled Automatic flame cut sawn or milled edges
10	19	17
12	19	17
16	29	25
20	32	29
22	38	32
24	44	38
28	51	44
30	57	51

4.6.5 Connections

In general, welding will be used for fabrications and joint connections at shop. However in few cases like shear connection, bolted connections may be adopted. For removable type beams, bolted connections will be used. Welding shall be done as per IS 816, 823 & 861 (latest). Bolting shall be done as per IS: 1363, 1364 & 1367 (latest).

4.7 DESIGN CONCEPT

4.7.1 Machine Foundation

The machine/equipment foundation shall be designed and detailed as per job specification and IS: 2974. However, appendages to such foundations shall be reinforced suitably to ensure integral action.

All machine / equipment foundations shall be separated from adjoining parts of building, other foundations and floor / pavements slabs. Joints at floor / pavement slab shall be suitably sealed.

The soil pressure below the foundations, under the dead load case, shall not be allowed to exceed 80% of the net SBC of the soil or the pile capacity.

The raft foundations shall be provided with 15% extra reinforcement over and above that required as per design.

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Foundations and structures for machines subject to vibrations, shall be so proportioned, that the amplitude and frequency of the foundations / structures are within the permissible limits as per relevant IS codes.

Machine foundations shall be so designed that the natural frequency of the foundation system shall not resonate with the following:

- a) Operating speed of motor.
- b) Operating speed of machine.
- c) 2 x operating speed of the machine.
- d) Critical speed of the machine (for centrifugal machines)

The natural frequency of the foundation shall be $\pm 20\%$ away from the above-mentioned frequencies. However, the amplitudes of vibration of the foundation block shall always be checked to be within permissible limits.

When several foundations for similar machines need to be seated on a common raft, the computation of the vibration shall proceed assuming that each machine foundation is independent of others by breaking the raft into sections corresponding to separate foundations. The design value of the amplitude shall be increased by 30%.

Dynamic analysis of compressor foundation and amplitude calculation will be done by STAAD-Pro / STARDYNE software / Excel calculation.

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ANNEXURE – I

Latest revision of Codes / Standards shall be followed, as applicable, Unless specified otherwise

1. Concrete & Steel Design

- IS: 456 - Code of Practice for Plain & Reinforced Concrete
- IS: 3370 - Code of Practice for concrete structures for storage of liquids
- IS: 4326 - Code of Practice for Earthquake Resistant Design and construction of buildings
- IS: 4991 - Criteria for blast resistant design and construction of buildings
- IS: 5525 - Detailing of reinforcement in RCC works
- IS: 8112 - 43 Grade OPC
- IS: 13290 - Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces
- IS: 800 - Code of Practice for general construction in steel
- IS: 816 - Code of Practice for use of metal Arc Welding for general construction

2. Foundation Design

- IS: 1080 - Code of practice for design and construction of Shallow foundations On soil
- IS: 1904 - Code of practice for design and construction of foundations in soils, General requirements
- IS: 2911 - Code of practice for Design and Construction of Piled Foundations.(Part I, Part II, Part III, Part IV)
- IS: 2950 - Code of practice for Design of Raft Foundations
- IS: 2974 - Code of practice for Design and Construction of Machine Foundations (All parts)
- IS: 6403 - Code of practice for determination of bearing capacity of shallow foundations
- IS: 8009 - Code of practice for calculation of settlements of foundation

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD ARCHITECTURE/CIVIL/STRUCTURAL DESIGN BASIS				
JPEC	DOC.NO.FGGS-BJN-CIV-DBM-8000	REV.0	DATE:17-07-19	Page 48 of 48	OIL INDIA LIMITED

1. Loading Standards

- IS: 875 - Code of practice for design loads for buildings and Part I to V structures.
- IS: 1893 - 2002 Criteria for earthquake resistant design of structures.

2. Cement

- IS: 8112 - Specification for 43 Grade Ordinary Portland Cement (OPC)
- IS: 1489 - Specification for Portland Pozzolona Cement (PPC)

3. Reinforcement

- IS: 432 - Mild Steel Bars Part I & II
- IS: 1786 - Cold Twisted Steel Bars
- IS: 2502 - Bending and fixing of bars for concrete reinforcement
- IS: 5525 - Detailing of reinforcement in RCC works

4. Structural Steel

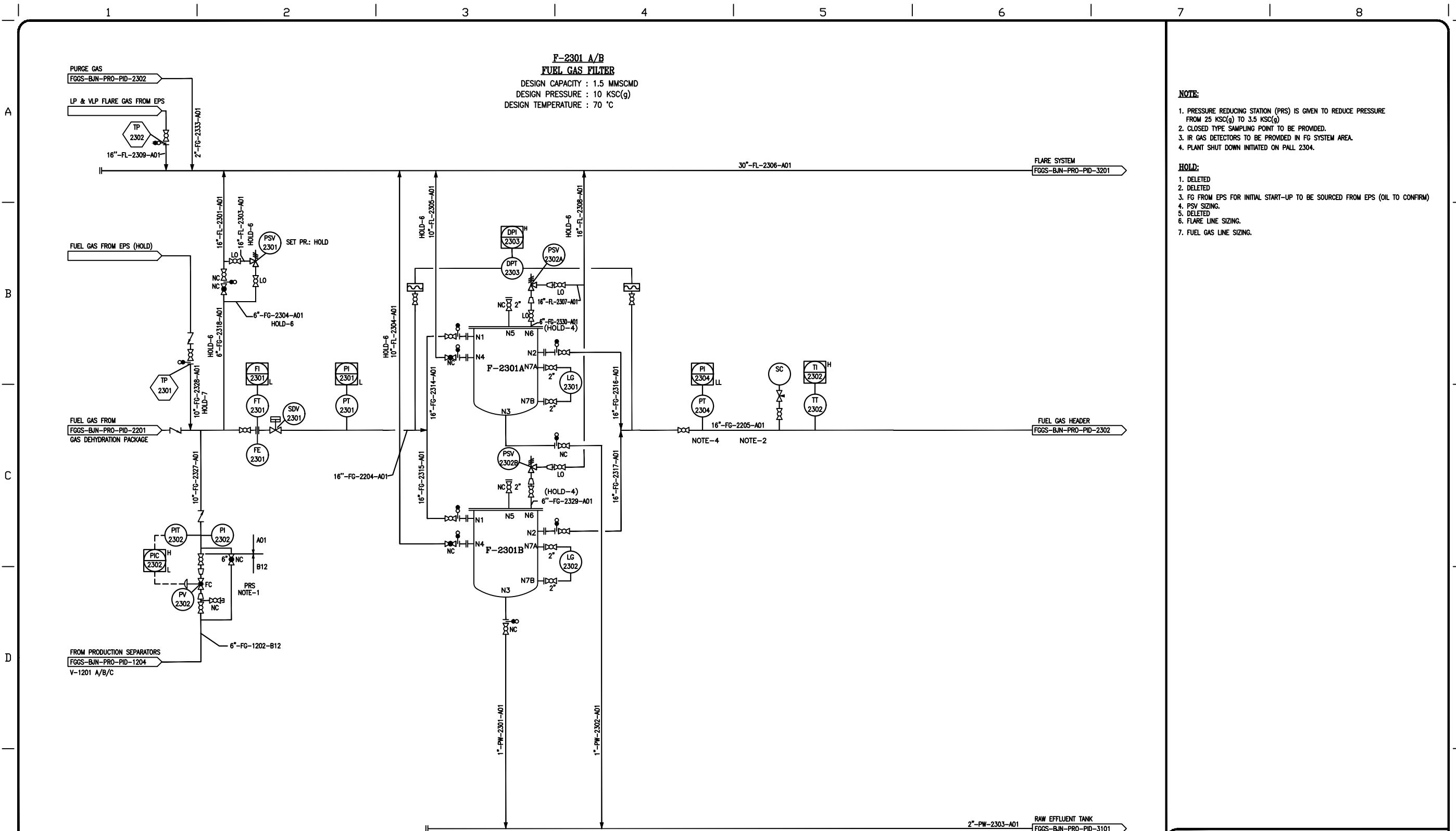
- IS: 2062 - Steel for General Structure Purposes
- IS: 1161 - Steel tubes for structural purpose
- IS: 1363 - Hexagon Head Bolts, Screws & Nuts

5 Design Aids

- SP: 6 - Structural Steel Handbook
- SP: 7 - National Building Code of India
- SP: 16 - Design Aids for Reinforcement Concrete
- SP: 22 - Explanatory Handbook on Codes of Earthquake

Section-II

Annexure



- NOTE:**
1. PRESSURE REDUCING STATION (PRS) IS GIVEN TO REDUCE PRESSURE FROM 25 KSC(g) TO 3.5 KSC(g)
 2. CLOSED TYPE SAMPLING POINT TO BE PROVIDED.
 3. IR GAS DETECTORS TO BE PROVIDED IN FG SYSTEM AREA.
 4. PLANT SHUT DOWN INITIATED ON PALL 2304.
- HOLD:**
1. DELETED
 2. DELETED
 3. FG FROM EPS FOR INITIAL START-UP TO BE SOURCED FROM EPS (OIL TO CONFIRM)
 4. PSV SIZING.
 5. DELETED
 6. FLARE LINE SIZING.
 7. FUEL GAS LINE SIZING.

**OIL INDIA LIMITED**

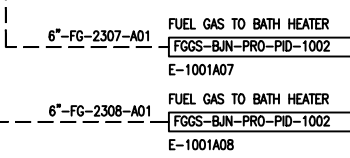
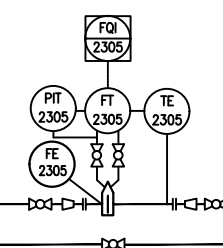
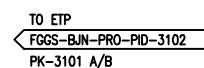
**JAYATHE PETROTECH ENGINEERS AND CONSULTANTS PVT LTD**

ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION(FGGS) AT BAGHJAN IN UPPER ASSAM

PIPING & INSTRUMENTATION DIAGRAM FUEL GAS SYSTEM

CADD NUMBER	DRAWING NUMBER	SHT. No	REV
FGGSBJN230101.dwg	FGGS-BJN-PRO-PID-2301	01/01	0

DRAWING No.	REFERENCE DRAWINGS	REV	DATE	DESCRIPTION	BY	CHK	APP	DWN	SCALE	NTS
		A	11.04.2019	ISSUED FOR REVIEW	DP	LG	ST		DRAWN	DP
		B	07.05.2019	ISSUED FOR APPROVAL	DP	LG	ST		CHECKED	LG
		C	06.06.2019	HAZOP COMMENTS INCORPORATED. ISSUED FOR APPROVAL	DP	LG	ST		APPROVED	ST
		D	24.06.2019	ISSUED FOR ITB	DP	LG	ST		OWNER	



1. FUEL GAS LINE SIZE.

[illegible]

CADD NUMBER	DRAWING NUMBER	REV
FGGSBJN230201.dwg	FGGS-BJN-PRO-PID-2302	SHT. No 01/01



	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM				
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DATASHEET FOR GAS GENERATOR

1	Issued for ITB	14/08/2019	KPS	MKV	CK	
0	Issued for ITB	08/01/2021	KPS	MKV	CK	
A	Issued for Review	27/05/2019	KPS	MKV	CK	
REV	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT



DATASHEET FOR GAS GENERATOR



PROJECT	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM		DOCUMENT NO.	FGGS-BJN-ELC-DST-6001		
			REV.:	1	REV.DATE	08/01/2021
CLIENT	OIL INDIA LIMITED		PAGE:	2 OF 6		
SPECIFIC REQUIREMENTS			VENDOR DATA			
APPLICABLE SPECIFICATION, CODES AND STANDARDS, DRAWINGS			DATA SUPPLIED BY BIDDER/VENDOR			
1	Project Specification	: FGGS-BJN-ELC-SPC-6000				
2	IEC	: As per Specification	A. GENERATOR			
SYSTEM PARTICULARS			1. General			
3	Voltage	: 415V +/- 5%	Make	:		
4	Phases/ Wires	: 3Phase / 4Wire	Model No	:		
5	Frequency	: 50Hz +/- 3%	Power Absorbed in Auxiliaries	:	kW	
6	Fault Rating	: 80kA for 1 sec	Minimum Load below Which Set is not recommended for operation	:	☐ 30% ☐ 40% ☐ 50%	
7	Combine voltage/ frequency variation	: (+-5% & +-3%)	Power Rating at Site Conditions	:		
INSTALLATION ATMOSPHERIC CONDITIONS						
8	Wind Velocity at 10m Height	: 50 m/s	2. Engine Configuration			
9	Average Rainfall (in 24 hours)	: 15.9 cm	No of cylinders	:		
10	Generator design temperature	: 7 to 41 °C	Bore	:	mm	
11	Maximum relative humidity	: 93.00%	Stroke	:	mm	
12	Tropicalization	: Required	Displacement/ Compression Ratio	:	Litres	
13	Location	: Outdoor	Piston Speed	:	m/s	
TECHNICAL REQUIREMENTS			BMEP at Rated Load			
14	A. GENERATOR					
15	1. General		3. Governer			
16	Power Rating at Site Conditions	: 1500 kWe (Note-7)	Make	:		
17	Net Power output at Alternator terminal	: 1875 kVA at 0.8 pf	Model No	:		
18	Quantity	: 4	Signal Range	:		
19	Tag no.	: AS PER SLD	Speed Range	:		
20	Duty	: ☒ CONTINUOUS ☐ PRIME ☐ STANDBY				
21	Speed	: 750-1000 RPM (Vendor to confirm)	4. Air inlet Filter			
22	2. Engine Configuration		Make	:		
23	Driver	: ☒ DIRECT ☐ GEAR ☐ V BELT	Model No	:		
24	Turbo charger	: Required				
25	After Cooler	: Required	5. Lube Oil Filter			
26	No of Stroke	: ☐ TWO ☒ FOUR	Make	:		
27	Cylinder Arrangement	: ☐ INLINE ☒ VEE	Model No	:		
28	Exhaust Manifold	: ☐ AIR COOLED ☐ WATER COOLED ☒ VTA				
29			6. Spark Arresting Exhaust Silencer			
30	Engine Configuration	: Total 4Nos. With N+1 working philosophy	Make	:		
31	3. Governer		Model No	:		
32	Load Sharing during parallel operation	: Required - Class(G2) governing electronic type governer as per ISO 8528 Part 1.	Cylinder Arrangement	:		
33	4. Air inlet Filter		Extension piece Length	:		
34	Type	: ☐ OIL BATH ☒ DRY	Exhaust outlet gas temperature	:		
35	Mounting	: ☒ SKID ☐ REMOTE				
36	5. Lube Oil Filter		7. Cooling			
37	Type	: ☒ SIMPLEX ☐ DUAL WITH TRANSFER VALVE ☐ DUAL W/O TRANSFER VALVE	Self mounted radiator	:		
38	6. Spark Arresting Exhaust Silencer		Radiator with electric fan	:		
39	Type	: ☒ RESIDENTIAL ☐ COMMERCIAL	Water cooled	:		
40	Rain Cover	: Required	Radiator Air flow	:		
41			Engine coolant capacity	:		



DATASHEET FOR GAS GENERATOR



PROJECT	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM	DOCUMENT NO.	FGGS-BJN-ELC-DST-6001		
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DATA SUPPLIED BY PURCHASER				VENDOR DATA			
SPECIFIC REQUIREMENTS (CONT'D)				DATA SUPPLIED BY BIDDER/VENDOR			
42	7. Starting System			8. Starting System			
43	Method of Starting	:	■ BATTERY □ PNEUMATIC □ HYDRAULIC	Make	:		
44	Mounting	:	■ SKID □ REMOTE	Model No	:		
45	No of start in 15 sec	:	Three Times				
46	Battery Type	:	Heavy-duty and electrolyte should be gel type				
47	8. Cooling						
48	Method of cooling	:	□ AIR ■ RADIATOR ■ WATER				
49	Cooler Mounting	:	■ SKID □ REMOTE				
50	9. Others			B. ALTERNATOR			
51	Acoustic Enclosure/ Container	:	Required	1. General			
52	Genset Location	:	Inside Generator Shed	Make	:		
53	Noise Level Limit	:	As per CPCB norms	Model No.	:		
54	Engine Accessories			Anti Condensation Heater	:	Watt	
55	Vibration Switch (Engine)	:	High	Insulation Class	:		
56	Oil Level Switch	:	Low	Temperature Rise	:	°C	
57	Vibration Switch (Cooler)	:	High	Degree of Enclosure			
58	Coolant Level Switch	:	Low	Guaranteed Efficiency			
59	Oil Temperature Switch	:	High	(125/130 deg Celsius temeprature rating)			
60	Exhaust Temperature Switch	:	VTA	at 25% Load	:	%	
61	Bearing Temperature Switch	:	High	at 50% Load	:	%	
62	Glow Plugs	:	Volt	at 75% Load	:	%	
63	Over speed, alarm/trip indicator lamps	:	Required	at 100% Load	:	%	
64				No Load losses	:	kW	
65	B. ALTERNATOR			Losses at rated pf	:	kW	
66	1. General			Largest Motor can start	:	kW	
67	Output Voltage Adjustment	:	+/- 5% Continuously adjustable type	Inrush kVA	:	kVA	
68	Range						
69	Output voltage	:	415V +/-1% under Isosynchronous	2. Alternator Parameter			
70	Output voltage under parallel	:	+/- 5%(drop)	% Negative Sequence withstar	:	%	
71	Output Frequency	:	50Hz +/-0.3% under Isosynchronous	Negative Sequence Withstand	:	sec	
72	Output Frequency under parallel	:	3% (drop)	Apparent Power	:	MVA	
73	No of phase	:	3 phase, star	Power factor (cosθ)	:		
74	Generator Earthing	:	Resistive	Power (Pn)	:	MW	
75	Rated Power factor	:	0.8	Voltage (Un)	:	kV	
76	Rating	:	1875 kVA (Note-9)	Voltage Regualtion range	:	±%	
77	Phase Sequence	:	R/Y/B	Current (In)	:	kA	
78	Insulation Class	:	F	Frequency(Fn)	:	Hz	
79	Temperature Rise	:	Class B	Speed (Nn)	:	/min	
80	Degree of Enclosure	:	IP 23 for alternator				
81	Stator RTDs	:	2Nos / Phase, 100 Ohms Patinum				
82	Bearing RTD's	:	1No / Bearing, 100 Ohms Patinum				
83	Anti Condensation Heaers	:	240V AC				
84	System Earthing	:	Via Earthing Resistor				

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DATASHEET FOR GAS GENERATOR

[illegible]



PROJECT	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM	DOCUMENT NO.	FGGS-BJN-ELC-DST-6001		
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INFORMATION BY VENDOR

[illegible]



DATASHEET FOR GAS GENERATOR



PROJECT	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM	DOCUMENT NO.	FGGS-BJN-ELC-DST-6001		
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INFORMATION BY VENDOR

SPECIFIC REQUIREMENTS	VENDOR DATA

ATTACHMENT 1

COMPOSITION OF FUEL GAS

GAS COMPONENTS	GAS COMPOSITION (VOL%)
Methane	90.05
Ethane	4.43
Propane	1.29
i-Butane	0.22
n-Butane	0.29
i-Pentane	0.11
n-Pentane	0.09
n-Heptane	0
n-Octane	0
n-Nonane	0
n-Decane	0
n-Hexane	0.17
Nitrogen	1.15
CO2	2.21
H2O	0

PROPERTIES OF FUEL GAS

PROPERTIES	UNIT	VALUE
Vapour Fraction		1
Temperature	°C	30
Pressure	KSC(g)	3.5
Heat Flow	KJ/hr	-2.151 x 10 ⁸
Cp/Cv		1.301
Mass Heat Capacity	KJ/Kg°C	2.124
Z Factor		0.9897
LHV (Std),	BTU/SCF	915
HHV (Std)	BTU/SCF	1007
Mass Density	Kg/m ³	3.157
Molecular weight		17.74
Viscosity	cP	0.01162

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM				
JPEC	DOC.No.:FGGS-BJN-ELC-DST-6002	REV.0	DATE:16-07-19	PAGE 1 OF 5	OIL INDIA LIMITED

DATASHEET FOR DIESEL GENERATOR

REV	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT
0	Issued for ITB	08/01/2021	KPS	MKV	CK	
A	Issued for Review	27/05/2019	KPS	MKV	CK	



DATASHEET FOR DIESEL GENERATOR



PROJECT	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM	DOCUMENT NO.	FGGS-BJN-ELC-DST-6002	
		REV.:	0	REV.DATE 08/01/2021
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PART - A : DIESEL GENERATOR

