



# TECHNICAL SPECIFICATION

## SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

**Document No:** GGL/TS/CNG/SUPPLY/ONLINE MOTOR COMPRESSOR/SPEC

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## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### • Introduction

Gujarat Gas Ltd (GGL), a Group Company of Gujarat State Petroleum Corporation Ltd., (State Government undertaking), is in business of Natural Gas distribution to Industrial/ Commercial/ Non-Commercial/ Domestic Customers and CNG Stations in various cities authorized to GGL by PNGRB Viz: in the state of Gujarat, Maharashtra, Punjab, Haryana, Rajasthan, Madhya Pradesh and Dadra Nagar Haveli Union Territory etc.

### • Definition

Definitions of the terms used in this bid document, (unless the context otherwise requires), shall have the same meaning as respectively assigned hereunder.

The **"GGL"** or **"Company"** or **"Owner"** shall mean GUJARAT GAS LIMITED (GGL), incorporated under company's Act 1956, having its Corporate Office at Ahmedabad hereinafter mentioned as **"OWNER"** which expression shall, unless repugnant to the context or meaning or meaning thereof, include all its successors, administrators, executors and assigns.

The **"Bid"** shall mean the Bid submitted by the CONTRACTOR for acceptance by the GGL.

The **"Contract"** shall mean the agreement and all other documents between the company and the contractor for the execution of the works including supplies mentioned herein.

The **"Service Provider"** or **"Contractor"** or **"Bidder"** shall mean the person or persons, firm or Company whose Bid has been accepted by GGL and includes the Service Provider's legal representatives, his successors and permitted assigns.

The **"Supervisor"** shall mean the person deployed by the contractor for control & supervision of the work of his work force, as per the Scope of work mentioned and to receive instructions from Engineer-In-Charge or his representative.

The **"GGL Engineer-In-Charge"** or **"GGL's representative"** shall mean the person designated as such by the Gujarat Gas Limited and shall include his authorized nominee or agent, provided however that the GGL's Representative to be so designated by GGL may be one person for certain aspects of this agreement and another person for other aspects of work covered by this Bid/ Contract.

The **"Vendors"** shall mean a manufacturer/company who engaged agreement between the GGL and the Manufacturer for supplying the Material at GGL Designated store or Site through the transporter with required documents.

**"Stores"** shall mean the GGL Stores located across GGL working areas.

**"Site"** shall mean the various CNG Stations/ lands/ other places where work is to be carried out for the purpose of contract.

The **"Specification"** shall mean all directions, the various technical specifications, provisions attached and referred to in the Bid documents which pertain to the method and manner of performing the work or works to the quantities and qualities of the work or works and the materials to be furnished under the contract or works or works as may be amplified or modified by the COMPANY during the performance of Contract in order to provide the unforeseen conditions or in the best interests of the work or works. It shall also include the latest edition of relevant standard specifications including all addenda/ corrigenda published before entering into the contract.

**"Approved"** shall mean approved in writing including subsequent written confirmation of previous verbal approval and **"Approval"** means approved in writing including as aforesaid.

**"Third Party Inspection Agency"** (TPIA) shall mean outside inspection agency approved by the Company.

**"Guarantee"** means the period and other conditions governing the warranty/ guarantee in respect of the work as detailed in section hereunder.

**"HSE"** means Health, Safety & Environment.

### 1. Project Introduction and Site Particulars



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### 1.1. Project Introduction

Gujarat Gas Limited intends to set up CNG refueling stations; in the state of Gujarat, Maharashtra, Rajasthan, Madhya Pradesh, UT of DNH, Punjab, Haryana and the PNGRB authorized area allotted to GGL, India; in phase manner during the period mentioned by GGL. Although details about each site shall be furnished as and when it is finalized, the brief general site details shall be as under.

Location	CNG refueling stations across GGL Authorized location.
Nearest Railway Station	- (Shall be informed later)
Nearest Airport	- (Shall be informed later)
Altitude of nearby Railway Station	- (Shall be informed later)
Ambient Air Temperature	
- Maximum	50°C
- Minimum Wet Bulb	0°C
Temperature Relative	29°C (Maximum)
Humidity	
- Maximum	85-90 %
- Minimum	40 %
Rainfall	
- Annual Average	1100 mm June-July-August-Part
- Period	September
Wind Velocity	
- Maximum	As per IS 675 Part-III
- Prevailing Direction	As per IS 675 Part-III
Seismic Zone	As per IS – 1893



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### 1.2. Applicable Codes, Standards and Regulations

The design, construction, manufacture, supply, testing and other general requirements of the compressor package equipment shall be strictly in accordance with the data sheets, applicable API/ equivalent Codes, and shall comply fully with relevant National/ International standards.