S.No.	TECHNICAL DESCRIPTION	UNITS	REQUIREMENT	
			MINIMUM REQUIREMENTS	VENDOR TO VERIFY
A	APPLICABLE SPECIFICATION & STANDARD		IEC 60034-3 / AS PER SPECIFICATION FGGS-BJN-ELC-SPC-6001	
	TAG NO.		GG-30001C	
B	QUANTITY		1 No.	
C	CLIMATIC CONDITIONS			
1	DESIGN AMBIENT TEMPERATURE (MIN/MAX)		7/41°C	
2	DRY BULB TEMPERATURE MAXIMUM		36°C	
3	DRY BULB TEMPERATURE MINIMUM		8°C	
4	MAXIMUM RELATIVE HUMIDITY		93%	
5	ANVERAGE RAINFALL (IN 24 HR)		15.9 cm	
6	ANVERAGE RAINFALL (IN MONSOON)		194.2 cm	
7	WIND VELOCITY AT 10M HEIGHT		50 m/s	
8	LOCATION		OUTDOOR	
D	DIESEL GENERATOR		VTA	
1.0	* MAKE		VTA	
2.0	* MODEL No.		VTA	
	TYPE OF DG		FOR EMERGENCY AND BLACK START	
3.0	POWER RATING AT SITE CONDITIONS	kW	600 kW RATED AT 41 °C	
4.0	* POWER ABSORBED IN AUXILIARIES	kW	VTA	
5.0	NET POWER OUTPUT AT ALTERNATOR	kVA	750 kVA AT 0.8 p.f.	
	TERMINAL AT SITE CONDITIONS			
6.0	DUTY		☐ CONTINUOUS ☒ PRIME ☐ STANDBY	
7.0	SPEED	RPM	1000/1500 RPM (*) (MEDIUM SPEED)	
8.0	* MINIMUM LOAD BELOW WHICH SET IS NOT RECOMMENDED FOR OPERATION	kW	☒ 30 % ☐ 40 % ☐ 50 %	
9.0	ENGINE CONFIGURATION :			
9.1	DRIVE		☐ DIRECT ☒ GEAR ☐ V-BELT	
9.2	TURBO-CHARGER		☒ REQUIRED ☐ NOT REQUIRED	
9.3	* AFTER-COOLER		☒ REQUIRED ☐ NOT REQUIRED	
9.4	No. OF STROKES	No. OF STROKES	☐ TWO ☒ FOUR	
9.5	CYLINDER ARRANGEMENT		☐ INLINE OR ☒ VEE	
9.6	No. OF CYLINDERS		VENDOR TO SPECIFY	
9.7	* BORE	mm	VENDOR TO SPECIFY	
9.8	* STROKE	mm	VENDOR TO SPECIFY	
9.9	* DISPLACEMENT / COMPRESSION RATIO	Litres	VENDOR TO SPECIFY	
9.10	* PISTON SPEED	m/s	VENDOR TO SPECIFY	
9.11	EXHAUST MANIFOLD		☒ AIR COOLED ☐ WATER COOLED ☐ INSULATED	
10.0	GOVERNOR :			
10.1	* MAKE		VENDOR TO SPECIFY	
10.2	* MODEL No.		VENDOR TO SPECIFY	
10.3	TYPE		ELECTRONIC	
10.4	* SIGNAL RANGE		VENDOR TO SPECIFY	
10.5	* SPEED RANGE		VENDOR TO SPECIFY	
10.6	LOAD SHARING DURING PARALLEL OPERATION		☒ REQUIRED ☐ NOT REQUIRED	
10.7	AUTO ENGINE SHUTDOWN (AFTER 1 MINUTE OF POWER RESUMPTION)		☒ REQUIRED ☐ NOT REQUIRED	
11.0	AIR INLET FILTER :			
11.1	MAKE		STANDARD MAKE OF ENGINE MANUFACTURER	
11.2	* MODEL No.		☒ REQUIRED ☐ NOT REQUIRED	
11.3	TYPE		☐ OIL BATH ☒ DRY	
11.4	MOUNTING		☒ SKID ☐ REMOTE	
12.0	LUBE OIL FILTER :			
12.1	MAKE		STANDARD MAKE OF ENGINE MANUFACTURER	
12.2	* MODEL No.		VENDOR TO SPECIFY	
12.3	TYPE		☐ SINGLE OR ☒ DUAL WITH TRANSFER VALVE	
13.0	SPARK ARRESTING EXHAUST SILENCER :		VENDOR TO SPECIFY	
13.1	MAKE		STANDARD MAKE OF ENGINE MANUFACTURER	
13.2	* MODEL No.		VENDOR TO SPECIFY	
13.3	TYPE		☐ RESIDENTIAL ☒ COMMERCIAL	
13.4	RAIN COVER		☒ REQUIRED ☐ NOT REQUIRED	
13.5	* CYLINDER ARRANGEMENT		VENDOR TO SPECIFY	
13.6	* EXTENSION PIECE LENGTH	Mtrs.	(VENDOR TO GIVE PER METRE RATE ABOVE HIS STANDARD SUPPLY LENGTH)	
			☐ DUAL WITHOUT TRANSFER VALVE	

(**) HOLD

DATA MARKED WITH ASTERISK MARK (*)

WILL BE FURNISHED BY VENDOR.

[illegible]



DATASHEET FOR DIESEL GENERATOR



PROJECT	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM	DOCUMENT NO.	FGGS-BJN-ELC-DST-6002		
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CLIENT	OIL INDIA LIMITED	PAGE:	4 OF 5		

PART - B : ALTERNATOR

S.No.	TECHNICAL DESCRIPTION	UNITS	REQUIREMENT	VENDOR TO VERIFY
A	ALTERNATOR			
1.0	* MAKE		VENDOR TO SPECIFY	
2.0	* MODEL No.		VENDOR TO SPECIFY	
3.0	OUTPUT VOLTAGE ADJUSTMENT RANGE	%	0.415 kV $\pm$ 10 % CONTINUOUSLY ADJUSTABLE TYPE	
4.0	OUTPUT VOLTAGE	V	0.415 kV $\pm$ 2 % UNDER AUTO MODE AND STEADY STATE OPERATION	
5.0	OUTPUT FREQUENCY	Hz	50 Hz $\pm$ 1 % UNDER AUTO MODE AND STEADY STATE OPERATION	
6.0	No. OF PHASES		3 PHASE/4 WIRE	
7.0	SYSTEM GROUNDING		☐ SOLID ☒ RESISTOR	
8.0	RATED POWER FACTOR		0.8	
9.0	RATING	kVA	750 kVA	
10.0	PHASE SEQUENCE		R / Y / B	
11.0	INSULATION CLASS		F	
12.0	TEMPERATURE RISE		CLASS B	
13.0	DEGREE OF ENCLOSURE		VENDOR TO SPECIFY	
14.0	* STATOR RTDs		VENDOR TO SPECIFY	
15.0	* BEARING RTDs		VENDOR TO SPECIFY	
16.0	* VOLTAGE & WATTAGE RATING OF SPACE HEATER		240 V, 1- PHASE, 50 Hz	
17.0	CURRENT TRANSFORMER		1000 V GRADE EPOXY RESIN CAST INSULATED TYPE	
17.1	MOUNTED ON PHASE LEADS ON NEUTRAL SIDE BEFORE FORMATION OF STAR POINT	Nos.	REFER SLD	
17.2	MOUNTED ON NEUTRAL AFTER FORMATION OF STAR POINT	Nos.	REFER SLD	
17.3	RATIO		REFER SLD	
17.4	* ACCURACY CLASS		AS PER SLD	
17.5	* VA BURDEN		AS PER SLD	
17.6	LOCATION		ON NEUTRAL TERMINAL BOX	
18.0	* GUARANTEED EFFICIENCY : (125 / 130 °C TEMPERATURE RATING)	%		
	i) AT 25% LOAD		VENDOR TO SPECIFY	
	ii) AT 50% LOAD		VENDOR TO SPECIFY	
	iii) AT 75% LOAD		VENDOR TO SPECIFY	
	AT 100% LOAD		VENDOR TO SPECIFY	
19.0	* TRANSIENT REACTANCE (SATURATED) DIRECT AXIS (X' d)	Pu	VENDOR TO SPECIFY	
20.0	* TRANSIENT REACTANCE (UNSATURATED) DIRECT AXIS (X' d)	Pu	VENDOR TO SPECIFY	
21.0	* SUB-TRANSIENT REACTANCE (SATURATED) DIRECT AXIS (X'' d)	Pu	VENDOR TO SPECIFY	
22.0	* SUB-TRANSIENT REACTANCE (UNSATURATED) DIRECT AXIS (X'' d)	Pu	VENDOR TO SPECIFY	
23.0	* SYNCHRONOUS REACTANCE (SATURATED) DIRECT AXIS (X d)	Pu	VENDOR TO SPECIFY	
24.0	* SYNCHRONOUS REACTANCE (UNSATURATED) DIRECT AXIS (X d)	Pu	VENDOR TO SPECIFY	
25.0	* ROTOR INERTIA	kg-m ²	VENDOR TO SPECIFY	
26.0	* SHORT CIRCUIT RATIO		VENDOR TO SPECIFY	
27.0	* TIME CONSTANTS :		VENDOR TO SPECIFY	
27.1	* T' d	s	VENDOR TO SPECIFY	
27.2	* T'' d	s	VENDOR TO SPECIFY	
27.3	* T' do	s	VENDOR TO SPECIFY	
27.4	* Ta	s	VENDOR TO SPECIFY	
27.5	OVERSPEED CAPABILITY		120 % FOR 1 MINUTE	
27.6	SHORT CIRCUIT WITHSTAND CAPABILITY	kA & Secs	FOR 3 SECS DURING 3-PHASE SHORT CIRCUIT AT GENERATOR TERMINAL WHEN EXCITATION VOLT-AGE IS 5 % HIGHER THAN ITS RATED LINE VOLTAGE	
27.7	MOMENTARY OVERLOAD CAPABILITY		50 % FOR 15 SECS.	
27.8	MIN. AIR CLEARANCE BETWEEN PHASE TO PHASE AS WELL AS BETWEEN PHASE TO EARTH IN MAIN TERMINAL BOX	mm	SHALL BE AS PER STANDARDS	



DATASHEET FOR DIESEL GENERATOR



PROJECT	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM	DOCUMENT NO.	FGGS-BJN-ELC-DST-6002		
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PART - B : ALTERNATOR

S.No.	TECHNICAL DESCRIPTION	UNITS	REQUIREMENT	VENDOR TO VERIFY
28.0	EXCITATION SYSTEM :			
28.1	* MAKE		VENDOR TO SPECIFY	
28.2	* MODEL No.		VENDOR TO SPECIFY	
28.3	* TYPE		VENDOR TO SPECIFY	
28.4	SHORT CIRCUIT CAPABILITY	%	300 % FOR 10 SECS.	
28.5	* EXCITATION CURRENT			
	i) FULL LOAD	A	VENDOR TO SPECIFY	
	ii) NO LOAD	A	VENDOR TO SPECIFY	
29.0	AUTOMATIC VOLTAGE REGULATOR :			
29.1	* MAKE		VENDOR TO SPECIFY	
29.2	* MODEL No.		VENDOR TO SPECIFY	
29.3	* TYPE			
29.4	CROSS-CURRENT COMPENSATION FOR PARALLEL OPERATION		■ REQUIRED □ NOT REQUIRED FURNISH THE SPECIFICATION OF CTs	
29.5	REMOTE VOLTAGE RAISE / LOWER CONTROL		■ REQUIRED □ NOT REQUIRED	
30.0	LUBRICATION SYSTEM FOR ENGINE		PRESSURE FED SYSTEM	
31.0	COOLING SYSTEM FOR ENGINE		INDIRECT COOLING SYSTEM WITH RADIATOR COOLED	
32.0	AUDIO-VISUAL ANNUNCIATOR		■ REQUIRED □ NOT REQUIRED	
33.0	GENERATOR CONTROL PANEL AND PARALLEL OPERATING PANNEL		■ REQUIRED □ NOT REQUIRED	
	GENERATOR AUTOMATIC SYNCHRONOUS SYSTEM			
34.0	GENERAL:			
34.1	* MAXIMUM WEIGHT OF THE LARGEST PART OF THE DG SET FOR SIZING THE CRANE (IN kgs)		VENDOR TO SPECIFY	
34.2	* MINIMUM HEIGHT OF THE HOOK OF THE CRANE (IN mm)		VENDOR TO SPECIFY	
34.3	TOTAL HEAD LOAD OF ALL THE THREE DG SETS, AT 100% LOAD (IN WATTS)		VENDOR TO SPECIFY	
34.4	* TOTAL AUXILIARY POWER OF 400V, 3P ,50Hz TO BE PROVIDED BY PURCHASER (IN kVA)		VENDOR TO SPECIFY	
34.5	* LIST OF ALL AUXILIARY PANELS PROVIDED BY VENDOR.		VENDOR TO SPECIFY	

NOTES

- 1 THE DIESEL ENGINE AND THE ALTERNATOR SHALL BE INSTALLED UNDER A SHADE (WITH NO WALLS AROUND).
- 2 VENDOR TO ENSURE THAT THE ENGINE AND THE ALTERNATOR, TOGETHER WITH ALL ACCESSORIES, ARE DESIGNED FOR A MINIMUM OF IP51 PROTECTION DEGREE. ELSE, NECESSARY RECOMMENDATION TO BE PROVIDED BY THE VENDOR, WITH REPECT TO THE DESIGN OF THE BUILDING, SO AS TO TAKE CARE OF THE WARRANTY REQUIREMENTS OF THE DG PACKAGE.

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PIPING MATERIAL SPECIFICATION

						
0	Issued for ITB	19-06-19	AW	RD	KPM	
A	Issued for Review	18-03-19	AW	RD	KPM	
REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

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1.0 SCOPE

This specification governs the selection and limitations of pipe and piping system components for FGGS at Baghjan.

2.0 CODES, REGULATIONS, STANDARDS

2.1 Vendor shall meet or exceed the requirements of the latest edition of the following codes, regulations and standards, except as superseded herein. In cases where more than one code, regulation or standard apply to the same condition, the most stringent shall be followed. In the event of a conflict between this specification and other specifications or correspondence, the OWNER shall be consulted and a ruling, in writing, shall be obtained before any work is started.

- ASME Boiler and Pressure Vessel Code, all applicable sections.
- ANSI/ASME B16.9, Wrought Steel Butt-welding Fittings
- ANSI/ASME B16.10, Face to Face and end to end dimensions of valves.
- ANSI/ASME B16.11, Steel Socket Weld Fittings
- ANSI/ASME B16.20, Metallic Gaskets for Pipe Flanges - Ring Joint, Spiral Wound and Jacketed
- ANSI/ASME B16.25, Butt welding ends
- ANSI/ASME B16.28, Butt-welding Short Radius Elbows and Returns
- ANSI/ASME B16.34, Valves - Flanged, Threaded and Weld End
- ANSI/ASME B16.5, Steel Pipe Flanges and Flanged Fittings
- ANSI/ASME B31.1, Power Piping
- ANSI/ASME B31.3, Chemical Plant and Petroleum Refinery Piping
- ANSI/ASME B36.10, Welded and Seamless wrought steel pipes
- ANSI/ASME B36.19, Stainless steel pipes
- API 598, Valve Inspection and Testing
- API 600, Steel Gate Valves - Flanged and Butt-welding Ends
- API 602, Compact Steel Gate Valves

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- API RP 941, Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants
- ASTM Standards, as applicable
- BS EN ISO 15761, Steel Globe, Gate and Check valves $\leq$ NPS 100
- BS EN ISO 17292, Metal Ball valves
- BS 1868, Specification for Steel Check valves
- BS 1873, Specification for Steel Globe and Check valves
- MSS SP 95, Swage Nipples
- MSS SP 97, Integrally reinforced forged branch outlet fittings
- NACE MR-0175, Material Requirement - Sulfide Stress Cracking Resistant Material for Oilfield Equipment

2.2 The following General Specifications shall be used in conjunction with this specification where applicable:

- FGGS-BJN-PIP-SPC-5001 Valve Material Specification
- FGGS-BJN-PIP-SPC-5003 Specification for Fabrication and erection of Piping
- FGGS-BJN-PIP-SPC-5003 General Welding specification for Piping

2.3 Some requirements in this specification may be modified by specific requirements in the Purchase Specification. In case of conflict, the specific requirements supersede this specification.

2.4 Any deviation from this specification must be approved, in writing, by OWNER. Such written approval must be obtained prior to the commencement of any work which would constitute such a deviation.

3.0 GENERAL

3.1 All pressures given in this Specification are gauge pressure unless otherwise stated.

3.2 Except under special conditions of severity, hazard, etc., the materials used shall be in accordance with the Piping Material Specification which is based on the design pressure and temperature and on the type of service. The materials used under special conditions of severity and hazard must be suitable for the particular service conditions involved.

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- 3.3 The corrosion allowance specified for the classes shall be considered in the calculation of the wall thickness.

In no case it is reduced to obtain a thinner commercially available pipe thickness.

- 3.4 The abbreviated material description in the classes gives brief information to the piping designer. For the supply of the material, detailed technical requirements shall be included the purchasing requisitions.
- 3.5 All material used shall be in accordance with code requirements and industry standards for good workmanship.
- 3.6 Pipe materials shall be selected as follows, whenever temperature is the governing factor.

<u>Material</u>	<u>Temperature Range</u>
Carbon Steel	-20°C to 454°C
Type 316L stainless steel	-20°C to 454°C
Low alloy steel (carbon-moly and chrome alloys)	Over plus 454°C
Cast Iron	0°C to 90°C

Other types of materials or alloys shall be used where corrosive conditions are the governing factor. API RP. 941, Steels for Hydrogen Service at Elevated Temperatures and Pressures in Petroleum Refineries and Petrochemical Plants (the Nelson curves), shall be used for selecting materials for piping in hydrogen service.

- 3.7 All piping materials shall meet the impact requirements of ANSI B31.3. When Charpy V-notch testing is a requirement, it shall be conducted in accordance with ASTM Standard A370 at a test temperature 5°C below the minimum design temperature. A minimum average absorbed energy for each set of three full sizes Charpy specimens shall be 17.6 joules with no individual impact value below 13.6 joules.

4.0 PIPE

- 4.1 Pipe shall normally be as specified in the Piping Material Specification for the applicable Piping Class Rating and Service.
- 4.2 Piping for service below -20°C and above 454°C shall be approved by OWNER.

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4.3 Seamless Pipe

The following materials shall normally be used. Other materials may be used if approved by OWNER.

<u>Material</u>	<u>Specification</u>	<u>Temperature (°C)</u>	
		<u>Minimum</u>	<u>Maximum</u>
Carbon Steel	A 53 Gr. B	-20 *	425
	API-5L Gr. B	-20 *	425
	A106 Gr. B	-20 *	425
C-1/2 Mo	A335 Gr. P1	-20	537
5 Cr-1/2 Mo	A335 Gr. P5	-20	648
1-1/4 Cr-1/2 Mo	A335 Gr. P11	-20	648
2-1/4 Cr-1 Mo	A335 Gr. P22	-20	648
11-13 Cr	A268 Gr. 405	-20	371
11-13 Cr	A268 Gr. 410	-20	371
Cr- Ni	A312 Type 316L	-20	537

* Pipe with nominal wall thickness greater than 12.7 mm must have the minimum design metal temperature (MDMT) increased as per ANSI/ASME B31.3 Fig. 323.2.2, Curve B.

4.4 Welded Pipe

The following materials shall normally be used. Other materials may be used if approved by OWNER

<u>TYPE</u>	<u>MATERIAL</u>	<u>LIMITATIONS</u>	<u>SPECIFICATIONS</u>
Butt Weld	Carbon Steel	65°C and 1034 kPag	API 5L Gr. B, A 53 Gr. B,
Electric Resistance Weld (Non-Expanded)	Carbon Steel	425°C	API 5L Gr. B, A 53 Gr. B,
Electric Resistance Weld (Cold Expanded)	Carbon Steel	204°C	API 5L Gr. B
Electric Fusion Weld	Carbon Steel*	398°C	A 671 Class 2* or A 672
	Carbon Steel*	425°C	A 671 Class 1* or A 672
	Cr- Ni	537°C	A 312 TP316L

* Specify grade, class and longitudinal joint factor.

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4.5 Marking and Finish

Pipe shall be legibly marked in accordance with the applicable ASTM or API specification. In addition, the requirements of ASTM Standard Specification A-530 shall apply where it is referenced to in the individual ASTM piping specification.

4.6 Hardness of Pipe Material

The maximum hardness of pipe with welded seams shall not exceed 225 BHN anywhere in the weld, heat-affected zone, or parent metal.

5.0 VALVES

5.1 Valves shall be provided in accordance with the Piping Material Specification for the applicable Piping Class Rating and Service and Valve Material Specifications FGGS-BJN-PIP-SPC-5001

5.2 No valves of brass, cast iron, ductile iron, nodular iron, or semi-steel; nor valves containing rubber, bronze or plastics shall be used unless specifically noted in the Piping Material Specification, Valve Material Specifications FGGS-BJN-PIP-SPC-5001 or a specific project directive.

6.0 FLANGES

6.1 Flanges shall be provided in accordance with the Piping Material Specification for the applicable Piping Class Rating and Service.

6.2 Flanges and flanged fittings shall comply with ANSI B16.5 and ANSI B 16.47.

6.3 Weld neck / Socket weld flanges shall be used unless otherwise specified by OWNER. In ANSI 900 and higher ratings, RTJ flanges are recommended except in salt water or other corrosive service. Raised face flanges are recommended for ease of fit up and installation and removal of valves and equipment.

7.0 FITTINGS

7.1 Fittings shall be provided in accordance with the Piping Material Specification for the applicable Piping Class Rating and Service.

7.2 Branch Connections using welding tees or commercial integrally reinforced fittings such as weldolets, sockolets (forged only) or socket weld couplings are equally acceptable, with the choice of the type of connection based on the criteria provided by the Branch Connection Tables contained in Appendix C.

8.0 BOLTING

8.1 Flange bolting shall be provided in accordance with the Piping Material Specification for the applicable Piping Class Rating and Service.

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- 8.2 Bolting for temperatures -20°C to 482°C shall be A -193 Grade B-7 with A194 Grade 2H nuts and for temperatures 482°C to 593°C shall be A-193 Grade B-16 with A194 Grade 2HM nuts.
- 8.3 Materials for use below -20°C and above 593°C shall be approved in writing by OWNER unless otherwise specified in supplementary specifications.
- 8.4 Studs shall be threaded full length.
- 8.5 Threads on stud bolts and nuts under 1" diameter shall be coarse thread series. Larger diameter studs shall have Unified 8 Class 2A threads. Nuts shall have Class 2B threads.
- 8.6 The stud length shall be selected so that when nuts are fully engaged the stud projects beyond the nuts but not more than two full threads.

9.0 GASKETS

- 9.1 Gaskets shall be provided in accordance with the Piping Material Specification for the applicable Piping Class Rating and Service.
- 9.2 Materials for use below -20°C and above 645°C shall be approved by OWNER.
- 9.3 Spiral wound gaskets shall have a metal winding of Cr-Ni stainless steel and a carbon steel cantering ring.
- 9.4 Ring joint gaskets shall be soft iron of 90 BHN maximum for sweet service and SS 316 in sour service piping.
- 9.5 Where alloy flanges are used or flanges faced with an alloy, the rings may be the same material as the flange or flange facing.
- 9.6 A minimum difference of 50 BHN shall be maintained between flange facings and rings, with the ring being the softer material.
- 9.7 Where required for corrosive conditions, materials other than those listed in the Pipe Material Specification may be used with approval by OWNER.

10.0 SOUR SERVICE PIPING

- 10.1 A sour environment shall be defined as follows:

(a) Sour Gas

The gas being handled is at a total pressure of 448 kPa (abs) or greater and the partial pressure of H₂S in the gas is greater than 0.35 kPa (abs). Systems operating below 448 kPa (abs) total pressure or below 0.35 kPa (abs) H₂S partial pressure shall be considered sweet.

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(b) Sour Multiphase

The total system pressure is 1827 kPa (abs) or greater and the partial pressure of H₂S in the gas phase is greater than 69 kPa (abs), or whenever the gas phase contains over 15 mole % H₂S at any system pressure.

(c) Naphthene Acid

When the acid value of crude oil is more than and equal to 0.5 mg koH/g, it is high acid value. The equipment and piping materials shall be inhibited corrosion of naphthene acid. The temperature influences on the performance of corrosion of naphthene acid:

The Naphthene acid is not corrosive below 220°C, and subsequently, the corrosion will increase with the temperature rise. It is highly corrosive at 270°C ~280°C, and when the temperature rises, the corrosion will decrease. The corrosion will increase again at about 350°C and is not corrosive above 400°C.

The equipment and piping materials shall be corrosion resistant to Naphthene acid according to the operating temperature (e.g. 316L stainless steel).

The above definitions are adopted from NACE Standard MR-01-75 and provide a convenient means of determining the limits of sweet vs. sour service.

11.0 PIPING CLASSIFICATIONS AND MATERIAL SPECIFICATIONS

11.1 Abbreviations Used

ABBREVIATION	NAME	NOTE
AL	Aluminum	
ANSI	American National Standard Institute	
API	American Petroleum Institute	
ASME	American Society of Mechanical Engineers	
ASTM	American Society of Testing and Materials	
ATM	Atmosphere	
BB	Bolted Bonnet	
BBE	Beveled both Ends	
BC	Bolted Cover	
BE	Beveled End	

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ABBREVIATION	NAME	NOTE
BLE	Beveled Large End	
BOE	Beveled One End	
Br	Bronze	
BRZG	Capillary Brazing End	
BSE	Beveled Small End	
BW	Butt Welding	
CA	Corrosion Allowance	
CALC	Calculate	
CAS	Cast Alloy Steel	
CCS	Cast Carbon Steel	
CI	Cast Iron	
CONC	Concentric	
Cr	Chromium	
CS	Carbon Steel	
CSA	Canadian Standards Association	
CuNi	Copper-Nickel	
CWP	Cold Working Pressure	
D	Diameter	
ECC	Eccentric	
EFW	Electric Fusion Welded	
EQ	Equal	
ERW	Electric Resistance Welded	
F6	Stainless Steel, 13% Cr	
FAS	Forged Alloy Steel	
FCS	Forged Carbon Steel	
FSS	Forged Stainless Steel	
FF	Flat Face	
FLGD	Flanged	
FM	Female Face	

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ABBREVIATION	NAME	NOTE
GALV	Galvanize	
Gr.	Grade	
HEX	Hexagonal	
HT	Heat Tracing	
ID	Inside diameter	
IH	Hot Insulation	
IP	Personnel Protection Insulation	
LJ	Lap Joint	
LR	Long Radius	
M	Male Face	
Mnfr	Manufacturer	
Max	Maximum	
MI	Malleable Cast iron	
Min	Minimum	
Mo	Molybdenum	
MPCS	Micro-porous Calcium Silicate	
NCS	Normalized Carbon Steel	
Ni	Nickel	
NPT	Threading as per ANSI B1.20.1	
OD	Outside Diameter	
PBE	Plain both Ends	
PE	Plain End	
PLE	Plain Large End	
PO	Polyurethane	
POE	Plain One End	
PSE	Plain Small End	
PT	Polyethylene Type	
PVC	Polyvinyl Chloride	
R	Radius	

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ABBREVIATION	NAME	NOTE
RED	Reducing	
RF	Raised Face	
RJ	Machined Face for Ring Joint	
RTJ	Ring Joint Face	
SAW	Submerged Arc Welding	
SB	Screwed Bonnet	
SCH	Schedule	
SCRD	Screwed	
SMLS	Seamless	
SS	Stainless Steel	
STD	Standard	
SW	Socket Weld	
TBE	Threaded both Ends	
TE	Threaded End	
THK	Thickness	
TLE	Threaded Large End	
TLPR	Two layer Polyolefin Resin	
TOE	Threaded one End	
TSE	Threaded Small End	
WB	Welded Bonnet	
WLD	Welded	
WN	Weld Neck	

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APPENDIX A

PIPING CLASSES SPECIFICATIONS

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PIPING CLASSES SPECIFICATION								
CLASS	SERVICE	SYMBOL	RATING	MATERIAL	C.A. (mm)	DESIGN		REMARKS
						Pr.	Temp.	
						Kg/cm ²	°C	
A01	Closed Drain	CD	150#	CS	1.5			
	Diesel	DO						
	Fuel Gas	FG						
	Fire water	FW						
	Flare Gas	FL						
	Oily water	OW						
	Process Gas	PG						
	Process Condensate	PC						
	Produced Water	PW						
	Treated water	TW						
	Utility Air	UA						
	Well Water	WW						
A12	Closed Drain	CD	150 #	CS	3.0			
	Oily Water	OW						
	Produced Water	PW						
A41	Instrument Air	IA	150 #	CS (GALV)	0			
	Potable Water	DW						
A61	Biocide	BI	150 #	SS 316L	0			
	Corrosion Inhibitor	CI						
	Oxygen Scavenger	OS						

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CLASS	SERVICE	SYMBOL	RATING	MATERIAL	C.A. (mm)	DESIGN		REMARKS
						Pr.	Temp.	
						Kg/cm ²	°C	
B01	Closed Drain	CD	300#	CS	1.5			
	Produced Water	PW						
B12	Process Condensate	PC	300#	CS	3.0			
	Process Gas	PG						
	Produced Water	PW						
	Oily Water	OW						
	Fuel Gas	FG						
	Flare Gas	FL						
	Closed Drain	CD						
C61	Corrosion Inhibitor	CI	600#	SS 316L	0			
E12	Closed Drain	CD	900#	CS	3.0			
	Corrosion Inhibitor	CI						
	Flare Gas	FG						
	Process Condensate	PC						
	Produced Water	PW						
	Process Gas	PG						
	Oily Water	OW						
	Methanol	ME						

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						Pr.	Temp.	
						Kg/cm ²	°C	
E 61	Corrosion Inhibitor	CI	900#	SS 316L	0			
	Methanol	ME						
G01	Process Condensate	PC	2500#	CS	1.5			
	Process Gas	PG						
	Closed Down	CD						
	Oily Water	OW						
	Flare Gas	FG						
G12	Process Gas	PG	2500#	CS	3			
	Flare Gas	FG						
G61	Corrosion Inhibitor	CI	2500#	SS 316L	0			

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APPENDIX B

PIPING MATERIAL SPECIFICATION

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A01	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE			1.5 mm		
RATING	150 #				MATERIAL			C.S.		
SERVICE LIMITS	Pr. (Kg/cm²)	19.98	19.98	19.57	18.05	16.11	14.07	10.4	6.62	5.61
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING / SCH.	ENDS	DESCRIPTION					
	FROM	TO								
PIPE	1½"	1½"	SCH 80	PE	CS. SMLS, A 106 Gr. B, B36.10					
	2"	6"	SCH 40	BE	CS. SMLS, A 106 Gr. B, B36.10					
	8"	24"	STD	BE	CS. ERW, API 5L Gr B PSL 1, B36.10					
	26"	36"	STD	BE	CS. ERW, API 5L Gr B PSL 1, B36.10					
FITTING (NOTE-2)	1½"	1½"	3000#	SW	FCS, A105N, B16.11					
	2"	6"	SCH 40	BW	CS,SMLS, A234 Gr.WPB, B16.9					
	8"	24"	STD	BW	CS,WLD, A234 Gr.WPB-W, B16.9					
	26"	36"	STD	BW	CS,WLD, A234 Gr.WPB-W, B16.9					
FLANGE	1½"	1½"	150#	SW	FCS, A105N, B16.5 ,RF, ID TO MATCH PIPE					
	2"	24"	150#	WN	FCS, A105N, B16.5, RF, ID TO MATCH PIPE					
	26"	36"	150	WN	FCS, A105N, B16.47-B, RF, ID TO MATCH PIPE					
STUD BOLT/ NUTS	1½"	36"	150#	-	A193 Gr.B7 /194 Gr.2H, WITH TWO HEAVY HEXAGONAL NUTS AND WASHERS, B 18.2.1/18.2.2					
GASKET	1½"	36"	150#	-	SPIRAL WOUND, SS304+GRAFOIL WITH SOFT STEEL CENTERING RING, B16.20					
O'LET	1½"	1½"	3000#	SW/SCR	FCS, A105N , MSS SP-97					
	2"	14"		BW	FCS, A105N , SCH TO MATCH PIPE, MSS SP-97					
SWAGE	1½"	1½"	SCH 80	PE/SCR	FCS, A105N, MSS SP-95					
NIPPLE	1½"	1½"	SCH. 80	PE/SCR	CS, SMLS, A106 Gr. B, B36.10					

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 19 of 47	OIL INDIA LIMITED	

A01	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE			1.5 mm		
RATING	150 #				MATERIAL			C.S.		
SERVICE LIMITS	Pr. (Kg/cm ²)	19.98	19.98	19.57	18.05	16.11	14.07	10.4	6.62	5.61
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING / SCH.	ENDS	DESCRIPTION					
	FROM	TO								
BALL VALVE	1½"	1½"	150#	FLGD	FLOATING BALL, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM - AISI 304, SEAT-RPTFE, BS EN ISO17292, RF, TAG No. BA-CA121					
	2"	8"	150#	FLGD						
	10"	24"	150#	FLGD	TRUNNION MOUNTED, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM -13% Cr, SEAT– RPTFE, BS EN ISO17292, RF, TAG No. BA-CA121					
	26"	36"	150#	FLGD	TRUNNION MOUNTED, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM -13% Cr, SEAT –RPTFE, API 6D, RF, B 16.47-B, TAG No. BA-CA121					
GATE VALVE	1½"	1½"	800#	SW	BODY/BONNET – A105N, TRIM - 13% Cr, API 602. TAG No. GA-CA810					
	2"	24"	150#	FLGD	BODY/BONNET – A216 WCB, TRIM - 13%Cr, API 600, RF, TAG No. GA-CA121					
GLOBE VALVE	1½"	1½"	800#	SW	BODY/BONNET –A105N, TRIM - 13% Cr, BS EN ISO 15761, TAG No. GL-CA810					
	2"	16"	150#	FLGD	BOLTED BONNET, BODY/BONNET – A216 WCB, TRIM - 13% Cr, BS 1873, RF, TAG No. GL-CA121					
CHECK VALVE	1½"	1½"	800#	SW	LIFT CHECK TYPE, BODY – A105, TRIM 13% Cr, BS EN ISO 15761, TAG No. CH-CA810					
	2"	16"	150#	FLGD	SWING TYPE, BODY- A216 WCB, TRIM-13% Cr, BS 1868, RF, TAG No. CH-CA121					
BUTTERFLY VALVE	2"	16"	150#	-	WAFER TYPE, BODY- A216 WCB, DISC- A 182 Gr. F 316, API 609,RF, TAG No. BU-CA141					
NEEDLE VALVE	1½"	1½"	800#	SCRD	BODY- SS 316, DISC- A 182 F 316, NPT(F), Tag No. NE-SC811					

NOTE 1 : FOR HANDWHEEL OR GEAR OPERATION REQUIREMENT OF VALVES, REF. VALVE MATERIAL SPECIFICATION FGGS-BJN-PIP-SPC-5001.

NOTE 2 : FOR BRANCHING TABLE REF. APPENDIX C.



PIPING MATERIAL SPECIFICATION

JPEC

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A12	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A					CORROSION ALLOWANCE			3.0 mm	
RATING	150 #					PIPING MATERIAL			C.S.	
SERVICE LIMITS	Pr. (Kg/cm ²)	19.98	19.98	19.57	18.05	16.11	14.07	10.4	6.62	5.61
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING / SCH.	ENDS	DESCRIPTION					
	FROM	TO								
PIPE	½”	2”	SCH 80	PE	CS. SMLS, A 106 Gr. B, B36.10					
	3”	6”	SCH 40	BE	CS. SMLS, A 106 Gr. B, B36.10					
	8”	24”	STD	BE	CS. ERW, API 5L Gr B PSL 2, B36.10					
	26”	36”	STD	BE	CS. ERW, API 5L Gr B PSL 2, B36.10					
FITTING (NOTE-2)	½”	1½”	3000#	SW	FCS, A105N, B16.11					
	2”	2”	SCH80	BW	CS, SMLS, A234 Gr. WPB, B16.9					
	3”	6”	SCH 40	BW	CS, WLD,A234 Gr.WPB-W, B16.9					
	8”	24”	STD	BW	CS, WLD, A234 Gr.WPB-W, B16.9					
	26”	36”	STD	BW	CS, WLD, A234 Gr.WPB-W, B16.9					
FLANGES	½”	1½”	150#	SW	FCS, A105N, B16.5,RF, ID TO MATCH PIPE					
	2”	24”	150#	WN	FCS, A105N, B16.5, RF, ID TO MATCH PIPE					
	26”	36”	150#	WN	FCS, A105N, B16.47-B, RF, ID TO MATCH PIPE					
STUD BOLT/ NUTS	½”	36”	150#	-	A193 Gr.B7 /194 Gr.2H, WITH TWO HEAVY HEXAGONAL NUTS AND WASHERS, B 18.2.1/18.2.2					
GASKET	½”	36”	150#	-	SPIRAL WOUND, SS304+GRAFOIL WITH SOFT STEEL CENTERING RING, B16.20					
O’LET	½”	1½”	3000#	SW/SCR	FCS, A105N ,SCH 80 , MSS SP-97					
	2”	14”	-	BW	FCS, A105N ,SCH. TO MATCH PIPE , MSS SP-97					
SWAGE	½”	1½”	SCH. 80	PE/SCR	FCS, A105N, MSS SP-95					

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 21 of 47	OIL INDIA LIMITED	

A12	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE			3.0 mm		
RATING	150 #				PIPING MATERIAL			C.S.		
SERVICE LIMITS	Pr. (Kg/cm²)	19.98	19.98	19.57	18.05	16.11	14.07	10.4	6.62	5.61
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING / SCH.	ENDS	DESCRIPTION					
	FROM	TO								
NIPPLE	½”	1½”	SCH. 80	PE/SCR	CS, SMLS. A-106 Gr. B, B36.10					
BALL VALVE	½”	1½”	150#	FLGD	FLOATING BALL, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM -13% Cr, SEAT- RPTFE. BS EN ISO17292, RF , Tag No. BA-CA121					
	2”	8”								
	10”	14”	150#	FLGD	TRUNNION MOUNTED, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM -13% Cr, SEAT- RPTFE. BS EN ISO17292, RF, Tag No. BA-CA121					
GATE VALVE	½”	1½”	800#	SW	BODY/BONNET – A105N, TRIM - 13% Cr, API 602 , Tag No. GA-CA810					
	2”	14”	150	FLGD						
GLOBE VALVE	½”	1½”	800#	SW	BODY/BONNET –A105N, TRIM -13% Cr , BS EN ISO 15761, Tag No. GL-CA810					
	2”	14”	150#	FLGD						
CHECK VALVE	½”	1½”	800#	SW	LIFT CHECK TYPE, BODY – A105, TRIM 13% Cr, BS EN ISO 15761, Tag No. CH-CA810					
	2”	14”	150#	FLGD						

NOTE 1 : FOR HANDWHEEL AND GEAR OPERATION REFER VALVE MATERIAL SPECIFICATION
FGGS-BJN-PIP-SPC-5001.

NOTE 2 : FOR BRANCHING TABLE REFER APPENDIX C.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 22 of 47	OIL INDIA LIMITED	

A41	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A					CORROSION ALLOWANCE			1.5mm	
RATING	150 #					PIPING MATERIAL			C.S. (GALV)	
SERVICE LIMITS	Pr. (Kg/cm ²)	19.98	19.98	19.57	18.05	16.11	14.07	10.4	6.62	5.61
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING / SCH.	ENDS	DESCRIPTION					
	FROM	TO								
PIPE	½”	1½”	HEAVY	SCRD	CS. ERW, IS 1239-I,GALV, NPT(M)					
	2”	6”	HEAVY	SCRD	CS. ERW, IS 1239-I,GALV, NPT(M)					
FITTING (NOTE 2)	½”	1½”	3000#	SCRD	FCS, A 105, GALV, B 16.11, NPT(F)					
	2”	6”	HEAVY	SCRD	CS, WLD, IS 1239-II, GALV, NPT(F)					
COUPLING	½”	1½”	3000#	SCRD	FCS, A 105, GALV, B 16.11, NPT(F)					
	2”	6”	SCH40	SCRD	IS 1239-II, GALV, NPT(F)					
FLANGE	½”	6”	150#	SCRD	FCS, A105,GALV,, B16.5, FF , NPT(F)					
STUD BOLT/ NUTS	½”	6”	150#		A193 Gr.B7 /194 Gr.2H, WITH TWO HEAVY HEXAGONAL NUTS AND WASHERS, B 18.2.1/18.2.2					
GASKET	½”	6”	150#		FULL FACE RING GASKET, BUTYL RUBBER, 2 MM THK, B16.21					
UNION	½”	1½”	3000#	SCRD	FCS, A105 GJ,GALV, INTEGRAL SEAT,MSS SP-83,NPT(F)					
	2”	6”	HEAVY	SCRD	IS 1239-II, GALV, NPT(F)					
SWAGE	½”	1½”	3000#	SCRD	FCS, A105 ,GALV, MSS SP-95,NPT(M)					
NIPPLE	½”	1½”	HEAVY	SCRD	CS. ERW, IS 1239-I,GALV, NPT(M)					

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 23 of 47	OIL INDIA LIMITED	

A41	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE			1.5mm		
RATING	150 #				PIPING MATERIAL			C.S. (GALV)		
SERVICE LIMITS	Pr. (Kg/cm²)	19.98	19.98	19.57	18.05	16.11	14.07	10.4	6.62	5.61
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING / SCH.	ENDS	DESCRIPTION					
	FROM	TO								
BALL VALVE	½”	1½”	800#	SCRD	FLOATING BALL, REDUCED BORE, BODY/BONNET – A105N, TRIM 13% Cr, SEAT – RPTFE,. BS EN ISO17292,NPT(F), Tag No. BA-CA811.					
	2”	6”	150#	FLGD,	FLOATING BALL, REDUCED BORE, BODY/BONNET – ASTM A216 WCB, TRIM 13% Cr, SEAT – RPTFE,. BS EN ISO17292, FF, Tag No. BA-CA120.					
GATE VALVE	½”	1½”	800#	SCRD	BODY/BONNET - A105N, TRIM - 13% Cr, API 602, NPT (F), Tag No. GA-CA811					
	2”	6”	150#	FLGD	BODY/BONNET – A216 WCB, TRIM -13% Cr , API 600, FF, Tag No. GA-CA120					
GLOBE VALVE	½”	1½”	800#	SCRD	BODY/BONNET – A105N, TRIM - 13% Cr, BS EN ISO 15761, NPT(F), Tag No. GL-CA811.					
	2”	6”	150#	FLGD	BOLTED BONNET, BODY/BONNET – A216 WCB, TRIM - 13% Cr, BS 1873, FF, Tag No. GL-CA120.					
CHECK VALVE	½”	1½”	800#	SCRD	LIFT CHECK TYPE, BODY – A105N, TRIM 13% Cr , BS EN ISO15761, NPT(F), Tag No. CH-CA811.					
	2”	6”	150#	FLGD	SWING TYPE, BODY- A216 WCB, 13% Cr , BS 1868, FF, Tag No. CH-CA120.					