Any modification suggested by the statutory bodies either during drawing approval or during inspection, if any shall be carried out by the Bidder without any additional cost and delivery implications.

The following codes and standards (versions/revisions valid on the date of order) are referenced to and made part of specification:

- Compressor, auxiliaries design: ISO 13631(Incorporating API - 11P /API 618)Vehicular Fuel Systems Code : NFPA-52
- Standard on CO2 Extinguishing Systems: NFPA-12
- Design / Construction Code for Heat exchanger: TEMA, API 661/660, ASME Section VIII & IX, BS 5500
- Design and construction code for Pressure vessels: ASME Section VIII & IX, BS 5500
- Gas Inlet Battery Limit Piping : As Per ANSI/ASME B31.3
- Pressure Safety Valve Design Code : API-520
- Design and layout : OISD 179
- IS: 6382,
- Gas Cylinder Rule-2016
- IS: 5571, IS: 5572, IS: 5580, IS – 7285, IS 3224 -2002
- ANSI, ASTM, NEC, NEMA
- Indian Electricity Rules
- Indian Explosives Act
- Gujarat Factory Rules
- PNGRB T4S Retail Outlet, Bidder may enhance compressor design for reduction of gas loss post compliance of PNGRB T4S Retail Outlet.

### 2. Scope of Work

#### ● Phase-I

Design, engineering, manufacturing, inspection and testing including complete performance run test at works with natural gas; supply at site (FOT site basis) including packing & forwarding , transportation from Bidder works to site including sea/air freight, transit insurances, land freight, land transit insurance; unloading and safe storage at site, erection, installation, testing, field / site trial run tests, site acceptance test, commissioning, handing over, training of owner's personnel, guarantee/ warrantee and operations during the defect liability period including spares, oil and consumables etc. for Quantity specified in SOR. Comprehensive electrical motor driven CNG compressor packages including dispensers, cascades and their interconnecting piping/accessories and PLC system. Each training module of engineers at Gujarat Gas Ltd shall span for 1-2 days and shall cover the equipment constructional features, operational and maintenance procedures, practical hands on experience on assembling, dismantling etc.

Gujarat Gas Ltd intends to integrate all CNG Refueling stations to a central control station across all the CNG stations of Gujarat Gas Ltd. Although setting up of central control station including hub stations shall be handled through a separate contract, the control system and its necessary features, software and hardware, at CNG Refueling stations, shall be selected and provided to ensure their compatibility with each other and the central control station

#### ● Phase-II:

The scope of work also includes comprehensive Operations & Maintenance (O&M) on man-month basis for the period specified in the Schedule of Rates from the date of completion of mandatory defect liability period.





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The work shall be handled through a separate O & M Contract. Bidder to furnish the rates separately for each year of O&M.

- The complete work is to be carried out on 'Turnkey' lump-sum basis and total contract value shall be inclusive of all applicable charges for insurances, taxes, duties, levies etc.
- Various parts of this specification shall be read in conjunction with each other and in case of differences, the more stringent requirement shall govern.
- Any additional work/equipment or technical requirement not mentioned in the specification but required to make the offered system complete in accordance with the specification or required for safe operation, shall be deemed to be included in the offer and provided by the bidder, without any additional payment.

The brief details of the packages are as under. For further details, please refer the detailed specifications in the subsequent sections.