NOTE 1 : FOR HANDWHEEL AND GEAR OPERATION REFER VALVE MATERIAL SPECIFICATION FGGS-BJN-PIP-SPC-5001.
2 : FOR BRANCHING TABLE REFER APPENDIX C.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 25 of 47		OIL INDIA LIMITED

A61	PIPING MATERIAL SPECIFICATION										
SERVICE	See Appendix A					CORROSION ALLOWANCE			0 mm		
RATING	150 #					MATERIAL			S.S. 316L		
SERVICE LIMITS	Pr. (Kg/cm²)	16.21	16.21	15.60	13.56	12.23	11.42	10.19	6.62	4.69	
	Temp. (°C)	-29	38	50	100	150	200	300	400	450	
ITEMS	NPS		RATING/ SCH.	ENDS	DESCRIPTION						
	FROM	TO									
BALL VALVE	½”	1½”	150#	FLGD	FLOATING BALL, REDUCED BORE, BODY/BONNET – A351CF3M, TRIM – AISI 316L, SEAT - RPTFE. BS EN ISO17292, RF, Tag No. BA-SD121.						
	2”	8”	150#								
	10”	10”	150#		TRUNNION MOUNTED, REDUCED BORE, BODY/BONNET – A351CF3M, TRIM – AISI 316L, SEAT - RPTFE. BS EN ISO 17292, RF, Tag No. BA-SD121						
CHECK VALVE	½”	1½”	800#	SW	LIFT CHECK TYPE, BODY/BONNET -A182 F316L, TRIM - SS316L, BS EN ISO 15761, Tag No. CH-SD810.						
	2”	10”	150#	FLGD	SWING TYPE, BODY/BONNET - A351 Gr. CF3M, TRIM - SS316L, BS1868, RF, Tag No. CH-SD121.						

NOTE 1 : FOR HANDWHEEL AND GEAR OPERATION REFER TO VALVE MATERIAL SPECIFICATION FGGS-BJN-PIP-SPC-5001.

NOTE 2 : FOR BRANCHING TABLE REFER APPENDIX C.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 26 of 47	OIL INDIA LIMITED	

B01	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE			1.5 mm		
RATING	300 #				MATERIAL			C.S.		
SERVICE LIMITS	Pr. (Kg/cm²)	52.1	52.1	51.08	47.51	45.98	44.66	40.58	35.38	29.36
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING / SCH.	ENDS	DESCRIPTION					
	FROM	TO								
PIPE	1½"	1½"	SCH 80	PE	CS. SMLS, A 106 Gr. B, B36.10					
	2"	2"	SCH 80	BE	CS. SMLS, A 106 Gr. B, B36.10					
	3"	14"	STD	BE	CS. SMLS, A 106 Gr. B, B36.10					
	16"	20"	XS	BE	CS. ERW, API 5L Gr B PSL 1, B36.10					
	22"	24"	CALC	BE	CS. ERW, API 5L Gr B PSL 1, B36.10					
FITTING (NOTE-2)	1½"	1½"	3000#	SW	FCS, A105N, B16.11					
	2"	2"	SCH 80	BW	CS, SMLS, A234 Gr.WPB, B16.9					
	3"	14"	STD	BW	CS, SMLS, A234 Gr.WPB, B16.9					
	16"	20"	XS	BW	CS, WLD, A234 Gr.WPB-W, B16.9					
	22"	24"	CALC	BW	CS, WLD, A234 Gr.WPB-W, B16.9					
FLANGE	1½"	1½"	300#	SW	FCS, A105N, B16.5 ,RF, ID TO MATCH PIPE					
	2"	24"	300#	WN	FCS, A105N, B16.5 ,RF, ID TO MATCH PIPE					
STUD BOLT/ NUTS	1½"	24"	300#		A193 Gr.B7 /194 Gr.2H, WITH TWO HEAVY HEXAGONAL NUTS AND WASHERS, B 18.2.1/18.2.2					
GASKET	1½"	24"	300#		SPIRAL WOUND, SS304+GRAFOIL WITH SOFT STEEL CENTERING RING, B16.20					
O'LET	1½"	1½"	3000#	SW	FCS, A105N ,SCH 80 , MSS SP-97					
	2"	8"		BW	FCS, A105N ,SCH TO MATCH PIPE , MSS SP-97					
SWAGE	1½"	1½"	SCH 80	PE	FCS, A105N, MSS SP-95					

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 27 of 47	OIL INDIA LIMITED	

B01	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE			1.5 mm		
RATING	300 #				MATERIAL			C.S.		
SERVICE LIMITS	Pr. (Kg/cm ²)	52.1	52.1	51.08	47.51	45.98	44.66	40.58	35.38	29.36
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING / SCH.	ENDS	DESCRIPTION					
	FROM	TO								
NIPPLE	½"	1½"	SCH. 80	PE/SCR	CS, SMLS, A-106 Gr. B, B36.10					
BALL VALVE	½"	1½"	300#	FLGD	FLOATING BALL, REDUCED BORE, BODY/BONNET – ASTM A216 WCB, TRIM – SS 304, SEAT RPTFE. BS EN ISO17292, RF, Tag No. BA-CA321					
	2"	4"	300#	FLGD	FLOATING BALL, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM - SS 304, SEAT- RPTFE. BS EN ISO17292, RF, Tag No. BA-CA321					
	6"	18"	300#	FLGD	TRUNNION MOUNTED, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM - AISI304, SEAT -RPTFE. BS EN ISO17292, RF, Tag No. BA-CA321					
GATE VALVE	½"	1½"	800#	SW	BODY/BONNET – A105N, TRIM - AISI410, API602, Tag No. GA-CA810					
	2"	24"	300#	FLGD	BODY/BONNET – A216 WCB, TRIM -13% Cr, API600, RF, Tag No. GA-CA321					
GLOBE VALVE	½"	1½"	800#	SW	BODY/BONNET – A105N, TRIM - 13% Cr, BS EN ISO 15761, Tag No. GL-CA810					
	2"	18"	300#	FLGD	BOLTED BONNET, BODY/BONNET – A216 WCB, TRIM - AISI410, BS 1873, RF, Tag No. GL-CA321					
CHECK VALVE	½"	1½"	800#	SW	LIFT CHECK TYPE, BODY – A105, TRIM 13% Cr, BS EN ISO 15761, Tag No. CH-CA810					
	2"	18"	300#	FLGD	SWING TYPE, BODY A216 WCB, 13% Cr, BS 1868, RF, Tag No. CH-CA321					

NOTE 1 : FOR HANDWHEEL AND GEAR OPERATION REFER TO VALVE MATERIAL SPECIFICATION FGGS-BJN-PIP-SPC-5001.

NOTE 2 : FOR BRANCHING TABLE REFER APPENDIX C.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 28 of 47	OIL INDIA LIMITED	

B12	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE			3.0 mm		
RATING	300 #				MATERIAL			C.S		
SERVICE LIMITS	Pr. (Kg/cm ²)	52.1	52.1	51.08	47.51	45.98	44.66	40.58	35.38	29.36
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING / SCH.	ENDS	DESCRIPTION					
	FROM	TO								
PIPE	1/2"	3/4"	SCH 160	PE	CS. SMLS, A 106 Gr. B, B36.10					
	1"	1 1/2"	SCH 80	PE	CS. SMLS, A 106 Gr. B, B36.10					
	2"	2"	SCH 80	BE	CS. SMLS, A 106 Gr. B, B36.10					
	3"	10"	SCH 40	BE	CS. SMLS, A 106 Gr. B, B36.10					
	12"	14"	XS	BE	CS. SMLS, A 106 Gr. B, B36.10					
	16"	18"	SCH 40	BE	CS. ERW, API 5L Gr B PSL 1, B36.10					
	20"	24"	CALC	BE	CS. ERW, API 5L Gr B PSL 1, B36.10					
FITTING (NOTE-2)	1/2"	3/4"	6000#	SW	FCS, A105N, B16.11					
	1"	1 1/2"	3000"	SW	FCS, A105N, B16.11					
	2"	14"	-	BW	CS, SMLS, A234 Gr.WPB, SCH TO MATCH PIPE, B16.9,.					
	16"	24"	-	BW	CS, WLD, A234 Gr.WPB-W, SCH TO MATCH PIPE, B16.9					
FLANGE	1/2"	1 1/2"	300#	SW	FCS, A105N, B16.5 ,RF, ID TO MATCH PIPE					
	2"	24"	300#	WN	FCS, A105N, B16.5 ,RF, ID TO MATCH PIPE					
STUD BOLT/ NUTS	1/2"	24"	300#		A193 Gr.B7 /194 Gr.2H, WITH TWO HEAVY HEXAGONAL NUTS AND WASHERS, B 18.2.1/18.2.2					
GASKET	1/2"	24"	300#		SPIRAL WOUND, SS304+GRAFOIL WITH SOFT STEEL CENTERING RING, B16.20					
O'LET	1/2"	1 1/2"	3000#	SW	FCS, A105N ,SCH TO MATCH PIPE , MSS SP-97					
	2"	8"		BW	FCS, A105N ,SCH TO MATCH PIPE , MSS SP-97					

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 29 of 47	OIL INDIA LIMITED	

B12		PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE				3.0 mm		
RATING	300 #				MATERIAL				C.S		
SERVICE LIMITS	Pr. (Kg/cm²)	52.1	52.1	51.08	47.51	45.98	44.66	40.58	35.38	29.36	
	Temp. (°C)	-29	38	50	100	150	200	300	400	425	
ITEMS	NPS		RATING / SCH.	ENDS	DESCRIPTION						
	FROM	TO									
SWAGE	½”	1½”	-	PE	FCS, A105N, SCH TO MATCH PIPE, MSS SP-95						
NIPPLE	½”	1½”	-	PE/SCR	CS, SMLS, A-106 Gr. B, SCH TO MATCH PIPE, B36.10						
BALL VALVE	½”	1½”	300#	FLGD	FLOATING BALL, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM – AISI 304, SEAT- RPTFE. BS EN ISO17292, RF RF, Tag No. BA-CA321						
	2”	4”	300#								
	6”	24”	300#	FLGD	TRUNNION MOUNTED, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM – AISI 304, SEAT- RPTFE, BS EN ISO17292, RF, Tag No. BA-CA321						
GATE VALVE	½”	1½”	800#	SW	BODY/BONNET – A105N, TRIM - 13% Cr, API602 , Tag No. GA-CA810						
	2”	24”	300#	FLGD	BODY/BONNET –A216 WCB, TRIM - 13% Cr, API 600, RF, Tag No. GA-CA321						
GLOBE VALVE	½”	1½”	800#	SW	BODY/BONNET –A105N, TRIM - 13% Cr, BS EN ISO 15761, Tag No.GL-CA810						
	2”	24”	300#	FLGD	BOLTED BONNET, BODY/BONNET – A216 WCB, TRIM -13% Cr , BS 1873, RF , Tag No. GL-CA321						
CHECK VALVE	½”	1½”	800#	SW	LIFT CHECK TYPE, BODY – A105, TRIM 13% Cr, BS EN ISO 15761, Tag No. CH-CA810						
	2”	24”	300#	FLGD	SWING TYPE, BODY A216 WCB, 13% Cr, BS 1868, RF, Tag No. CH-CA321						
NEEDLE VALVE	½”	1½”	800#	SCRD	BODY- SS 316, DISC – A 182 F 316, Tag No. NE-SC811						

NOTE 1 : FOR HANDWHEEL AND GEAR OPERATION REFER TO. VALVE MATERIAL SPECIFICATION FGGS-BJN-PIP-SPC-5001.

NOTE 2 : FOR BRANCHING TABLE REFER APPENDIX C.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 30 of 47	OIL INDIA LIMITED	

C61	PIPING MATERIAL SPECIFICATION										
SERVICE	See Appendix A					CORROSION ALLOWANCE			0 mm		
RATING	600 #					MATERIAL			S.S. 316L		
SERVICE LIMITS	Pr. (Kg/cm²)	84.33	84.33	81.57	70.97	63.03	59.44	53.12	49.55	47.72	
	Temp. (°C)	-29	38	50	100	150	200	300	400	450	
ITEMS	NPS		RATING/ SCH.	ENDS	DESCRIPTION						
	FROM	TO									
PIPE	½”	¾”	80S	PE	S.S. SMLS, A 312 TP 316L, B36.19						
	1”	1½”	40S	PE	S.S. SMLS, A 312 TP 316L, B36.19						
	2”	6”	40S	BE	S.S. SMLS, A 312 TP 316L, B36.19						
FITTING (NOTE 2)	½”	1½”	3000#	SW	FSS, A182 F316L, B16.11						
	2”	6”	40S	BW	SS, SMLS, A403 WP316L, B16.9						
FLANGE	½”	6”	600#	WN	FSS, A182 F316L, B16.5, RF, ID TO MATCH PIPE						
STUD BOLT/ NUTS	½”	6”	600#		A193 Gr.B8M/194 Gr.2 WITH TWO HEAVY HEXAGONAL NUTS AND WASHERS B 18.2.1/18.2.2						
GASKET	½”	6”	600#		SPIRAL WOUND, SS316L+GRAFOIL WITH SOFT STEEL CENTERING RING, B16.20						
O’LET	½”	1½”	3000#	SW	FSS, A182 F316L ,SCH TO MATCH PIPE , MSS SP-97						
	2”	2”		BW	FSS, A182 F316L ,SCH. TO MATCH PIPE , MSS SP-97						
SWAGE	½”	1½”		PE	FSS, A182 F316L, SCH TO MATCH PIPE, MSS SP-95						
NIPPLE	½”	1½”		PE/SCR	SS, SMLS, A 312 TP 316L, SCH TO MATCH PIPE, B36.19						

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD. PIPING MATERIAL SPECIFICATION				
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 31 of 47	OIL INDIA LIMITED

C61	PIPING MATERIAL SPECIFICATION										
SERVICE	See Appendix A					CORROSION ALLOWANCE			0 mm		
RATING	600 #					MATERIAL			S.S. 316L		
SERVICE LIMITS	Pr. (Kg/cm ²)	84.33	84.33	81.57	70.97	63.03	59.44	53.12	49.55	47.72	
	Temp. (°C)	-29	38	50	100	150	200	300	400	450	
ITEMS	NPS		RATING/ SCH.	ENDS	DESCRIPTION						
	FROM	TO									
BALL VALVE	½”	1½”	600#	FLGD	FLOATING BALL, REDUCED BORE, BODY/BONNET –A351 CF3M, TRIM – AISI 316L, SEAT- RPTFE, BS EN ISO17292, RF, Tag No. BA-SD621						
	2”	6”	600#	FLGD	TRUNNION MOUNTED, REDUCED BORE, BODY/BONNET – 351CF3M, TRIM – AISI16L, SEAT- RPTFE. BS EN ISO17292,RF, Tag No. BA-SD621						
CHECK VALVE	½”	1½”	800#	SW	LIFT CHECK TYPE, BODY/BONNET ASTM A182 F316L, TRIM SS316L, BS EN ISO 15761, Tag No.CH-SD810						
	2”	6”	600#	FLGD	SWING TYPE, BODY/BONNET - A351 CF3M, TRIM- SS316L, BS1868, RF, Tag No. CH-SD621						

NOTE 1 : FOR HANDWHEEL AND GEAR OPERATION REFER TO VALVE MATERIAL SPECIFICATION FGGS-BJN-PIP-SPC-5001.

NOTE 2 : FOR BRANCHING TABLE REFER APPENDIX C.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.				
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 32 of 47	OIL INDIA LIMITED

E12		PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE				3.0 mm		
RATING	900 #				MATERIAL				CS		
SERVICE LIMITS	Pr. (Kg/cm²)	156.22	156.22	153.36	142.55	137.86	133.99	121.85	106.25	88.00	
	Temp. (°C)	-29	38	50	100	150	200	300	400	425	
ITEMS	NPS		RATING / SCH.	ENDS	DESCRIPTION						
	FROM	TO									
PIPE	1½"	1½"	SCH 160	BE	CS. SMLS, A 106 Gr. B, B36.10						
	2"	3"	SCH 160	BE	CS. SMLS, A 106 Gr. B, B36.10						
	4"	14"	SCH 120	BE	CS. SMLS, A 106 Gr. B, B36.10						
	16"	24"	CALC	BE	CS. ERW, API 5L Gr B PSL 2, B36.10						
FITTING (NOTE 2)	1½"	1½"	SCH 160	BW	CS, SMLS, A234 Gr.WPB, B16.9						
	2"	3"	SCH 160	BW	CS, SMLS, A234 Gr.WPB, B16.9						
	4"	14"	SCH 120	BW	CS, SMLS, A234 Gr.WPB, B16.9						
	16"	24"	CALC	BW	CS, WLD, A234 Gr.WPB-W, B16.9						
FLANGE	1½"	24"	900#	WN	FCS, A105N, B16.5, RTJ, ID TO MATCH PIPE						
STUD BOLT/ NUTS	1½"	24"	900#		A193 Gr.B7 /194 Gr.2H, WITH TWO HEAVY HEXAGONAL NUTS AND WASHERS, B 18.2.1/18.2.2						
GASKET	1½"	24"	900#		RING TYPE JOINT, OCTAGONAL, SOFT IRON, 90BHN MAX, B16.20						
O'LET	1½"	8"		BW	FCS, A105N ,SCH TO MATCH PIPE , MSS SP-97						
SWAGE	1½"	1½"	SCH 160	BE	FCS, A105N, MSS SP-95						
NIPPLE	1½"	1½"	SCH 160	PE/SCR	CS, SMLS, A-106 Gr. B, B36.10						

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 33 of 47	OIL INDIA LIMITED	

E12	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A			CORROSION ALLOWANCE			3.0 mm			
RATING	900 #			MATERIAL			CS			
SERVICE LIMITS	Pr. (Kg/cm ²)	156.22	156.22	153.36	142.55	137.86	133.99	121.85	106.25	88.00
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING / SCH.	ENDS	DESCRIPTION					
	FROM	TO								
BALL VALVE	½"	1½"	900#	FLGD	FLOATING BALL, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM – AISI 304, SEAT- RPTFE. BS EN ISO17292, RTJ , Tag No. BA-CA922					
BALL VALVE	2"	16"	900#	FLGD	TRUNNION MOUNTED, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM - AISI 304, SEAT- RPTFE. BS EN ISO17292, RTJ, Tag No. BA-CA922					
GATE VALVE	½"	1½"	1500#	BW	SCRD & SEALWELDED BONNET, BODY/BONNET – A105N, TRIM – 13% Cr, API602, Tag No. GA-CA1530					
	2"	24"	900#	FLGD	PRESS SEALED BONNET, BODY/BONNET – A216 WCB, TRIM – 13% Cr, API600, RTJ, Tag No. GA-CA922					
GLOBE VALVE	½"	1½"	1500#	BW	SCRD & SEALWELDED BONNET, BODY/BONNET – A105N, TRIM – 13% Cr, BS EN ISO 15761, Tag No. GL-CA1530					
	2"	16"	900#	FLGD	PRESS. SEALED BONNET , BODY/BONNET – A216 WCB, TRIM – 13% Cr, BS 1873, RTJ , Tag No. GL-CA922					
CHECK VALVE	½"	1½"	1500#	BW	LIFT CHECK TYPE, SCRD & SEALWELDED BONNET, BODY – A105, TRIM 13% Cr, BS EN ISO 15761, Tag No. CH-CA1530					
	2"	16"	900#	FLGD	SWING TYPE, PRESS SEALED BONNET, BODY A216 WCB, 13% Cr, BS 1868, RTJ, Tag No. CH-CA922					
NEEDLE VALVE	½"	1½"	900#	SCRD	BODY-SS 316, DISC-A 182 F 316, NPT(F), Tag No. NE-SC911					

NOTE 1 : FOR HANDWHEEL AND GEAR OPERATION REFER TO VALVE MATERIAL SPECIFICATION
FGGS-BJN-PIP-SPC-5001.

NOTE 2 : FOR BRANCHING TABLE REFER APPENDIX C.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 35 of 47	OIL INDIA LIMITED	

E61		PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A					CORROSION ALLOWANCE			0 mm		
RATING	900 #					MATERIAL			S.S. 316L		
SERVICE LIMITS	Pr. (Kg/cm ²)	126.51	126.51	122.43	106.42	96.02	89.19	79.71	74.31	73.0	
	Temp. (°C)	-29	38	50	100	150	200	300	400	450	
ITEMS	NPS		RATING/ SCH.	ENDS	DESCRIPTION						
	FROM	TO									
BALL VALVE	½”	1½”	900#	FLGD	FLOATING BALL, REDUCED BORE, BODY/BONNET –A351 CF3M, TRIM – AISI 316L, SEAT- RPTFE, RTJ, BS EN ISO17292, Tag No. BA-SD922						
	2”	10”	900#	FLGD	TRUNNION MOUNTED, REDUCED BORE, BODY/BONNET – 351CF3M, TRIM – AISI16L, SEAT- RPTFE. BS EN ISO17292,RTJ, Tag No. BA-SD922						
CHECK VALVE	½”	1½”	1500#	BW	LIFT CHECK TYPE, SCRD AND SEAL WELDED BONNET, BODY/BONNET -ASTM A182 F316L, TRIM SS316L, BS EN ISO 15761, Tag No. CH-SD1530						
	2”	10”	900#	BW	SWING TYPE, PRESS. SEALED BONNET, BODY/BONNET - A351 CF3M, TRIM- SS316L, BS1868, RTJ, Tag No. BA-SD930						

NOTE 1 : FOR HANDWHEEL AND GEAR OPERATION REFER TO VALVE MATERIAL SPECIFICATION FGGS-BJN-PIP-SPC-5001.

NOTE 2 : FOR BRANCHING TABLE REFER APPENDIX C.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 36 of 47	OIL INDIA LIMITED	

G01	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE			1.5 mm		
RATING	2500 #				PIPING MATERIAL			C.S.		
SERVICE LIMITS	Pr. (Kg/cm²)	433.8	433.8	425.9	395.9	383.0	372.1	338.3	295.0	244.4
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING/ SCH	ENDS	REMARKS					
	FROM	TO								
PIPE	½”	1½”	XXS	BE	CS SMLS, A 106 Gr.B, B36.10					
	2”	3”	XXS	BE	CS SMLS, A 106 Gr.B, B36.10					
	4”	6”	XXS	BE	CS SMLS, API 5L Gr X60, B36.10					
	8”	12”	SCH 160	BE	CS SMLS, API 5L Gr X70, B36.10 (NOTE 3)					
FITTING (NOTE 2)	½”	1½”	XXS	BW	CS, SMLS, A234 Gr. WPB, B16.9					
	2”	3”	XXS	BW	CS, SMLS, A234 Gr. WPB, B16.9					
	4”	6”	XXS	BW	CS, SMLS, A860 Gr WPHY 60, B16.9					
	8”	12”	SCH 160	BW	CS, SMLS, A860 Gr WPHY 70, B16.9					
FLANGES	½”	10”	2500#	WN	FCS, A105N, B16.5 , RTJ, ID TO MATCH PIPE					
STUD BOLT/ NUTS	½”	10”	2500#		A193 Gr.B7 /194 Gr.2H, WITH TWO HEAVY HEXAGONAL NUTS AND WASHERS, B 18.2.1/18.2.2					
GASKET	½”	10”	2500#		RING TYPE JOINT, OCTAGONAL, SOFT IRON, 90BHN MAX, B16.20					
O’LET	½”	3”		BW	FCS, A105N ,SCH TO MATCH PIPE , MSS SP-97					
SWAGE	½”	1½”	XXS	BE	FCS, A105N, MSS SP-95					
NIPPLE	½”	1½”	XXS	PE/SCR	CS, SMLS, A-106 Gr. B, B36.10					

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 37 of 47	OIL INDIA LIMITED	

G01	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE			1.5 mm		
RATING	2500 #				PIPING MATERIAL			C.S.		
SERVICE LIMITS	Pr. (Kg/cm ²)	433.8	433.8	425.9	395.9	383.0	372.1	338.3	295.0	244.4
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING/ SCH	ENDS	REMARKS					
	FROM	TO								
BALL VALVE	½”	1½”	2500#	FLGD	FLOATING BALL, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM – AISI 304, SEAT- RPTFE. BS EN ISO17292, RTJ, Tag No. BA-CA2522					
	2”	10”	2500#	FLGD	TRUNNION MOUNTED, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM - SS 304, SEAT- RPTFE. BS EN ISO17292, RTJ, Tag No. BA-CA2522					
GATE VALVE	½”	1½”	2500#	BW	SCRD & SEALWELDED BONNET, BODY/BONNET – A105N, TRIM – 13% Cr, API 602, Tag No. GA-CA2530					
	2”	10”	2500#	BW	PRESS SEALED BONNET, BODY/BONNET – A216 WCB, TRIM – 13% Cr, AP I600, Tag No. GA-CA2530					
GLOBE VALVE	½”	1½”	2500#	BW	SCRD & SEALWELDED BONNET, BODY/BONNET – A105N, TRIM – 13% Cr, BS EN ISO 15761, Tag No. GL-CA2530					
	2”	10”	2500#	BW	PRESS SEALED BONNET, BODY/BONNET – A216 WCB, TRIM – 13% Cr, BS 1873, Tag No. GL-CA2530					
CHECK VALVE	½”	1½”	2500#	BW	LIFT CHECK TYPE, SCR D & SEALWELDED BONNET, BODY – A105, TRIM 13% Cr, BS EN ISO 15761, Tag No. CH-CA2530					
	2”	10”	2500#	BW	SWING TYPE, PRESS SEALED BONNET, BODY ASTM A216 WCB, 13% Cr, BS 1868, Tag No. CH-CA2530					

NOTE 1 : FOR HANDWHEEL AND GEAR OPERATION REFER TO . VALVE MATERIAL SPECIFICATION
FGGS-BJN-PIP-SPC-5001.

NOTE 2 : FOR BRANCHING TABLE REFER APPENDIX C.

NOTE 3 : PIPE WALL THICKNESS IS CALCULATED BASED ON ACTUAL LINE DESIGN CONDITION. (100°C & 350 KSC) FOR HYDRAULICS PURPOSE.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 38 of 47	OIL INDIA LIMITED	

G12	PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE			3 mm		
RATING	2500 #				PIPING MATERIAL			C.S.		
SERVICE LIMITS	Pr. (Kg/cm ²)	433.8	433.8	425.9	395.9	383.0	372.1	338.3	295.0	244.4
	Temp. (°C)	-29	38	50	100	150	200	300	400	425
ITEMS	NPS		RATING/ SCH	ENDS	REMARKS					
	FROM	TO								
PIPE	½”	1”	XXS	BE	CS SMLS, A 106 Gr.B, B36.10					
	1½”	1½”	XXS	BE	CS SMLS, A 106 Gr.B, B36.10 (NOTE: 3)					
	2”	4”	XXS	BE	CS SMLS, API 5L Gr X 60, B36.10					
	6”	6”	XXS	BE	CS SMLS, API 5L Gr X 70, B36.10 (NOTE: 3)					
FITTING (NOTE-2)	½”	1”	XXS	BW	CS, SMLS, A234 Gr. WPB, B16.9					
	1½”	1½”	XXS	BW	CS, SMLS, A234 Gr. WPB, B16.9					
	2”	4”	XXS	BW	CS, SMLS, A860 Gr WPHY 60, B16.9					
	6”	6”	XXS	BW	CS, SMLS, A860 Gr WPHY 70, B16.9					
FLANGES	½”	10”	2500#	WN	FCS, A105N, B16.5 , RTJ, ID TO MATCH PIPE					
STUD BOLT/ NUTS	½”	10”	2500#		A193 Gr.B7 /194 Gr.2H, WITH TWO HEAVY HEXAGONAL NUTS AND WASHERS, B 18.2.1/18.2.2					
GASKET	½”	10”	2500#		RING TYPE JOINT, OCTAGONAL, SOFT IRON, 90BHN MAX, B16.20					
O’LET	½”	3”	-	BW	FCS, A105N ,SCH TO MATCH PIPE , MSS SP-97					
SWAGE	½”	1½”	-	BE	FCS, A105N, SCH TO MATCH PIPE, MSS SP-95					
NIPPLE	½”	1½”	-	PE/SCR	CS, SMLS, A-106 Gr. B, SCH TO MATCH PIPE, B36.10					

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 39 of 47	OIL INDIA LIMITED	

G12		PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A					CORROSION ALLOWANCE			3 mm		
RATING	2500 #					PIPING MATERIAL			C.S.		
SERVICE LIMITS	Pr. (Kg/cm ²)	433.8	433.8	425.9	395.9	383.0	372.1	338.3	295.0	244.4	
	Temp. (°C)	-29	38	50	100	150	200	300	400	425	
ITEMS	NPS		RATING/ SCH	ENDS	REMARKS						
	FROM	TO									
BALL VALVE	½”	1½”	2500#	FLGD	FLOATING BALL, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM – AISI 304, SEAT- RPTFE. BS EN ISO17292, RTJ, Tag No. BA-CA2522						
	2”	10”	2500#	FLGD	TRUNNION MOUNTED, REDUCED BORE, BODY/BONNET – A216 WCB, TRIM – SS 304, SEAT- RPTFE. BS EN ISO17292, RTJ, Tag No. BA-CA2522						
GATE VALVE	½”	1½”	2500#	BW	SCRD & SEALWELDED BONNET, BODY/BONNET – A105N, TRIM – 13% Cr, API 602, Tag No. GA-CA2530						
	2”	10”	2500#	BW	PRESS SEALED BONNET, BODY/BONNET – A216 WCB, TRIM – 13% Cr, AP I600, Tag No. GA-CA2530						
GLOBE VALVE	½”	1½”	2500#	BW	SCRD & SEALWELDED BONNET, BODY/BONNET – A105N, TRIM – 13% Cr, BS EN ISO 15761, Tag No. GL-CA2530						
	2”	10”	2500#	BW	PRESS SEALED BONNET, BODY/BONNET – A216 WCB, TRIM – 13% Cr, BS 1873, Tag No. GL-CA2530						
CHECK VALVE	½”	1½”	2500#	BW	LIFT CHECK TYPE, SCRD & SEALWELDED BONNET, BODY – A105, TRIM 13% Cr, BS EN ISO 15761, Tag No. CH-CA2530						
	2”	10”	2500#	BW	SWING TYPE, PRESS SEALED BONNET, BODY ASTM A216 WCB, 13% Cr, BS 1868, Tag No. CH-CA2530						

NOTE 1 : FOR HANDWHEEL AND GEAR OPERATION REFER TO . VALVE MATERIAL SPECIFICATION FGGS-BJN-PIP-SPC-5001.

NOTE 2 : FOR BRANCHING TABLE REFER APPENDIX C.

NOTE 3 : PIPE WALL THICKNESS IS CALCULATED BASED ON ACTUAL LINE DESIGN CONDITION. (100°C & 350 KSC) FOR HYDRAULICS PURPOSE.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.					
PIPING MATERIAL SPECIFICATION						
JPEEC	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 40 of 47	OIL INDIA LIMITED	

G61		PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A					CORROSION ALLOWANCE			0 mm		
RATING	2500 #					MATERIAL			S.S. 316L		
SERVICE LIMITS	Pr. (Kg/cm²)	351.39	351.39	339.97	295.53	266.68	247.71	221.41	206.43	202.66	
	Temp. (°C)	-29	38	50	100	150	200	300	400	425	
ITEMS	NPS		RATING/ SCH.	ENDS	DESCRIPTION						
	FROM	TO									
PIPE	½”	1½”	SCH 80S	BE	S.S. SMLS, A 312 TP 316L, B36.19						
	2”	8”	CALC	BE	S.S. SMLS, A 312 TP 316L, B36.19						
FITTING (NOTE 2)	½”	1½”	SCH 80S	BW	SS, SMLS, A403 WP316L, B16.9						
	2”	8”	CALC	BW	SS, SMLS, A403 WP316L, B16.9						
FLANGES	½”	1½”	2500#	WN	FSS, A182 F316L, RTJ, B16.5, ID TO MATCH PIPE						
	2”	8”	2500#	WN	FSS, A182 F316L, RTJ, B16.5, ID TO MATCH PIPE						
STUDS BOLT/ NUTS	½”	8”	2500#		A193 Gr.B8M/194 Gr.2 WITH TWO HEAVY HEXAGONAL NUTS AND WASHERS, B 18.2.1/18.2.2						
GASKET	½”	8”	2500#		RING TYPE JOINT, OCTAGONAL, SS 316L, 90BHN MAX, B16.20						
O’LET	½”	2”		BW	FSS, A182 F316L ,SCH. TO MATCH PIPE , MSS SP-97						
SWAGE	½”	1½”		BE	FSS, A182 F316L, SCH TO MATCH PIPE, MSS SP-95						
NIPPLE	½”	1½”		BE	SS, SMLS, A 312 TP 316L, SCH TO MATCH PIPE, B36.19						

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD. PIPING MATERIAL SPECIFICATION				
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G61		PIPING MATERIAL SPECIFICATION									
SERVICE	See Appendix A				CORROSION ALLOWANCE				0 mm		
RATING	2500 #				MATERIAL				S.S. 316L		
SERVICE LIMITS	Pr. (Kg/cm ²)	351.39	351.39	339.97	295.53	266.68	247.71	221.41	206.43	202.66	
	Temp. (°C)	-29	38	50	100	150	200	300	400	425	
ITEMS	NPS		RATING/ SCH.	ENDS	DESCRIPTION						
	FROM	TO									
BALL VALVE	1½"	1½"	2500#	FLGD	FLOATING BALL, REDUCED BORE, BODY/BONNET – A351CF3M, TRIM – AISI 316L, SEAT –RPTFE, BS EN ISO17292, RTJ, Tag No. BA-SD2522						
	2"	4"	2500#								
	6"	8"	2500#	FLGD	TRUNNION MOUNTED, REDUCED BORE, BODY/BONNET –A351CF3M, TRIM –SS 316L, SEAT- RPTFE, BS EN ISO17292, RTJ , Tag No. BA-SD2522						
CHECK VALVE	1½"	1½"	2500#	BW	LIFT CHECK TYPE, BODY/BONNET- A182 F316L, TRIM -SS316L, BS EN ISO 15761, Tag No. CH-SD2530						
	2"	8"	2500#	BW	SWING TYPE, BODY/BONNET- A351 Gr. CF3M, TRIM- SS316L, BS1868, Tag No. CH-SD2530						

NOTE 1 : FOR HANDWHEEL AND GEAR OPERATION REFER TO VALVE MATERIAL SPECIFICATION FGGS-BJN-PIP-SPC-5001.

NOTE 2 : FOR BRANCHING TABLE REFER APPENDIX C.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD. PIPING MATERIAL SPECIFICATION				
JPECH	DOCU.NO.FGGS-BJN-PIP-SPC-5000	REV.0	DATE:19-06-19	Page 42 of 47	OIL INDIA LIMITED

APPENDIX C

BRANCH CONNECTIONS



PIPING MATERIAL SPECIFICATION

JPEC

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LIMITED**

BRANCH CONNECTION TABLE 1 - PIPING CLASS A01, A12,

		BRANCH																					
	Inches	¾	1	1½	2	3	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
HEADER	¾	T																					
	1	RT	T																				
	1½	RT	RT	T																			
	2	RT	RT	RT	T																		
	3	S	S	RT	RT	T																	
	4	S	S	S	RT	RT	T																
	6	S	S	S	W	RT	RT	T															
	8	S	S	S	W	P	RT	RT	T														
	10	S	S	S	W	P	P	RT	RT	T													
	12	S	S	S	W	P	P	P	RT	RT	T												
	14	S	S	S	W	P	P	P	P	RT	RT	T											
	16	S	S	S	W	P	P	P	P	P	RT	RT	T										
	18	S	S	S	W	P	P	P	P	P	P	RT	RT	T									
	20	S	S	S	W	P	P	P	P	P	P	P	RT	RT	T								
	22	S	S	S	W	P	P	P	P	P	P	P	P	RT	RT	T							
	24	S	S	S	W	R	R	R	R	R	R	R	R	R	RT	RT	T						
	26	S	S	S	W	R	R	R	R	R	R	R	R	R	R	RT	RT	T					
	28	S	S	S	W	R	R	R	R	R	R	R	R	R	R	R	RT	RT	T				
	30	S	S	S	W	R	R	R	R	R	R	R	R	R	R	R	R	RT	RT	T			
	32	S	S	S	W	R	R	R	R	R	R	R	R	R	R	R	R	R	RT	RT	T		
34	S	S	S	W	R	R	R	R	R	R	R	R	R	R	R	R	R	R	RT	RT	T		
36	S	S	S	W	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	RT	RT	T	
	Inches	¾	1	1½	2	3	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
		BRANCH																					

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD. PIPING MATERIAL SPECIFICATION				
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Notes:

T - Straight Tee
RT - Reducing Tee
P - Pipe to Pipe

W - Weldolet
S - Sockolet
R - Reinforced

- 1) Sockolets and tees, when used for branch connections, shall meet the rating requirements of the applicable Piping Material Specification.
- 2) Sockolets may be used for pressure and temperature connections in non-vibrating service. Elbowlets shall be used in lieu of Sockolets for temperature connections located at elbows. Minimum size elbows with temperature connection shall be 4" NPS. Where line is 3" NPS and smaller increase size to 4" NPS.
- 3) Any deviation from the connection type shown in the above table or branch connections for larger piping sizes shall be approved by OWNER.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.				
PIPING MATERIAL SPECIFICATION					
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BRANCH CONNECTION TABLE 2 - PIPING CLASS A61, B01, B12, C 61.

		B R A N C H												
H E A D E R	inches	¾"	1	1½	2	3	4	6	8	10	12	16	20	24
	¾	T												
	1	RT	T											
	1½	RT	RT	T										
	2	S	S	S	T									
	3	S	S	S	RT	T								
	4	S	S	S	RT	RT	T							
	6	S	S	S	W	RT	RT	T						
	8	S	S	S	W	R	RT	RT	T					
	10	S	S	S	W	R	R	RT	RT	T				
	12	S	S	S	W	R	R	R	RT	RT	T			
	16	S	S	S	W	R	R	R	R	RT	RT	T		
	20	S	S	S	W	R	R	R	R	R	RT	RT	T	
	24	S	S	S	W	R	R	R	R	R	RT	RT	T	

Notes:

T - Straight Tee	W - Weldolet
RT- Reducing Tee	S - Sockolet
R - Reinforced	

- 1) Sockolets and tees, when used for branch connections, shall meet the rating requirements of the applicable Piping Material Specification.
- 2) Sockolets may be used for pressure and temperature connections in non-vibrating service. Elbowlets shall be used in lieu of Sockolets for temperature connections located at elbows. Minimum size elbows with temperature connection shall be 4" NPS. Where line is 3" NPS and smaller increase size to 4" NPS
- 3) Any deviation from the connection type shown in the above table or branch connections for larger piping sizes shall be approved by OWNER.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.				
PIPING MATERIAL SPECIFICATION					
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BRANCH CONNECTION TABLE 3 - PIPING CLASS A41

		B R A N C H						
H E A D E R	inches	¾	1	1½	2	3	4	6
	¾	T						
	1	RT	T					
	1½	RT	RT	T				
	2	RT	RT	RT	T			
	3	S	S	S	RT	T		
	4	S	S	S	RT	RT	T	
	6	S	S	S	S	RT	RT	T

Notes:

- T - Straight Tee Screwed
- RT - Reducing Tee Screwed
- S - Thredolet

- 1) Any deviation from the connection type shown in the above table shall be approved by OWNER.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD.				
PIPING MATERIAL SPECIFICATION					
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BRANCH CONNECTION TABLE 4 - PIPING CLASS E12, E61, G01, G12, G 61

	BRANCH									
HEADERS	inches	¾	1	1½	2	3	4	6	8	10
	¾	T								
	1	RT	T							
	1½	RT	RT	T						
	2	S	RT	RT	T					
	3	S	S	S	RT	T				
	4	S	S	S	RT	RT	T			
	6	S	S	S	W	RT	RT	T		
	8	S	S	S	W	R	RT	RT	T	
	10	S	S	S	W	R	R	RT	RT	T

Notes:

T - Straight Tee	S - Sockolet
RT - Reducing Tee	W - Weldolet
R - Reinforced	

- 1) Sockolets, weldlets and tees, when used for branch connections, shall meet the rating requirements of the applicable Piping Material Specification.
- 2) Sockolets may be used for pressure and temperature connections in non-vibrating service. Elbowlets shall be used in lieu of Sockolets for temperature connections located at elbows. Minimum size elbows with temperature connection shall be 4" NPS. Where line is 3" NPS and smaller increase size to 4" NPS
- 3) Any deviation from the connection type shown in the above table shall be approved by OWNER.