**Table 2.1:**

Package Category	Compressor Capacity (SM <sup>3</sup> /Hr)	Per Package Details – Compressor, Motor, Dispenser, Cascade, 3 KVA- Industrial/ office Type UPS, SS Tubing (Minimum length)	Quantity – No. of Packages
1A	1700 @ 19 kg/cm <sup>2</sup> (g)	1 compressor with motor, 2 Car Dispensers, 1 Cascade (3000 Litres), 1 no. 3KVA- Office Type UPS, 1 LCV Point, 300 meters SS Tubing, 100 meters electrical cables (50 x 2 runs) from the soft starter to the panel, Pressure Reducing Skid, Filters, Ball Valves and Fittings (like Union, Reducer, Tee, Elbow, In-line Break-away coupling and QRC at outlet on LCV Fill Post), CO2 flooding system with 2 nos. of cylinders & accesoriees etc.	As per SOR
1B	1000 @ 19 kg/cm <sup>2</sup> (g)	1 compressor with motor, 2 Car Dispensers, 1 Cascade (3000 Litres) , 1 no. 3 KVA- office Type UPS, 200 meters (refer note-3) / 60 meters (refer note-4) SS Tubing, Pressure Reducing Skid, Filters, Ball Valves and Fittings (like Union, Reducer, Tee, Elbow), CO2 flooding system with 2 nos. of cylinders & accesoriees etc.	As per SOR
1C	650 @ 19 kg/cm <sup>2</sup> (g)	1 compressor with motor, 2 Car Dispensers, 1 Cascade (3000 Litres) , 1 no. 3 KVA- office Type UPS, 200 meters (refer note-3) / 60 meters (refer note-4) SS Tubing, Pressure Reducing Skid, Filters, Ball Valves and Fittings (like Union, Reducer, Tee, Elbow), CO2 flooding system with 2 nos. of cylinders & accesoriees etc.	As per SOR
1D	1200 @ 19 kg/cm <sup>2</sup> (g)	1 compressor with motor, 2 Car Dispensers, 1 Cascade (3000 Litres), 1 no. 3KVA- Office Type UPS, 1 LCV Point, 300 meters SS Tubing, 100 meters electrical cables (50 x 2 runs) from the soft starter to the panel, Pressure Reducing Skid, Filters, Ball Valves and Fittings (like Union, Reducer, Tee, Elbow, In-line Break-away coupling and QRC at outlet on LCV Fill Post), CO2 flooding system with 2 nos. of cylinders & accesoriees etc.	As per SOR



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1E	400 @3 kg/cm <sup>2</sup> (g)	1 compressor with motor, 2 Car Dispensers, 1 Cascade (3000 Litres), 1 no. 3 KVA- office Type UPS, 200 meters SS Tubing, Pressure Reducing Skid, Filters, Ball Valves and Fittings (like Union, Reducer, Tee, Elbow), CO2 flooding system with 2 nos. of cylinders & accesoriees etc.	As per SOR
1F	1000 @ 19 kg/cm <sup>2</sup> (g) -VIP compressor & 450 to 2000 SCMH @14 to 200 kg/cm <sup>2</sup> (VIP mode)	1 compressor with motor, 2 Car Dispensers, 1 Cascade (3000 Litres) , 1 no. 3 KVA- office Type UPS, 200 meters (refer note-3) / 60 meters (refer note-4) SS Tubing, Pressure Reducing Skid, Filters, Ball Valves and Fittings (like Union, Reducer, Tee, Elbow), CO2 flooding system with 2 nos. of cylinders & accesoriees etc.	

**\*Notes:**

- All the above mentioned requirements and schedule of delivery are indicative and the same shall be finalized before awarding the contracts.
- The suction pressure may vary from 3 kg/cm<sup>2</sup>(g) to 5 kg/cm<sup>2</sup>(g) for the rated pressure of 3 kg/cm<sup>2</sup>(g), 14 to 26 kg/cm<sup>2</sup>(g) for the rated pressure of 19 kg/cm<sup>2</sup>(g). Bidder shall perform 4-hour FAT of compressor at rated pressure (Guaranteed pressure). Bidder shall show variable suction pressure testing for 30 minutes. Bidder shall cover entire suction pressure range (i.e. 3 kg/cm<sup>2</sup>g to 5 kg/cm<sup>2</sup>g or 14 to 26 kg/cm<sup>2</sup>g (as applicable)) within 30 minutes of variable suction pressure testing.
- SS 316 tubing along with SS 316 fittings should be Supplied, Erected, Installed, Tested and Commissioned with both Compressor Package as well as Compressor Only by the bidder. SS tubing shall be 3/4" (174 meter/ 270 meter (as applicable)) and 1/2" (26 meter/ 30 meter (as applicable)) and Total length of tubing shall be as per table 2.1. Number of various fittings, valves, end plug, NRVs and clamp should be planned accordingly by considering the length of tubes and numbers of equipment connected with the compressor.
- For 1700/1200/1000/650/400 SCMH capacity Compressor with UPS only: SS 316 tubing along with SS 316 fittings should be Supplied, Erected, Installed, Tested and Commissioned by the bidder. SS tubing shall be 3/4" (60 meter). Number of various fittings, valves, end plug, NRVs and clamp should be planned accordingly by considering the length of tubes and numbers of equipment connected with the compressor.
- For 1000 SCMH VIP compressor: a) For online mode suction mass flow meter with flange end shall be considered in scope of bidder and bidder to supply this meter along with supply. b) for booster mode mass flow meter wit 1/2" end connections should be provided in MCV decanting post.