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD VALVE MATERIAL SPECIFICATION				
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VALVE MATERIAL SPECIFICATION

						
0	Issued for ITB	19-06-19	AW	RD	KPM	
A	Issued for Review	18-03-19	AW	RD	KPM	
REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD VALVE MATERIAL SPECIFICATION				
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APPENDIX A - VALVE IDENTIFICATION NUMBERS

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD VALVE MATERIAL SPECIFICATION				
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1.0 SCOPE

This specification covers the minimum requirements for manual valves used in hydrocarbon processing plants and facilities, whether field or shop installed. The intent of this specification is to serve as a guideline for valve selection.

2.0 GENERAL

- 2.1 Valve material Specification shall be read in conjunction with Technical notes of Valves (Doc. No: FGGS-BJN-PIP-SPC-5014) and Piping Material Specification (FGGS-BJN-PIP-SPC-5000).
- 2.2 Face-to-Face / End-to-End dimension of valves shall conform to B16.10 to the extent
For valves not covered in B16.10, reference shall be made to BS EN 558-1, BE EN 558-2, BS EN 12627 and / or the manufacturer's drawings.
- 2.3 Flange ends of the valve shall be of same rating as companion flange & weld ends of the valve shall match with connecting pipe thickness unless otherwise specified.
- 2.4 Pressure-temperature rating for flanged and butt-welding end valves shall be as per ASME B16.34. Wall thickness of valve body shall be as per B16.34.

3.0 CODES, REGULATIONS AND STANDARDS

Valves shall meet or exceed the requirements of the latest edition of all applicable Codes, Regulations and Standards, except as superseded herein. In cases where more than one code, regulation or standard apply to the same condition, the most stringent shall be followed. In the event of a conflict between this specification and other specifications or correspondence, the OWNER shall be consulted and a ruling, in writing, shall be obtained before any work is started. Reference codes, regulations and standards include, but are not necessarily limited to the following:

GATE VALVE:-

Spec	Size	Rating	Design Std.	Testing Std.
A01	½" to 1 ½"	800#	API-602	API-598
	2" to 24"	150#	API-600	API-598
A12	½" to 1 ½"	800#	API-602	API 598
	2" to 24"	150#	API-600	API-598
A41	½" to 1 ½"	800#	API-602	API-598
	2" to 6"	150#	API-600	API-598
B01	½" to 1 ½"	800#	API-602	API-598
	2" to 24"	300#	API-600	API-598

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD VALVE MATERIAL SPECIFICATION				
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B12	½" to 1 ½"	800#	API-602	API-598
	2" to 24"	300#	API-600	API-598
C01	½" to 1 ½"	800#	API-602	API-598
	2" to 24"	600#	API-600	API-598
C12	½" to 1 ½"	800#	API-602	API-598
	2" to 24"	600#	API-600	API 598
E01	½" to 1 ½"	1500#	API- 602	API 598
	2" to 24"	900#	API- 600	API 598
E12	½" to 1 ½"	1500#	API-602	API-598
	2" to 24"	900#	API-600	API-598
F01	½" to 1 ½"	1500#	API-602	API-598
	2" to 10"	1500#	API-600	API-598
F12	½" to 1 ½"	1500#	API-602	API-598
	2" to 10"	1500#	API-600	API-598
G01	½" to 1 ½"	2500#	API-602	API-598
	2" to 10"	2500#	API-600	API-598

GLOBE VALVE:-

Spec	Size	Rating	Design Std.	Testing Std.
A01	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I / API 598
	2" to 24"	150#	BS 1873	BS-6755 Pt-I / API 598
A12	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I / API 598
	2" to 8"	150#	BS 1873	BS-6755 Pt-I / API 598
A41	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I / API 598
	2" to 6"	150#	BS 1873	BS-6755 Pt-I / API 598
B01	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I / API 598
	2" to 24"	300#	BS 1873	BS-6755 Pt-I / API 598
B12	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I / API 598
	2" to 16"	300#	BS 1873	BS-6755 Pt-I / API 598
C01	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I / API 598

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD VALVE MATERIAL SPECIFICATION				
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	2" to 16"	600#	BS 1873	BS-6755 Pt-I / API 598
C12	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I / API 598
	2" to 16"	600#	BS 1873	BS-6755 Pt-I / API 598
E01	½" to 1 ½"	1500#	BS EN ISO 15761	BS-6755 Pt-I / API 598
	2" to 16"	900#	BS 1873	BS-6755 Pt-I / API 598
E12	½" to 1 ½"	1500#	BS EN ISO 15761	BS-6755 Pt-I / API 598
	2" to 16"	900#	BS 1873	BS-6755 Pt-I / API 598
F01	½" to 1 ½"	1500#	BS EN ISO 15761	BS-6755 Pt-I / API 598
	2" to 10"	1500#	BS 1873	BS-6755 Pt-I / API 598
F12	½" to 1 ½"	1500#	BS EN ISO 15761	BS-6755 Pt-I / API 598
	2" to 10"	1500#	BS 1873	BS-6755 Pt-I / API 598
G01	½" to 1 ½"	2500#	BS EN ISO 15761	BS-6755 Pt-I / API 598
	2" to 16"	2500#	BS 1873	BS-6755 Pt-I / API 598

BALL VALVE:-

Spec	Size	Rating	Design Std.	Testing Std.
A01	½" to 36"	150#	BS EN ISO 17292, ASME B 16.34	BS-6755 Pt-I / API 598
A12	½" to 1 ½"	150#	BS EN ISO 17292	BS-6755 Pt-I / API 598
	2" to 14"	150#	BS EN ISO 17292	BS-6755 Pt-I / API 598
A41	½" to 1 ½"	800#	BS EN ISO 17292	BS-6755 Pt-I / API 598
	2" to 6"	150#	BS EN ISO 17292	BS-6755 Pt-I / API 598
A61	½" to 10"	150#	BS EN ISO 17292	BS-6755 Pt-I / API 598
B01	½" to 1 ½"	300#	BS EN ISO 17292	BS-6755 Pt-I / API 6D
	2" to 16"	300#	BS EN ISO 17292	BS-6755 Pt-I / API 6D
B12	½" to 16"	300#	BS EN ISO 17292	BS-6755 Pt-I / API 6D
B61	½" to 10"	300#	BS EN ISO 17292	BS-6755 Pt-I / API 598
C01	½" to 16"	600#	BS EN ISO 17292	BS-6755 Pt-I / API 598
C12	½" to 16"	600#	BS EN ISO 17292	BS-6755 Pt-I / API 598

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD VALVE MATERIAL SPECIFICATION				
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C61	½" to 10"	600#	BS EN ISO 17292	BS-6755 Pt-I /API 598
E01	½" to 16"	900#	ASME B 16.34	BS-6755 Pt-I /API 598
F01	½" to 10"	1500#	ASME B 16.34	BS-6755 Pt-I /API 598
F12	½" to 10"	1500#	ASME B 16.34	BS-6755 Pt-I /API 598
G01	½" to 10"	2500#	ASME B 16.34	BS-6755 Pt-I /API 598

CHECK VALVE:-

Spec	Size	Rating	Design Std.	Testing Std.
A01	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 16"	150#	BS 1868	BS-6755 Pt-I /API 598
A12	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 14"	150#	BS 1868	BS-6755 Pt-I /API 598
A41	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 6"	300#	BS 1868	BS-6755 Pt-I /API 598
A61	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 10"	150#	BS 1868	BS-6755 Pt-I /API 598
B01	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 16"	300#	BS 1868	BS-6755 Pt-I /API 598
B12	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 16"	300#	BS 1868	BS-6755 Pt-I /API 598
B61	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 10"	300#	BS 1868	BS-6755 Pt-I /API 598
C01	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 16"	600#	BS 1868	BS-6755 Pt-I /API 598
C12	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 16"	600#	BS 1868	BS-6755 Pt-I /API 598
C61	½" to 1 ½"	800#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 10"	600#	BS 1868	BS-6755 Pt-I /API 598
E01	½" to 1 ½"	1500#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 16"	900#	BS 1868	BS-6755 Pt-I /API 598

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD VALVE MATERIAL SPECIFICATION				
JPEC	DOC.NO.FGGS-BJN-PIP-SPC-5001	REV.0	DATE:19-06-19	Page 7 of 11	OIL INDIA LIMITED

E12	½" to 1 ½"	1500#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 16"	900#	BS 1868	BS-6755 Pt-I /API 598
F01	½" to 1 ½"	1500#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 10"	1500#	BS 1868	BS-6755 Pt-I /API 598
F12	½" to 1 ½"	1500#	BS EN ISO 15761	BS-6755 Pt-I /API 598
	2" to 10"	1500#	BS 1868	BS-6755 Pt-I /API 598
G01	½" to 1 ½"	2500#	BS 1868	BS-6755 Pt-I /API 598
	2" to 10"	2500#	BS 1868	BS-6755 Pt-I /API 598

3.1 If not covered in above, the valve shall be as per B16.34 / relevant MSS-SP Standard.

4.0 DESIGN

- 4.1 All Ball Valves shall be fire safe design. Fire test shall be as per BS 6755(Part-I)/API 6FA.
- 4.2 Features not covered by Valve Material Specification and the relevant code shall be to the Manufacturer's standard.
- 4.3 For piping class 150 & 300 all small bore Gate, Globe & Check valves (½"- 1½") shall have Socket weld ends & be supplied in 800 rating.
- 4.4 Unless otherwise specifically called for upto 600#, 2" and larger size steel Gate, Globe & Check valves in Hydrocarbon and utility service shall be bolted Bonnets. Pressure-seal Bonnets or covers shall be used for classes 900# and above to minimize Bonnet leakage. However, valves with pressure-seal Bonnet shall have wall thickness & stem diameter as per API-600, (if required). Welded Bonnets or screwed & seal welded Bonnets are acceptable for sizes lower than 2" for classes 900# & above.
- 4.5 Materials shall be carbon steel from ANSI B16.5 material groups 1.1, 1.3 or 1.4 unless otherwise specified by OWNER
- 4.6 Globe and Gate valves shall have outside stem and yoke (OS&Y) with bolted or welded bonnets. Bonnets on check valves shall be bolted or welded. Screwed bonnets or union bonnets shall not be used. Bonnet bolts shall be ASTM A193 Grade B7. On all Check and Globe valves, the direction of flow shall be cast, stamped or forged on the valve body.
- 4.7 Sour service valves shall meet the requirements of NACE Standard.
- 4.8 Generally the valves are hand wheel or lever operated. However, suitable gear operator in enclosed gear box shall be provided for valves as follows:-

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD VALVE MATERIAL SPECIFICATION				
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<u>VALVE TYPE</u>	<u>CLASS</u>	<u>FOR SIZES</u> > =
GATE, GLOBE	150	12"
	300	12"
	600	10"
	900	6"
	1500	3"
	2500	3"
BALL/PLUG	150	6"
	300	6"
	600	4"
	900	3"
	1500	3"
	2500	3"
BUTTERFLY	150	10"
	300	6"

- 4.9 Hand wheel diameter shall not exceed 750mm and lever length shall not exceed 500mm on each side. Effort to operate shall not exceed 35 kgf at hand wheel periphery. However, failing to meet the above requirement, vendor shall offer gear operation.
- 4.10 Quarter turn valve shall have "open" position indicators with limit stop.
- 4.11 Each valve shall be supplied with a lever / wrench except for gear operated / motor operated valves.
- 4.12 Soft- seated Ball, Plug & Butterfly valves shall be supplied with antistatic devices.
- 4.13 The ball of Ball valves shall not protrude outside the end flanges.
- 4.14 Soft seated BW/SW end ball valves shall have a 100 mm long seamless pipe nipple welded to each end of the valve. Nipples are to be welded prior to assembling Teflon seats/seals.
- 4.15 Ball valves shall be floating ball type / Trunnion mounted as per follows:-

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD VALVE MATERIAL SPECIFICATION				
JPEC	DOC.NO.FGGS-BJN-PIP-SPC-5001	REV.0	DATE:19-06-19	Page 9 of 11	OIL INDIA LIMITED

<u>Class</u>	<u>Floating ball</u>	<u>Trunnion mounted</u>
150 #	8" & below	10" & above
300 #	4" & below	6" & above
600 # & above	1½" & below	2" & above

- 4.16 Use of soft-seated Ball/Plug/Butterfly valves shall be suitably selected based on Temperatures handled.
- 4.17 Butterfly valves shall be suitable for throttling application.
- 4.18 For heavy Check Valves (above 50 Kg) provision shall be available for lifting by way of lugs, eye bolts and other such standard means.
- 4.19 All the valves of 300 # and above shall be 100% radio-graphed for body and bonnet.

5.0 INSTALLATION

- 5.1 Wherever possible, valves should be kept near grade level. All operating valves installed 2100 mm or more above floor, platform or other point of easy access shall be hammer blow chain wheel operated. Hammer blow chain wheels shall have U-bolt clamps, not J-bolt clamps.
- 5.2 Hand wheels and stems shall be kept out of operating aisles, where practical, otherwise elevated to 2100 mm from grade to bottom of hand wheel.
- 5.3 Valves shall not be installed with stems below a horizontal position.
- 5.4 Block valves, when required, shall be installed at nozzles of pressure vessels or in lines connected to nozzles to permit valve operation from grade or a platform.
- 5.5 Gate valves shall be provided with an equalizing globe valve bypass for the following:

150 #	NPS 26" and above.
300 #	NPS 16" and above
600 #	NPS 6" and above
900 #	NPS 4" and above
1500 #	NPS 4" and above
2500 #	NPS 3" and above

- 5.6 The size of the bypass globe valve shall be as given below:

Main valve size ≤ 4 "	½"
Main valve size 6" to 8"	¾"
Main valve size 10" and above	1"

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5.7 All valves shall have sufficient clearance to facilitate removal of the bonnets, plugs and internals.

5.8 Ball valves shall not be used for throttling service.

6.0 VALVE SELECTION

Valves type shall be as indicated on the P & ID and the material of construction shall confirm to relevant pipe class / data sheets.

7.0 VALVE IDENTIFICATION

7.1 Each valve in the facility shall be designated by a descriptive valve identification number consisting of the following identifiers.

- Valve type
- Valve body material
- End connection

7.2 **Appendix A** provides a detailed list of valve identifiers which shall be used.

e.g: **GA – CA 1 21**

GA - Valve type (Gate valve)

CA - Valve body material (Carbon steel)

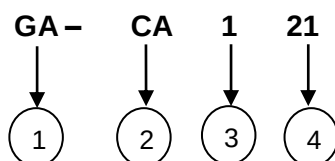
1 - Pressure rating (Class 150#)

21 - End connection (Flanged RF)

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD VALVE MATERIAL SPECIFICATION				
JPEC	DOC.NO.FGGS-BJN-PIP-SPC-5001	REV.0	DATE:19-06-19	Page 11 of 11	OIL INDIA LIMITED

APPENDIX A

VALVE IDENTIFICATION NUMBERS

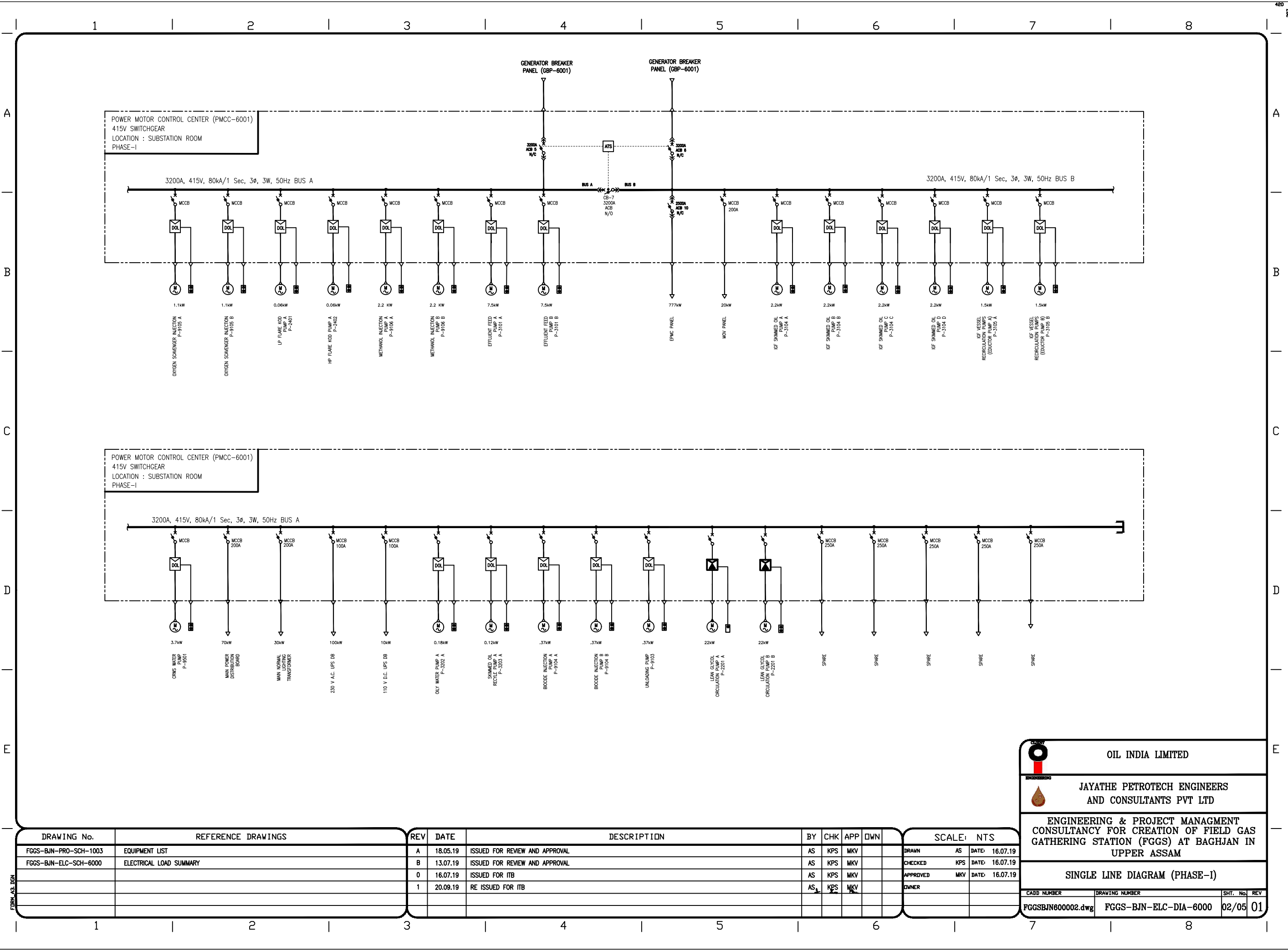


1 Valve Type	
BA	Ball
BU	Butterfly
CH	Check
DB	Valve with Integral Double Block & Bleed
GA	Gate
GL	Globe
NE	Needle
PL	Plug

2 Valve body material	
CA	Carbon steel
CL	Low temp. Carbon steel
SA	SS 304
SB	SS 304L
SC	SS 316
SD	SS 316L
CI	Cast Iron

3 Rating:	
1	150 #
3	300 #
6	600 #
8	800 #
9	900 #
15	1500 #
25	2500 #

4 End Connections:-	
10	Socket Weld
11	NPT Screwed
12	SW x NPT
20	Flanged FF
21	Flanged RF
22	Flanged RTJ
30	Butt weld
40	Wafer type





OIL INDIA LIMITED



**JAYATHE PETROTECH ENGINEERS
AND CONSULTANTS PVT LTD**

ENGINEERING & PROJECT MANAGMENT
CONSULTANCY FOR CREATION OF FIELD GAS
GATHERING STATION (FGGS) AT BAGHJAN IN
UPPER ASSAM

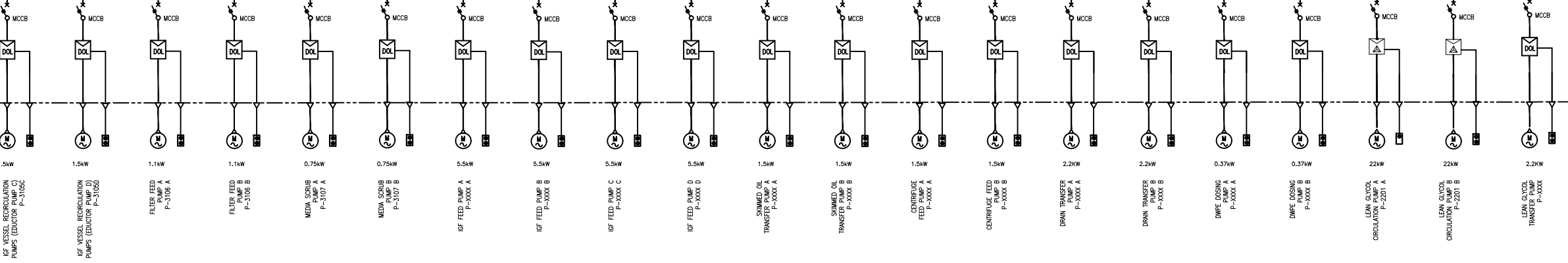
SINGLE LINE DIAGRAM (PHASE-I)