### 2.1 The Station Package

Each CNG station package shall be complete with, but not limited to following. It is not the intent to completely specify all the details, equipment, item, accessories etc. of the package. Any additional work/equipment or technical requirement not mentioned hereunder but required to make the offered system complete in accordance with the specification or required for safe operation, shall be deemed to be included in the offer and provided by the bidder, without any additional payment.

- The compressor shall be of reciprocating, lubricated/non-lubricated, high pressure, multistage, totally air cooled/inbuilt water cooled, Pressurized/non-Pressurized, electric motor driven and of robust construction.



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2. Gas Inlet Pressure Regulator with SSV of 150 # class rating with an outlet discharge range of 3 kg/cm<sup>2</sup>(g) to 10 kg/cm<sup>2</sup>(g) adjustable, as applicable
3. Gas Inlet Pressure Regulator with SSV of 300 # class rating with an outlet discharge range of 14 kg/cm<sup>2</sup>(g) to 26 kg/cm<sup>2</sup>(g) adjustable, as applicable.
4. Gas Inlet Pressure Regulator with SSV of 600 # class rating with an outlet discharge range of 45 kg/cm<sup>2</sup>(g) to 60 kg/cm<sup>2</sup>(g) adjustable, as applicable.
5. Subsequent suction filter, PRV and SSV shall be designed and tagged as per highest pressure of particular class i.e. 19 KG/cm<sup>2</sup> for 150 Class, 49 KG/cm<sup>2</sup> for 300 class and 99 KG/cm<sup>2</sup> for 600 class and tested at 1.5 times of Designed pressure.
6. For VIP Compressor: Vairable Inlet Pressure (VIP) compressor shall run as (a) booster compressor package at inlet pressure from 200 KG/cm<sup>2</sup>Suction filtration skid (Pressure Regulating Skid (PRS)) P&ID, QAP and other details enclosed separately. Bidder shall refer the same All SRVs, Pressure vessels, PRV, SSV and Valves etc. shall be designed at highest pressure as per applicable pressure class. Suction skid along with Filter, SSV, PRV and SRV shall be designed at applicable pressure class i.e. 150#, 300# and 600# for subsequent compressor. PRS size shall not be greater than 2500 mm X 1100 mm.
7. The complete lubricated / non-lubricated compressor unit with suction/discharge volume bottles (dampers) for each stage (separators) with (single/double isolation valves) automatic drain system which shall ensure that there is no oil carry over from discharge of compressor lube oil system, closed circuit cooling water system (console type)/Air cooled as required. However, double isolation to be provided for oil drains and package vent point.
8. Appropriate size of Mass flow meter along with local display, hooked up to compressor PLC via Modbus and with isolated valves to measure the Natural Gas consumption at
  - (a) package suction point
  - (b) package discharge point
  - (c) mobile filling point (if LCV fill point is provided by the bidder)
  - (d) Vent point (Excluding SRV and Impulse vent)
9. All the mass flow meters shall be provided with online test measurement. Mass flow meters in the inlet and outlet of the compressor to be provided with a spool piece in series with the existing mass flow meter, so that a master (calibrated) flow meter can be installed by removing the spool piece to check the existing flow meter for proving activity. The Non Return Valve shall be installed to protect the suction, discharge and mobile fill point flow meter against the back pressure.
10. Duplex suction gas filters, suitable for the higher pressure specified in the range of pressure, with oil drain and Differential Pressure Gauge on Suction filter, at the compressor package inlet before PRV and SSV.
11. One no. relief valve at each stage discharge, first (1st) stage suction and Blow Down Vessel (BDV). All relief valves to be vented to common relief valve header with flame arrestor. Height of vent line shall be minimum 3 meter from highest working platform at site. If 1st stage suction is taken from BDV then bidder can provide common relief valve for 1st stage suction and BDV. However, Compressor shall not have any intervention (i.e ball valve, globe valve etc.) between first stage suction and blow down vessel. Color of Vent line shall be "Yellow".
12. Air-cooled heat exchanger for inter-stage and discharge gas.