CADD NUMBER	DRAWING NUMBER	SHT. No.	REV
FGGSBJN600002.dwg	FGGS-BJN-ELC-DIA-6000	02/05	01

DRAWING No.	REFERENCE DRAWINGS	REV	DATE	DESCRIPTION	BY	CHK	APP	OWN	SCALE: NTS
FGGS-BJN-PRO-SCH-1003	EQUIPMENT LIST	A	18.05.19	ISSUED FOR REVIEW AND APPROVAL	AS	KPS	MKV		DRAWN AS DATE: 16.07.19
FGGS-BJN-ELC-SCH-6000	ELECTRICAL LOAD SUMMARY	B	13.07.19	ISSUED FOR REVIEW AND APPROVAL	AS	KPS	MKV		CHECKED KPS DATE: 16.07.19
		0	16.07.19	ISSUED FOR ITB	AS	KPS	MKV		APPROVED MKV DATE: 16.07.19
		1	20.09.19	RE ISSUED FOR ITB	AS	KPS	MKV		OWNER

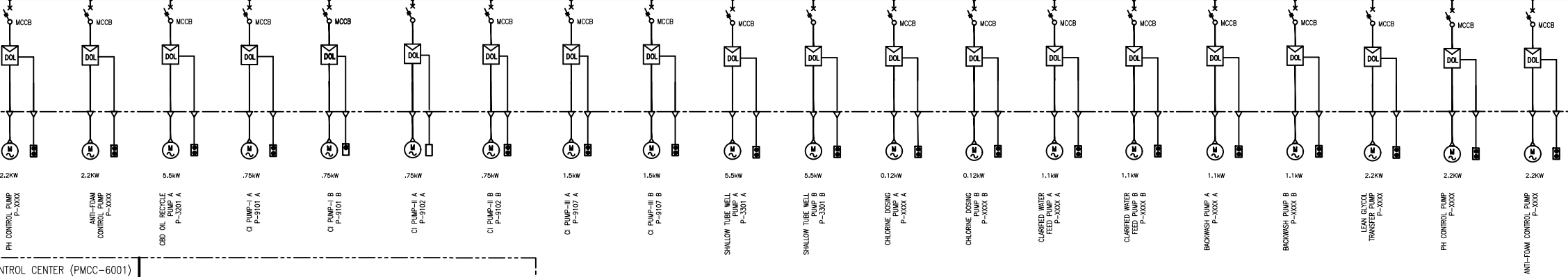
POWER MOTOR CONTROL CENTER (PMCC-6001)
415V SWITCHGEAR
LOCATION : SUBSTATION ROOM
PHASE-I

3200A, 415V, 80kA/1 Sec, 3Ø, 3W, 50Hz BUS B



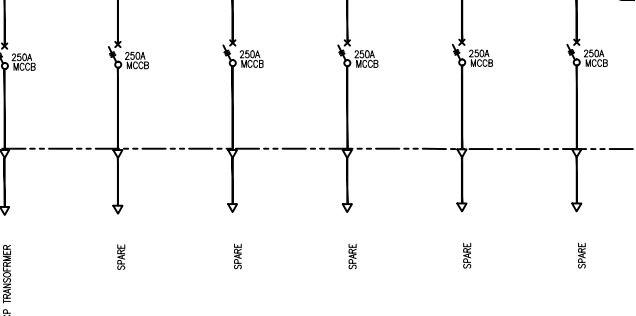
POWER MOTOR CONTROL CENTER (PMCC-6001)
415V SWITCHGEAR
LOCATION : SUBSTATION ROOM
PHASE-I

3200A, 415V, 80kA/1 Sec, 3Ø, 3W, 50Hz BUS B



POWER MOTOR CONTROL CENTER (PMCC-6001)
415V SWITCHGEAR
LOCATION : SUBSTATION ROOM
PHASE-I

3200A, 415V, 80kA/1 Sec, 3Ø, 3W, 50Hz BUS B





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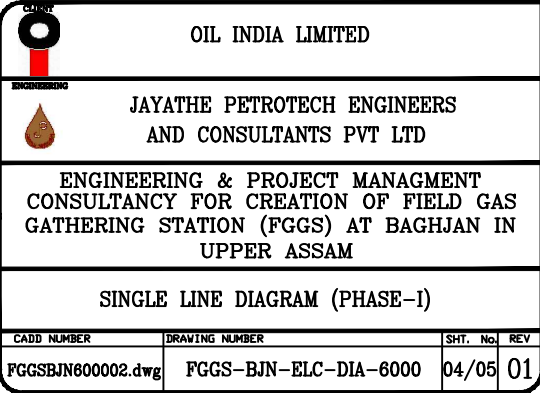
JAYATHE PETROTECH ENGINEERS
AND CONSULTANTS PVT LTD

ENGINEERING & PROJECT MANAGMENT
CONSULTANCY FOR CREATION OF FIELD GAS
GATHERING STATION (FGGS) AT BAGHJAN IN
UPPER ASSAM

SINGLE LINE DIAGRAM (PHASE-I)

CADD NUMBER	DRAWING NUMBER	SHT. No	REV
FGGSBJN600002.dwg	FGGS-BJN-ELC-DIA-6000	03/05	01

DRAWING No.	REFERENCE DRAWINGS	REV	DATE	DESCRIPTION	BY	CHK	APP	OWN	SCALE: NTS
FGGS-BJN-PRO-SCH-1003	EQUIPMENT LIST	A	18.05.19	ISSUED FOR REVIEW AND APPROVAL	AS	KPS	MKV		DRAWN AS DATE: 16.07.19
FGGS-BJN-ELC-SCH-6000	ELECTRICAL LOAD SUMMARY	B	13.07.19	ISSUED FOR REVIEW AND APPROVAL	AS	KPS	MKV		CHECKED KPS DATE: 16.07.19
		0	16.07.19	ISSUED FOR ITB	AS	KPS	MKV		APPROVED MKV DATE: 16.07.19
		1	20.09.19	RE ISSUED FOR ITB	AS	KPS	MKV		OWNER



	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM				
JPEC	DOC.No.:FGGS-BJN-ELC-SCH-6000	REV.0	REV. DATE:18-07-19	PAGE 1 OF 7	OIL INDIA LIMITED

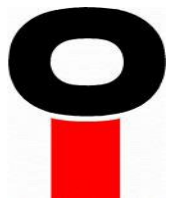
ELECTRICAL LOAD SUMMARY

0	Issued for ITB	18/07/2019	AS	KPS	MKV	
B	Issued for Approval	13/07/2019	AS	KPS	MKV	
A	Issued for Review/Approval	21/05/2019	AS	KPS	MKV	
REV	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM				
JPEC	DOC.No.:FGGS-BJN-ELC-SCH-6000	REV.0	REV. DATE:18-07-19	PAGE 2 OF 7	OIL INDIA LIMITED
1. SCOPE					
This document is intended to prepare electrical load list of FGGS Loads. This data will provide reference to estimate the rating of generators.					
2. REFERENCES					
1. Process Equipment List : FGGS-BJN-PRO-SCH-1003					
2. P&ID : FGGS-BJN-PRO-PID-1001 to 1002, FGGS-BJN-PRO-PID-1101 to 1102 FGGS-BJN-PRO-PID-1201 to 1205, FGGS-BJN-PRO-PID-2201 FGGS-BJN-PRO-PID-2301 to 2302, FGGS-BJN-PRO-PID-2401 to 2402 FGGS-BJN-PRO-PID-3101 to 3102, FGGS-BJN-PRO-PID-3201 to 3202 FGGS-BJN-PRO-PID-3103 to 3104, FGGS-BJN-PRO-PID-3301 to 3303 FGGS-BJN-PRO-PID-9201 to 9202, FGGS-BJN-PRO-PID-9101 to 9104 FGGS-BJN-PRO-PID-9301					
3. BASIS AND ASSUMPTIONS					
1. The load schedule shall be updated based on vendor data.					
2. The value of absorbed power are estimated. Final value shall be finalized with various Vendors.					
3. The efficiency and power factor shall be finalized with various Vendors.					
4. Motor rating shall be updated after issuing of Order.					
4. NOTES					
1. Electrical loads shall be classified as performing a service which is 'vital', 'essential', or 'non-essential', as defined below:					
1.1 Vital Service: A service which, if it fails in operation or when called upon, can cause an unsafe condition of the process and/or electrical installation, jeopardise life, or cause major damage to the installation.					
1.2 Essential service: A service which, if it fails in operation or when called upon, will affect the continuity, quality or quantity of the product.					
1.3 Non-essential service : A service that is neither vital nor essential.					
2 Duty Type : "C" Continuous; "I" Intermittent; "S" Stand-by, "E" - Emergency; " M "- Maintenance					
3 Absorbed Load is considered on the following basis:					
3.1 For pumps, shaft load on duty point;					
3.2 For instrumentation, computers, communication, air conditioning, the required load during full operation of plant;					
3.3 For lighting during dark hours;					
3.4 For workshops, the average total load in normal full operation.					
4 Consumed Loads are indicated on the following basis:					
4.1 E - "Continuous"; all loads that may continuously be required for normal operation including lighting.					
4.2 F - "Intermittent ; the load required for intermediate pumping, storage, loading, etc. and all electrical spare of electrically driven units.					
4.3 G - "Stand-by"; loads required in emergencies only, such as fire-water pumps or those of normally not running electrically driven units stand by for normally running steam-driven ones (e.g. charge pumps, boiler feed pumps.)					
5 The following coincidence factors are assumed for the maximum and peak load calculation::					
5.1 Continuous x = 1					
5.2 Intermittent I = 0.3					
5.3 Spare/stand by s = 0.1					
6 Load List Explanatory Notes:					
6.1 Item : Item no of the equipment					
6.2 Tag Number : Actual or proposed facility equipment tag number					



ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM



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DOC.No.:FGGS-BJN-ELC-SCH-6000

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**OIL INDIA
LIMITED**

6.3	Description	: Equipment description
6.4	Rated volts	: Equipment nominal voltage supply
6.5	Absorbed load	: Process/Mechanical power requirement.
6.6	Equipment Rating	: IEC standard rating for required power value
6.7	Units	: Load rating units, e.g.:- kW / kVA /A

7	The Load factor, efficiency and power factor are taken based on the following assumption.However the same will be updated / verified by the equipment vendor.

Rating (kW)	Load Factor	Efficiency	Power Factor
$x < 15$	0.7	0.85	0.73
$15 \leq x < 45$	0.75	0.91	0.78
$45 \leq x \leq 150$	0.83	0.93	0.82
> 150	0.85	0.94	0.91

8 For Heater loads power factor is taken as 1.

9 The following equations are used in computing the maximum load demand:

Absorbed Load	=	Equipment Rating x Load Factor
Consumed Load in Kw	=	Absorbed Load / Efficiency
Consumed Load in kVAr	=	Absorbed Load / Efficiency x sinφ

The consumed Load is classified as Continuous , Intermittent and Standby as per the load duty.

Maximum Normal running Plant Load in kW	=	Total continuous load (kW) + Total intermittent load (kW)x 0.3
Maximum Normal running Plant Load in kVAr	=	Total continuous load (kVAr) + Total intermittent load (kVAr)x 0.3
Maximum Normal running Plant Load in kVA	=	$\sqrt{(kW^2 + kVAr^2)}$

Peak Load in kW	=	Total continuous load (kW) + Total intermittent load (kW)x 0.3 + Total Standby Load(kW) x 0.1
Peak Load in kVAr	=	Total continuous load (kVAr) + Total intermittent load (kVAr)x 0.3 + Total Standby Load(kVAr) x 0.1

Peak Load in kVA	=	$\sqrt{(kW^2 + kVAr^2)}$
Generator Design size(considering 20% margin)	=	Running load in kVA *1.2

Suitable generator sizes are selected based on the available standard ratings.

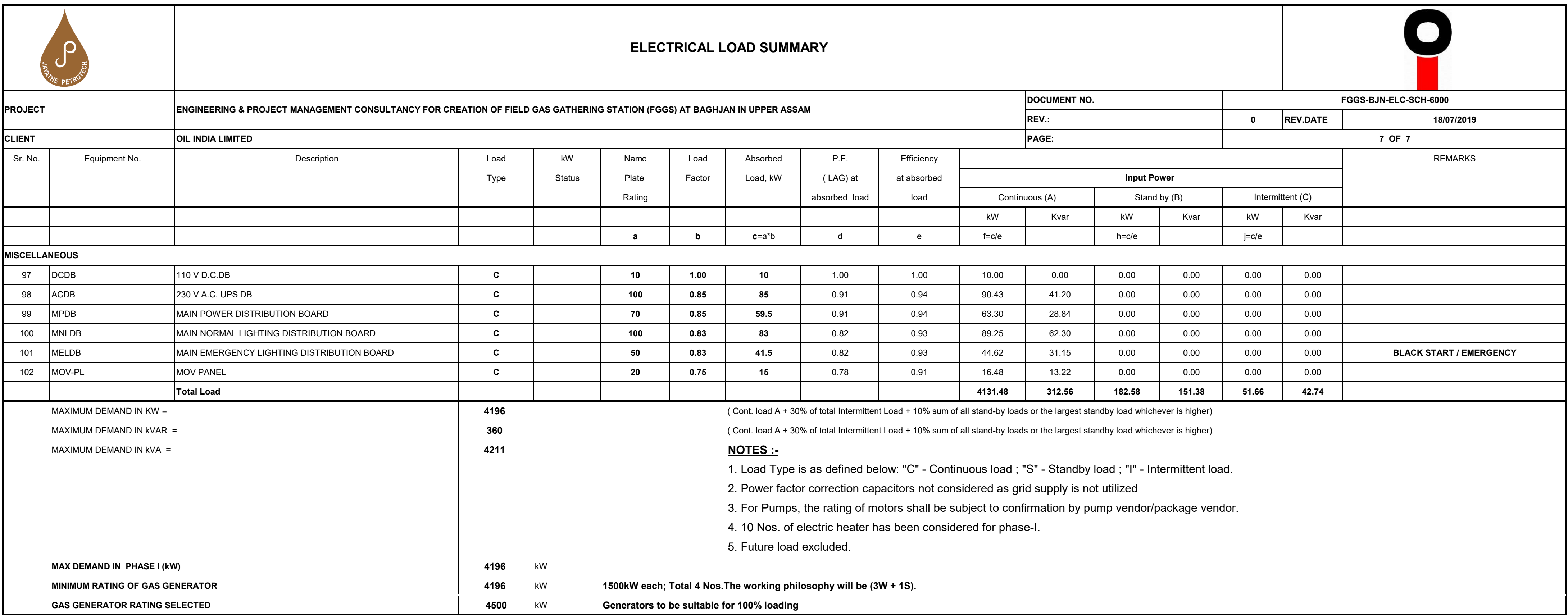
GENERAL NOTE:

- | |
|---|
| 1. Detailed load summary will be developed during Detail Engineering by EPCC contractor during EPCC phase of design. |
| 2. As per OIL INDIA request load summary has been divided in to Phase-I & Phase-II. However, the common facilitie load details included in Phase-I. |
| 3. The kW rating of equipment which is included in a package shall be subject to confirmation by pump vendor/package vendor. The ratings shall be updated by EPCC contractor during EPCC phase of design. |
| 4. The basic engineering load details are to be verified and correct by EPCC contractor in detailed engineering. |
| 5. The total plant load requirment is = 4196 kW |

		ELECTRICAL LOAD SUMMARY															
PROJECT		ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM									DOCUMENT NO.		FGGS-BJN-ELC-SCH-6000				
											REV.:		0	REV.DATE	18/07/2019		
CLIENT		OIL INDIA LIMITED									PAGE:		4 OF 7				
Sr. No.	Equipment No.	Description	Load Type	kW Status	Name Plate Rating	Load Factor	Absorbed Load, kW	P.F. (LAG) at absorbed load	Efficiency at absorbed load	Input Power						REMARKS	
										Continuous (A)		Stand by (B)		Intermittent (C)			
										kW	Kvar	kW	Kvar	kW	Kvar		
					a	b	c=a*b	d	e	f=c/e		h=c/e		j=c/e			
ELECTRIC HEATER AREA																	
1	H-1001 A01-A10	ELECTRIC HEATER	C		4910	0.70	3437	1	0.94	3656.38	0.00	0.00	0.00	0.00	0.00	NOTE:4	
GAS DEHYDRATION TRAIN-1																	
2	P-2201A	LEAN GLYCOL RECIRCULATING PUMP A	C		22	0.75	16.5	0.75	0.91	18.13	15.99	0.00	0.00	0.00	0.00	NOTE:3	
3	P-2201B	LEAN GLYCOL RECIRCULATING PUMP B	S		22	0.75	16.5	0.75	0.91	0.00	0.00	18.13	15.99	0.00	0.00	NOTE:3	
4	P-XXXX	LEAN GLYCOL TRANFER PUMP	C		2.2	0.75	1.65	0.75	0.91	1.81	1.60	0.00	0.00	0.00	0.00	NOTE:3	
5	P-XXXX	PH CONTROL PUMP	C		2.2	0.75	1.65	0.75	0.91	1.81	1.60	0.00	0.00	0.00	0.00	NOTE:3	
6	P-XXXX	ANTI-FOAM CONTROL PUMP	C		2.2	0.75	1.65	0.75	0.91	1.81	1.60	0.00	0.00	0.00	0.00	NOTE:3	
GAS DEHYDRATION TRAIN-2																	
7	P-2201A	LEAN GLYCOL RECIRCULATING PUMP A	C		22	0.75	16.5	0.75	0.91	18.13	15.99	0.00	0.00	0.00	0.00	NOTE:3	
8	P-2201B	LEAN GLYCOL RECIRCULATING PUMP B	S		22	0.75	16.5	0.75	0.91	0.00	0.00	18.13	15.99	0.00	0.00	NOTE:3	
9	P-XXXX	LEAN GLYCOL TRANFER PUMP	C		2.2	0.75	1.65	0.75	0.91	1.81	1.60	0.00	0.00	0.00	0.00		
10	P-XXXX	PH CONTROL PUMP	C		2.2	0.75	1.65	0.75	0.91	1.81	1.60	0.00	0.00	0.00	0.00		
11	P-XXXX	ANTI-FOAM CONTROL PUMP	C		2.2	0.75	1.65	0.75	0.91	1.81	1.60	0.00	0.00	0.00	0.00	NOTE:2	
FLARE SYSTEM																	
12	P-2401A	LP FLARE KOD PUMP A	C		0.06	0.70	0.042	0.73	0.85	0.05	0.05	0.00	0.00	0.00	0.00	PUMP B IS STORE ROOM STANDBY	
13	P-2402A	HP FLARE KOD PUMP A	C		0.06	0.70	0.042	0.73	0.85	0.05	0.05	0.00	0.00	0.00	0.00		
CLOSED BLOW DOWN SYSTEM'																	
14	P-3201A	CBD OIL RECYCLE PUMP A	I		5.5	0.75	4.125	0.73	0.85	0.00	0.00	0.00	0.00	4.85	4.54	PUMP B IS WAREHOUSE STANDBY	
OILY WATER DRAIN SYSTEM																	
15	P-3202A	OILY WATER PUMP A	I		0.18	0.70	0.126	0.73	0.85	0.00	0.00	0.00	0.00	0.15	0.14	PUMP B IS WAREHOUSE STANDBY	
16	P-3203A	SKIMMED OIL RECYCLE PUMP A	I		0.12	0.70	0.084	0.73	0.85	0.00	0.00	0.00	0.00	0.10	0.09		
RAW EEFLUENT STORAGE SYSTEM																	
17	P-3101A	EFFLUENT FEED PUMP A	C		7.5	0.70	5.25	0.73	0.85	6.18	5.78	0.00	0.00	0.00	0.00		
18	P-3101B	EFFLUENT FEED PUMP B	S		7.5	0.70	5.25	0.73	0.85	0.00	0.00	6.18	5.78	0.00	0.00		
EFFLUENT TREATMENT PLANT TRAIN -1																	
19	P-3104A	IGF SKIMMED OIL PUMP A	C		2.2	0.70	1.54	0.73	0.85	1.81	1.70	0.00	0.00	0.00	0.00	NOTE:3	
20	P-3104B	IGF SKIMMED OIL PUMP B	S		2.2	0.70	1.54	0.73	0.85	0.00	0.00	1.81	1.70	0.00	0.00	NOTE:3	
21	P-3104C	IGF SKIMMED OIL PUMP C	C		2.2	0.70	1.54	0.73	0.85	1.81	1.70	0.00	0.00	0.00	0.00	NOTE:3	
22	P-3104D	IGF SKIMMED OIL PUMP D	S		2.2	0.70	1.54	0.73	0.85	0.00	0.00	1.81	1.70	0.00	0.00	NOTE:3	
23	P-3105A	IGF VESSEL RECIRCULATION PUMPS (EDUCTOR PUMP A)	C		1.5	0.70	1.05	0.73	0.85	1.24	1.16	0.00	0.00	0.00	0.00	NOTE:3	
24	P-3105B	IGF VESSEL RECIRCULATION PUMPS (EDUCTOR PUMP B)	S		1.5	0.70	1.05	0.73	0.85	0.00	0.00	1.24	1.16	0.00	0.00	NOTE:3	
25	P-3105C	IGF VESSEL RECIRCULATION PUMPS (EDUCTOR PUMP C)	C		1.5	0.70	1.05	0.73	0.85	1.24	1.16	0.00	0.00	0.00	0.00	NOTE:3	
26	P-3105D	IGF VESSEL RECIRCULATION PUMPS (EDUCTOR PUMP D)	S		1.5	0.70	1.05	0.73	0.85	0.00	0.00	1.24	1.16	0.00	0.00	NOTE:3	
27	P-3106A	FILTER FEED PUMP A	C		1.1	0.70	0.77	0.73	0.85	0.91	0.85	0.00	0.00	0.00	0.00	NOTE:3	
28	P-3106B	FILTER FEED PUMP B	S		1.1	0.70	0.77	0.73	0.85	0.00	0.00	0.91	0.85	0.00	0.00	NOTE:3	
29	P-3107A	MEDIA SCRUB PUMP A	C		0.75	0.70	0.525	0.73	0.85	0.62	0.58	0.00	0.00	0.00	0.00	NOTE:3	
30	P-3107B	MEDIA SCRUB PUMP B	S		0.75	0.70	0.525	0.73	0.85	0.00	0.00	0.62	0.58	0.00	0.00	NOTE:3	
31	P-XXXX	IGF FEED PUMP A	C		5.5	0.70	3.85	0.73	0.85	4.53	4.24	0.00	0.00	0.00	0.00	NOTE:3	
32	P-XXXX	IGF FEED PUMP B	S		5.5	0.70	3.85	0.73	0.85	0.00	0.00	0.00	0.00	0.00	0.00	NOTE:3	
33	P-XXXX	IGF FEED PUMP C	C		5.5	0.70	3.85	0.73	0.85	4.53	4.24	0.00	0.00	0.00	0.00	NOTE:3	
34	P-XXXX	IGF FEED PUMP D	S		5.5	0.70	3.85	0.73	0.85	0.00	0.00	4.53	4.24	0.00	0.00	NOTE:3	
35	P-XXXX	SKIMMED OIL TRANSFER PUMP	C		1.5	0.70	1.05	0.73	0.85	1.24	1.16	0.00	0.00	0.00	0.00	NOTE:3	

		ELECTRICAL LOAD SUMMARY															
PROJECT		ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM									DOCUMENT NO.		FGGS-BJN-ELC-SCH-6000				
											REV.:		0	REV.DATE	18/07/2019		
CLIENT		OIL INDIA LIMITED									PAGE:		5 OF 7				
Sr. No.	Equipment No.	Description	Load Type	kW Status	Name Plate Rating	Load Factor	Absorbed Load, kW	P.F. (LAG) at absorbed load	Efficiency at absorbed load	Input Power						REMARKS	
										Continuous (A)		Stand by (B)		Intermittent (C)			
										kW	Kvar	kW	Kvar	kW	Kvar		
					a	b	c=a*b	d	e	f=c/e		h=c/e		j=c/e			
36	P-XXXX	SKIMMED OIL TRANSFER PUMP	S		1.5	0.70	1.05	0.73	0.85	0.00	0.00	1.24	1.16	0.00	0.00	NOTE:3	
37	P-XXXX	CENTRIFUGE FEED PUMP	C		1.5	0.70	1.05	0.73	0.85	1.24	1.16	0.00	0.00	0.00	0.00	NOTE:3	
38	P-XXXX	CENTRIFUGE FEED PUMP	S		1.5	0.70	1.05	0.73	0.85	0.00	0.00	1.24	1.16	0.00	0.00	NOTE:3	
39	P-XXXX	DRAIN TRANSFER PUMP	C		2.2	0.70	1.54	0.73	0.85	1.81	1.70	0.00	0.00	0.00	0.00	NOTE:3	
40	P-XXXX	DRAIN TRANSFER PUMP	S		2.2	0.70	1.54	0.73	0.85	0.00	0.00	1.81	1.70	0.00	0.00	NOTE:3	
41	P-XXXX	DWPE DOSING PUMP	C		0.37	0.70	0.259	0.73	0.85	0.30	0.29	0.00	0.00	0.00	0.00	NOTE:3	
42	P-XXXX	DWPE DOSING PUMP	S		0.37	0.70	0.259	0.73	0.85	0.00	0.00	0.30	0.29	0.00	0.00	NOTE:3	
EFFLUENT TREATMENT PLANT TRAIN -2																	
43	P-3104A	IGF SKIMMED OIL PUMP A	C		2.2	0.70	1.54	0.73	0.85	1.81	1.70	0.00	0.00	0.00	0.00	NOTE:3	
44	P-3104B	IGF SKIMMED OIL PUMP B	S		2.2	0.70	1.54	0.73	0.85	0.00	0.00	1.81	1.70	0.00	0.00	NOTE:3	
45	P-3104C	IGF SKIMMED OIL PUMP C	C		2.2	0.70	1.54	0.73	0.85	1.81	1.70	0.00	0.00	0.00	0.00	NOTE:3	
46	P-3104D	IGF SKIMMED OIL PUMP D	S		2.2	0.70	1.54	0.73	0.85	0.00	0.00	1.81	1.70	0.00	0.00	NOTE:3	
47	P-3105A	IGF VESSEL RECIRCULATION PUMPS (EDUCTOR PUMP A)	C		1.5	0.70	1.05	0.73	0.85	1.24	1.16	0.00	0.00	0.00	0.00	NOTE:3	
48	P-3105B	IGF VESSEL RECIRCULATION PUMPS (EDUCTOR PUMP B)	S		1.5	0.70	1.05	0.73	0.85	0.00	0.00	1.24	1.16	0.00	0.00	NOTE:3	
49	P-3105C	IGF VESSEL RECIRCULATION PUMPS (EDUCTOR PUMP C)	C		1.5	0.70	1.05	0.73	0.85	1.24	1.16	0.00	0.00	0.00	0.00	NOTE:3	
50	P-3105D	IGF VESSEL RECIRCULATION PUMPS (EDUCTOR PUMP D)	S		1.5	0.70	1.05	0.73	0.85	0.00	0.00	1.24	1.16	0.00	0.00	NOTE:3	
51	P-3106A	FILTER FEED PUMP A	C		1.1	0.70	0.77	0.73	0.85	0.91	0.85	0.00	0.00	0.00	0.00	NOTE:3	
52	P-3106B	FILTER FEED PUMP B	S		1.1	0.70	0.77	0.73	0.85	0.00	0.00	0.91	0.85	0.00	0.00	NOTE:3	
53	P-3107A	MEDIA SCRUB PUMP A	C		0.75	0.70	0.525	0.73	0.85	0.62	0.58	0.00	0.00	0.00	0.00	NOTE:3	
54	P-3107B	MEDIA SCRUB PUMP B	S		0.75	0.70	0.525	0.73	0.85	0.00	0.00	0.62	0.58	0.00	0.00	NOTE:3	
55	P-XXXX	IGF FEED PUMP A	C		5.5	0.70	3.85	0.73	0.85	4.53	4.24	0.00	0.00	0.00	0.00	NOTE:3	
56	P-XXXX	IGF FEED PUMP B	S		5.5	0.70	3.85	0.73	0.85	0.00	0.00	0.00	0.00	0.00	0.00	NOTE:3	
57	P-XXXX	IGF FEED PUMP C	C		5.5	0.70	3.85	0.73	0.85	4.53	4.24	0.00	0.00	0.00	0.00	NOTE:3	
58	P-XXXX	IGF FEED PUMP D	S		5.5	0.70	3.85	0.73	0.85	0.00	0.00	4.53	4.24	0.00	0.00	NOTE:3	
59	P-XXXX	SKIMMED OIL TRANSFER PUMP	S		1.5	0.70	1.05	0.73	0.85	0.00	0.00	1.24	1.16	0.00	0.00	NOTE:3	
60	P-XXXX	CENTRIFUGE FEED PUMP	C		1.5	0.70	1.05	0.73	0.85	1.24	1.16	0.00	0.00	0.00	0.00	NOTE:3	
61	P-XXXX	CENTRIFUGE FEED PUMP	S		1.5	0.70	1.05	0.73	0.85	0.00	0.00	1.24	1.16	0.00	0.00	NOTE:3	
62	P-XXXX	DRAIN TRANSFER PUMP	C		2.2	0.70	1.54	0.73	0.85	1.81	1.70	0.00	0.00	0.00	0.00	NOTE:3	
63	P-XXXX	DRAIN TRANSFER PUMP	S		2.2	0.70	1.54	0.73	0.85	0.00	0.00	1.81	1.70	0.00	0.00	NOTE:3	
64	P-XXXX	DWPE DOSING PUMP	C		0.37	0.70	0.259	0.73	0.85	0.30	0.29	0.00	0.00	0.00	0.00	NOTE:3	
65	P-XXXX	DWPE DOSING PUMP	S		0.37	0.70	0.259	0.73	0.85	0.00	0.00	0.30	0.29	0.00	0.00	NOTE:3	
TREATED WATER STORAGE SYSTEM																	
66	P-3108A	TREATED WATER DISPOSAL PUMP A	C		55	0.83	45.65	0.82	0.93	49.09	34.26	0.00	0.00	0.00	0.00		
67	P-3108B	TREATED WATER DISPOSAL PUMP B	S		55	0.83	45.65	0.82	0.93	0.00	0.00	49.09	34.26	0.00	0.00		
WATER TREATMENT SYSTEM																	
68	P-3301A	SHALLOW TUBE WELL PUMP A	I		5.5	0.70	3.85	0.73	0.85	0.00	0.00	0.00	0.00	4.53	4.24		
69	P-3301B	SHALLOW TUBE WELL PUMP B	S		5.5	0.70	3.85	0.73	0.85	0.00	0.00	4.53	4.24	0.00	0.00		
70	P-3302A	DEEP WATER TUBE WELL PUMP A	I		37	0.75	27.75	0.78	0.91	0.00	0.00	0.00	0.00	30.49	24.47		
71	P-3302B	DEEP WATER TUBE WELL PUMP B	S		37	0.75	27.75	0.78	0.91	0.00	0.00	30.49	24.47	0.00	0.00		
72	P-XXXX	CHLORINE DOSING PUMP A	C		0.12	0.75	0.09	0.78	0.91	0.10	0.08	0.00	0.00	0.00	0.00	NOTE:3	
73	P-XXXX	CHLORINE DOSING PUMP B	S		0.12	0.75	0.09	0.78	0.91	0.00	0.00	0.10	0.08	0.00	0.00	NOTE:3	
74	P-XXXX	CLARIFIED WATER FEED PUMP A	C		1.1	0.75	0.825	0.78	0.91	0.91	0.73	0.00	0.00	0.00	0.00	NOTE:3	
75	P-XXXX	CLARIFIED WATER FEED PUMP B	S		1.1	0.75	0.825	0.78	0.91	0.00	0.00	0.91	0.73	0.00	0.00	NOTE:3	

		ELECTRICAL LOAD SUMMARY															
PROJECT		ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM									DOCUMENT NO.		FGGS-BJN-ELC-SCH-6000				
											REV.:		0	REV.DATE	18/07/2019		
CLIENT		OIL INDIA LIMITED									PAGE:		6 OF 7				
Sr. No.	Equipment No.	Description	Load Type	kW Status	Name Plate Rating	Load Factor	Absorbed Load, kW	P.F. (LAG) at absorbed load	Efficiency at absorbed load	Input Power						REMARKS	
										Continuous (A)		Stand by (B)		Intermittent (C)			
										kW	Kvar	kW	Kvar	kW	Kvar		
					a	b	c=a*b	d	e	f=c/e		h=c/e		j=c/e			
76	P-XXXX	BACKWASH PUMP A	C		1.1	0.75	0.825	0.78	0.91	0.91	0.73	0.00	0.00	0.00	0.00	NOTE:3	
77	P-XXXX	BACKWASH PUMP B	S		1.1	0.75	0.825	0.78	0.91	0.00	0.00	0.91	0.73	0.00	0.00	NOTE:3	
INSTRUMENT AIR PACKAGE																	
78	K-9201A	INST. AIR COMPRESSOR A	C		5.5	0.70	3.85	0.73	0.85	4.53	4.24	0.00	0.00	0.00	0.00	BLACK START / EMERGENCY NOTE:3	
79	K-9201B	INST. AIR COMPRESSOR B	S		5.5	0.70	3.85	0.73	0.85	0.00	0.00	4.53	4.24	0.00	0.00	BLACK START / EMERGENCY NOTE:3	
80	K-9202	COMPRESSOR AFTER COOLER	C		3.7	0.70	2.59	0.73	0.85	3.05	2.85	0.00	0.00	0.00	0.00	BLACK START / EMERGENCY NOTE:3	
CORROSION INHIBITOR INJECTION																	
81	P-9101A	CI PUMPS-I A	C		0.37	0.70	0.259	0.73	0.85	0.30	0.29	0.00	0.00	0.00	0.00	NOTE:3	
82	P-9101B	CI PUMPS-I B	S		0.37	0.70	0.259	0.73	0.85	0.00	0.00	0.30	0.29	0.00	0.00	NOTE:3	
83	P-9102A	CI PUMPS-II A	C		0.75	0.70	0.525	0.73	0.85	0.62	0.58	0.00	0.00	0.00	0.00	NOTE:3	
84	P-9102B	CI PUMPS-II B	S		0.75	0.70	0.525	0.73	0.85	0.00	0.00	0.62	0.58	0.00	0.00	NOTE:3	
85	P-9107A	CI PUMPS-III A	C		1.5	0.70	1.05	0.73	0.85	1.24	1.16	0.00	0.00	0.00	0.00	NOTE:3	
86	P-9107B	CI PUMPS-III B	S		1.5	0.70	1.05	0.73	0.85	0.00	0.00	1.24	1.16	0.00	0.00	NOTE:3	
BIOCIDE INJECTION																	
87	P-9103	UNLOADING PUMP	C		0.37	0.70	0.259	0.73	0.85	0.30	0.29	0.00	0.00	0.00	0.00	NOTE:3	
88	P-9104A	BIOCIDE INJECTION PUMP A	C		0.37	0.70	0.259	0.73	0.85	0.30	0.29	0.00	0.00	0.00	0.00	NOTE:3	
89	P-9104B	BIOCIDE INJECTION PUMP B	S		0.37	0.70	0.259	0.73	0.85	0.00	0.00	0.30	0.29	0.00	0.00	NOTE:3	
OXYGEN SCAVENGER INJECTION																	
90	P-9105A	OXYGEN SCAVENGER INJECTION PUMP A	C		0.37	0.70	0.259	0.73	0.85	0.30	0.29	0.00	0.00	0.00	0.00	NOTE:3	
91	P-9105B	OXYGEN SCAVENGER INJECTION PUMP B	S		0.37	0.70	0.259	0.73	0.85	0.00	0.00	0.30	0.29	0.00	0.00	NOTE:3	
METHANOL INJECTION																	
92	P-9106A	METHANOL INJECTION PUMP A	C		2.2	0.70	1.54	0.73	0.85	1.81	1.70	0.00	0.00	0.00	0.00	NOTE:3	
93	P-9106B	METHANOL INJECTION PUMP B	S		2.2	0.70	1.54	0.73	0.85	0.00	0.00	1.81	1.70	0.00	0.00	NOTE:3	
FIRE WATER SYSTEM																	
94	P-3402A	FIRE WATER JOCKEY PUMP A	I		15	0.70	10.5	0.78	0.91	0.00	0.00	0.00	0.00	11.54	9.26	BLACK START / EMERGENCY	
95	P-3402B	FIRE WATER JOCKEY PUMP B	S		15	0.70	10.5	0.78	0.91	0.00	0.00	11.54	9.26	0.00	0.00	BLACK START / EMERGENCY	
CONTAMINATED RAIN WATER SYSTEM																	
96	P-9501	CRWS WATER PUMP	C		3.7	0.70	2.59	0.78	0.91	2.85	2.28	0.00	0.00	0.00	0.00		



	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM FOR OIL INDIA LTD				
JPEC	DOC.NO: FGGS-BJN-PRO-DST-2301	REV.0	DATE: 28.06.19	Page 1 of 4	OIL INDIA LIMITED

PROCESS DATA SHEET- FUEL GAS FILTER (F-2301A/B)

0	Issued for ITB	28-06-19	AOV	LG	CK	
A	Issued for Review	28-05-19	AOV	LG	CK	
REV.	DESCRIPTION	DATE	BY	CHECKED	APPROVED	CLIENT

	DATA SHEET FOR FUEL GAS FILTER		
PROJECT:	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM	DOCUMENT No	FGGS-BJN-PRO-DST-2301
		REV. 0	REV. DATE: 28.06.19
CLIENT	OIL INDIA LIMITED	Page 2 of 4	

SR. NO	DESCRIPTION	SPECIFICATION	
	GENERAL		
1	Tag Number	F-2301A/B	
2	Service	Fuel Gas	
3	Type	Vertical, Cartridge	
4	Number Required: Operating + Standby	1+1	
5	Installation	Outdoor	
6	Dimensions mm(in)	VTA	
7	Corrosion allowance (mm)	3	
	GUARANTEED PERFORMANCE		
8	Particle Removal	98% particles above 40 microns at design flow rate	
	OPERATING CONDITIONS:		
9	Design Pressure	KSC(g)	10
10	Operating Pressure	KSC(g)	3.5
11	Design Temperature	°C	(-)20 / 70
12	Operating Temperature	°C	30
13	ΔP Maximum Operating / Design	bar	0.5
14	Design Flow Rate	MMSCMD	1.5
15	Molecular Weight		17.74
16	Viscosity	cP	0.01162
17	Mass Density	kg/m ³	3.157
	MOC		
18	Filter Element	Polypropylene	
19	Body	CS with 3 mm corrosion allowance	
20	Filter Support Plate	Duplex SS	
	OTHER		
21	Painting	Required, Note-3	
22	Internal Lining	Epoxy coating (300μ)	
	NOTES		
1	Reference P&ID - FGGS-BJN-PRO-PID-2301.		
2	Natural Gas from the Dehydration Package will be used as fuel gas in FGGS.		
3	As per Project specification		
	VTA- Vendor to advise		

	DATA SHEET FOR FUEL GAS FILTER		
PROJECT:	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM	DOCUMENT No	FGGS-BJN-PRO-DST-2301
		REV. 0	REV. DATE: 28.06.19
CLIENT	OIL INDIA LIMITED	Page 3 of 4	

TABLE- 1
COMPOSITION OF FUEL GAS

GAS COMPONENTS	GAS COMPOSITION (VOL%)
Methane	90.05
Ethane	4.43
Propane	1.29
i-Butane	0.22
n-Butane	0.29
i-Pentane	0.11
n-Pentane	0.09
n-Heptane	0.00
n-Octane	0.00
n-Nonane	0.00
n-Decane	0.00
n-Hexane	0.17
Nitrogen	1.15
CO ₂	2.21
H ₂ O	0.00

NOZZLE SCHEDULE						
	Nozzle	Qty	Size (NPS)	Type /Rating	Service	Remarks
1	N1	1	16"	150#	Inlet	
2	N2	1	16"	150#	Outlet	
3	N3	1	2"	150#	Drain	
4	N4	1	10"	150#	Flare Gas	Hold
5	N5	1	2"	150#	Vent	
6	N6	1	6"	150#	PSV Connection	Hold

	DATA SHEET FOR FUEL GAS FILTER		
PROJECT:	ENGINEERING & PROJECT MANAGEMENT CONSULTANCY FOR CREATION OF FIELD GAS GATHERING STATION (FGGS) AT BAGHJAN IN UPPER ASSAM	DOCUMENT No	FGGS-BJN-PRO-DST-2301
		REV. 0	REV. DATE: 28.06.19
CLIENT	OIL INDIA LIMITED	Page 4 of 4	

VESSEL SKETCH