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13. Suction, inter-stage and discharge Knockout Drums (KOD) with solenoid valve operated auto & manual drains. Demisters to be provided for each KOD. The Bidder to ensure that KOD and coalescent (hydro carbon) filter shall be provided after the final discharge and before the mass flow meter. All drain lines shall be provided with level operated / time based auto drain valves and NRVs. Any other arrangement supplied by bidder, in which no KOD is required, shall be completely on bidder's responsibility to comply with the statutory requirement. Bidder to ensure performance of compressor as per tender requirement and if the compressor does not deliver/ perform, bidder shall change/ replace full or partial compressor parts at bidder cost after installation/ during operation.
14. Blow-down recovery vessel
15. Dual Discharge filter (Coalescent, Duplex type, 3 micron rating) with differential pressure gauge with differential pressure transmitter as a part of compressor package. If bidder does not want to provide differential pressure transmitter, then bidder to provide separate pressure transmitter before and after of discharge duplex filter to monitor the filter clogging. However, requirement will be discussed during HAZOP and Bidder needs to comply HAZOP recommendation.
16. In the downstream of discharge filter, hydrocarbon absorber type filter assembly shall be provided after discharge mass-flow meter. Bidder to ensure that there shall not be any oil carry over from the discharge of the compressor to the cascade and dispensers.
17. All interconnecting oil, gas, water, air, blow-down, drain, etc. piping as applicable, , no flexible hose allowed in inter-stage / connection between compressor discharge to heat exchanger / heat exchanger to final outlet.
18. All inter connection piping/ flange connections, Filter Flanges shall be fastened with appropriate lengths/size and specifications hot deep Galvanized High tension steel grade studs with 02 nuts and washers while for compressor block bolt/stud can be considered.
19. Impulse and pneumatic piping/Tubing for all valves, fittings as specified and required for mounting the instruments. Block and bleed valves to be provided for pressure gauges and pressure transmitters.
20. NRV at final discharge.
21. Bidder to provide provision for Nitrogen purging connections up to main header (in case purging required).
22. Strainers/ filter, valves, sight flow indicators, check valves, auto and manual drain traps etc. as required for various auxiliary systems i.e. frame lube oil, cylinder lubrication system, cooling water systems, if applicable, etc.
23. Coupling/V-belts/pulleys.
24. Priority panel at package discharge. The priority panel shall be located outside the compressor package enclosure with weather proof canopy, GI powder coated enclosure (0.03 mm to 0.05 mm thick epoxy) and the same shall be attached to the main enclosure of the compressor package.
25. Instrumentation and control system as specified including Local panel, Console/Local gauge boards, PLC/ SCADA etc.
26. The PLC shall have provision of 100% redundancy to avoid downtime and loss of data in case of any problem. In case, redundancy is offered for CPU and power supply only, Bidder to ensure that all the requirement mentioned in the Statutory Regulations and relevant Standards are complied.
27. Flame proof electric motor preferably directly coupled to the compressor with coupling guard or



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- through non sparking V-belt drive with anti-spark coated guard. Slide rails for motor with jacking arrangement shall also provide.
28. All instrumentation and control shall be natural gas actuated type. The Bidder shall, therefore, provide all necessary natural gas regulators and other associated items. Outlet overpressure protection shall be provided in downstream of pressure regulator.
  29. Common structural steel skid for the compressor and motor combination and for all auxiliary equipment/ systems/ items etc. including storage cascade and control panel. Auxiliaries like CO2 can be supplied loose and to be mounted as per requirement mentioned in the Statutory Regulations and relevant Standards.
  30. Stationary storage cascade
  31. Dispensers
  32. Separate FLP junction boxes for different type of signals such as intrinsically safe signals, alarm, shutdowns, thermocouples, RTDs etc. for interfacing to local panel. The panel supplied by the bidders should contain 5 nos. of additional opening for meeting the future requirement.
  33. If LCP (With PLC) is mounted on package then separate FLP JB's are not required. Separate FLP JB for solenoid valve to be provided by the bidder. Transmitters shall be intrinsically safe these are routed thru barriers for additional safety. And also, Instrument FLP junction boxes shall not have any high voltage connection. Bidder has meet all statutory requirement for applicability of this clause.
  34. Flame proof (FLP) electrical motors and Flame Proof motor starter and other panels
  35. Structural supports within the compressor package for all tubing, piping, instruments etc. and all tube welds.
  36. GI Powder coated Acoustic enclosure
  37. Individual CO2 Flooding System to be installed for each CNG compressor separately. Inlet and outlet manual and automatic isolating valves for maintenance and emergency.
  38. Minimum two numbers of FLP type emergency stop switch shall be provided outside the hazardous area for easy access in case of emergency (One near compressor fencing and one at office building with proper signage's. All the systems shall cease the operations and gas supply including that from within the compressor package, priority panel, cascade and from dispenser(separate emergency switch and emergency actuator provided on priority panel shall shutdown gas supply to dispenser in case of emergency); shall be stopped immediately upon operating the emergency switch in case of emergency. Bidder to consider 50m cable length for the same.
  39. Compressor Unloading arrangement
  40. Lifting lug Arrangement for installation and maintenance
  41. Mandatory spares list shall be submitted by vendor as required for erection, maintenance and commissioning.
  42. Signages for Warning and Operating instructions to be displayed at equipments as per the statutory/ safety regulations as well as instruction given by GGL EIC.
  43. Provision and fixing of foundation bolt and grouting of all equipment, frames, supports etc.



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44. Electrical power and control cabling, FLP glands including FLP glands for incoming cables to compressor package incoming electrical package, electrical accessories and other electrical work as specified.
45. Bidder shall provide cable for connecting various equipment approximate length of the cables as below. However, in case of extra cable required the same is in the scope of bidder:
  - (a) Cable for SCADA connectivity between the PLC and Equipment like compressor, dispensers, LCV fill point - 200 m.
  - (b) Cable for connecting CO2 Flooding System - 20 m
  - (c) Cable for Emergency Push Button (2 nos) - 50 m
  - (d) Power Cable for Compressor, Dispensers, LCV Fill Points etc - 200 m
46. All other cables that are not specified above and required for commissioning of compressor package shall be in the scope of Bidder.
47. Documents as specified under Non Material Requirements.
48. Flame arrestor shall be installed in common vent line outside enclosure of the CNG compressor.
49. Bidder shall submit graph and relevant details in table for power consumption v/s. variable suction pressure (i.e. 14 to 26 bar or 3 to 5 barg) during detailed engineering. Testing at variable flow (i.e. 14 to 26 barg or 3 to 5 barg) shall be demonstrated by the bidder during factory acceptance test.
50. All power cable shall be armoured 3 core and FRLS type only.
51. Outlet flow shall increase proportionally with increase in the suction pressure after guaranteed flow. Same shall be shown by the bidder during performance test.
52. Dimension of the Compressor Canopy shall be less than 5.5m x 3.5m (L x W)
53. Compressor Automation
  - 53.1 The operations services required to be carried out by vendor remotely from their control room by 24x7 through automation however, one operator in 1 shift of 8 hours needs to be deployed at station, the shift timing shall be defined by the EIC of GGL.
  - 53.2 The compressor package shall be equipped for automation to operate remotely and locally with instrumentation & control is to be configured for including starting, shutdown as applicable for unmanned operations.
  - 53.3 PLC shall be suitable for recording of compressor parameters with DNP 3.0 protocol as indicated in instrumentation and all other parameters that are recommended by the compressor manufacturer for recording on hourly basis for at least 7 days for recording of parameters.
  - 53.4 PLC shall be configured as a remote terminal unit of supervisory control and data acquisition system (SCADA) complete with Ethernet Port shall be readily configurable for communication over MODBUS TCP protocol with one additional Modbus port through Leased Line/MPLS/VSAT/RF.
  - 53.5 Spare slots in the junction box at least 1 no. is required to add cards for future extension. Spare channel (DO) x 1 No. (for station isolation) is shall be provided by bidder.
  - 53.6 Additional spare holes for cable entries with glands (3/4" x 2 Nos., 1/2" x 2 Nos.) for future provisioning.
  - 53.7 There shall be three independent ports (one for HMI, 2nd for Vendor remote connectivity and 3rd port for GGL SCADA connectivity) available in the PLC with all the parameters available on each individual port.





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- 53.8 Panel shall be complete with start and stop push buttons, hours run meter, power on and fault indication lamps, fault reset button. All necessary timers and intrinsically safe relays to control the system on an automatic starting and stopping basis shall be provided. The compressor package control system shall be designed for unattended operation in automatic mode and in case of any fault it will go in a safe mode.
- 53.9 Bidder shall send daily report, weekly report, fortnightly report and monthly report to GGL. In addition to these reports, vendor shall submit the reports required by GGL EIC. Format of the report shall be as per GGL IMS procedure and Bidder need to build report format in system auto fill-up.
- 53.10 Bidder shall provide provision to keep SIM card in hardware for connectivity with Gujarat Gas control room/SCADA etc. Hence, GPRS Modem (4G or latest) with redundant SIM card option (both required for GGL SCADA connectivity) shall be supplied and installed inside the flameproof junction box with antenna installed outside the junction box for GGL SCADA connectivity. Bidder shall provide 1 SIM port for their control room and 2 SIM port for GGL.
- 53.11 No charges will be paid to the bidder for any hardware to establish SCADA connectivity to the compressor.
- 53.12 Bidder shall provide provision to connect 3 CNG car dispensers + 01 LCV filling point mass flow meter for 1200 SCMH, 1000 SCMH compressor in compressor PLC through RS485 or ethernet TCP/IP and the same shall be display in HMI.
- 53.13 Bidder shall provide provision to connect 3 CNG car dispensers + 01 LCV mass flow meter for 750 SCMH compressor in compressor PLC through RS485 or ethernet TCP/IP and the same shall be display in HMI.
- 53.14 Bidder shall provide provision to connect 2 CNG car dispensers + 01 LCV mass flow meter for 650 SCMH compressor in compressor PLC through RS485 or ethernet TCP/IP and the same shall be display in HMI.
- 53.15 Bidder shall provide provision to connect 2 CNG car dispensers + 01 LCV mass flow meter for 400 SCMH compressor in compressor PLC through RS485 or ethernet TCP/IP and the same shall be display in HMI.
- 53.16 If required, GGL may change price in dispenser through PLC/ remotely. Bidder shall have same facility. Bidder shall provide communication barriers if required to connect dispensers.
- 53.17 Internet connectivity for transfer of data is in bidder scope for remote operation of compressor/package by bidder.
- 53.18 Bidder's Remote control room shall have facility to acknowledge, reset all alarms as well as restart the compressor. Alarm annunciation shall also be available at service provider's control room for intimation to SCADA operator.
- 53.19 All alarm shall be visible to bidder in their control room. Bidder shall able to initiate necessary actions for the same. Bidder to submit Alarm History report.
- 53.20 Hooter can be auto closed based on timer for non-critical alarm. However, High intensity emergency light (As hooter) at compressor shall be provided by the bidder. Bidder shall provide audio (hooter) with visual (Flashing light type) device for alarm/ fault.
54. Requirement for compressor/ compressor package and their associated material (As applicable)
- All compliance certificate required by statutory authority will be provided by bidder to GGL without any cost during entire contract period.
  - Bidder will deploy the required manpower for meeting GGL requirements.
  - Bidder will provide necessary data addresses and protocol will be submitted along with Quality Assurance Plan (QAP) and drawing approval and also whenever sought by GGL without any additional cost.
  - Bidder will provide our service set-up in the locations falling under Gujarat Gas Limited for handling maintenance activities.
  - Bidder shall maintain Inventory/ Spares for trouble free operations for location falling under Gujarat Gas Limited.
  - Bidder will follow all required safety and work procedures of GGL as implemented or upgraded time to time.



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- Requirement of QRC is not applicable for CNG cascade supplied with compressor. This clause supersede requirement of QRC in cascade specification.
55. Bidder shall provide name plate in line with the PNGRB T4S Retail Outlet. Bidder shall find below mentioned minimum contain of name plate:
- Manufacturer's name;
  - Model;
  - Serial No. or month and year of manufacture
  - Certificate of approval no.;
  - Rated capacity (cubic meter per hour);
  - Operating speed (RPM);
  - Required driving power (in kW);
  - Maximum and minimum supply pressures;
  - Maximum outlet pressure; and
  - Certification for Natural Gas use.
56. Bidder shall provide 2 Nos. of hand-held explosive meter with CNG Compressor for operation of CNG Station. Hand held meter shall comply hazardous area classification provided in technical specification of compressor.
57. PESO (CCOE) certificate for electrical and instrumentation material used inside compressor is mandatory, as per statutory requirement.
58. Gujarat Gas Ltd logo sticker shall be pasted by bidder on all sides of compressor. However, Gujarat Gas Ltd. logo design will be provided by GGL to bidder.
59. For VIP (Variable Inlet Pressure) Compressor:
- a. During booster Application natural gas will be available till MCV post through LCV/HCV. MCV fill post along with mass flow meter, hose, valve etc. is in scope of bidder. Bidder to supply, install, commission fill post for decanting of gas from LCV/HCV.
  - b. During booster Application, Suction pressure may vary from 250 kg/cm<sup>2</sup>(g) to 14 kg/cm<sup>2</sup>(g), as applicable, with discharge pressure remaining constant at 255 kg/cm<sup>2</sup>(g)
  - c. Whenever there is conversion of station from booster to online station, the Fill post along with mass flow meter and accessories should be handed over to GGL.
  - d. For Online mode, bidder to provide Suction mass flow meter with flange end. bidder to supply this meter at the time of upgradation of station from booster to online station.

### 2.2 Connectivity & Data Logging

The Owner intends to monitor and partly control all the stations through a central monitoring system. It is intended that monitoring, control and necessary communications shall take place between the PLC of CNG station and the centralized SCADA system through internet connectivity. The provision of centralized monitoring, control system including SCADA is out of scope of this tender. Bidder shall provide PLC which shall be configured as a remote terminal unit of supervisory control and data acquisition system (SCADA). Bidder's scope shall be as follows but not limited to,

1. All the field instrument signals (except local pressure gauge, temperature gauge) shall be connected to RTU/SCADA in future. Hence necessary provisions (like supply & mountings of barriers, repeaters, etc.) shall be made available in the panel by the Bidder.

From I/O to PLC: Profi bus / Modbus TCP/IP





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PLC shall have interface facility with mass flow meter, F&G detection system, CO2 flooding system, with local monitoring system and GGL SCADA system. Local gauges shall be connected neither to local monitoring system nor SCADA system.

2. Provision shall be available to take Compressor PLC in LAN along with local monitoring system / SCADA
3. All data which are required for monitoring and control the performance of the CNG station including the compressor performance parameter, alarms/faults shall be available in the memory of PLC for minimum 30 days. All dispensers, LCV fill point mass flow meter, compressor suction /discharge mass flow meters shall be integral part of SCADA
4. The facility shall be provided to enable the Owner to change the sale rate of the gas from the remote central location through SCADA, Internet and PLC.
5. Batch wise data shall be logged for dispenser for each arm at least for seven days in Quantity, Amount (Rs.), Time and Date, rate resettable from common PLC or through SCADA.
6. Bidder shall demonstrate this with all points above 1-5 of clause 2.2 at their works during FAT every compressor package & during SAT after commissioning of each compressor.
7. All software shall be of valid license and with life time validity.

### 2.3 Battery Limits

1. Natural gas supply at the inlet of the first suction filter of the CNG compressor package.
2. Compressed Natural Gas up to the outlet of the hose arm of the dispenser.
3. All vents (i.e. Relief valve, distance piece, packing and starting air) shall be manifolded and terminated at skid edge outside the enclosure and vented to safe height, as per norms (3 m from the highest working point) at package roof.
4. All drains from different process equipment, distance piece and packing shall be manifolded and terminated as single point for customer interface duly flanged with isolation valve. Drains should be through a common header and discharge to be allowed in a pit to avoid spillage around compressor package
5. Cooling water is not available as utility.
6. Electric Power
  - (a) The Owner shall supply 415 VAC  $\pm 10\%$ , 50 Hz  $\pm 3\%$  electrical power at the incomer of the panel supplied by the Bidder. All further distribution of electric power shall be carried out by the Bidder.
  - (b) The motor starter panel if any shall be provided for the motor of 1200 SCMH, 1000 SCMH & 750 SCMH compressors. The starter panel shall be placed in the electrical panel room. All cables between the starter panel and compressor package shall be provided by the Bidder.
7. Bidder shall supply companion flanges for all battery limit flanges if it differs from ANSI B 16.5.

### 2.4 Exclusions

1. All civil works and foundation design. However:
  - (a) The Bidder shall furnish all the relevant data for design of any foundation / pedestal if required.
  - (b) The minor civil work such as grouting, bolting etc. for the levelling of the equipment/ skid etc. shall be provided by the Bidder.



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### 3. Specifications of Gas Compressor

#### 3.1 General Requirements

1. Multistage stage compressor configuration is envisaged. The compressor shall be of reciprocating, lubricated/non-lubricated, high pressure, multistage, totally air cooled/inbuilt water cooled, gas tight, flame proof electric motor driven and of robust construction. Gas composition, as stated elsewhere in the tender document, is given under Design Case and shall be used for Compressor selection, sizing and performance guarantee estimates. However compressor shall be suitable for continuous operation with the indicated gas composition with minor variations.
2. All instrumentation and control shall be natural gas base (Natural gas actuated) with all necessary regulators and other items. However the Bidder shall ensure that the total gas losses (Difference between Suction Mass Flow meter and Discharge Mass Flow Meter & Vent Mass Flow Meter) from the complete package shall not exceed 0.5%, else penalty shall be levied as per the relevant clauses of this tender. Bidder shall take impulse tap from downstream suction mass flow meter and upstream of discharge mass flow meter.
3. Suction line pressure may vary from 2 kg/cm<sup>2</sup> (g) to 6 kg/cm<sup>2</sup>, 14 kg/cm<sup>2</sup> (g) to 26 kg/cm<sup>2</sup> (g) as applicable, with discharge pressure remaining constant at 255 kg/cm<sup>2</sup>(g). A suction pressure regulator may be installed if required by the Bidder. The suction pressure of 3 kg/cm<sup>2</sup>(g) or 19 kg/cm<sup>2</sup>(g), as applicable shall be used for compressor sizing/ selection and performance test and guaranteed parameters.
4. The pressures specified on the data sheet are at the compressor package battery limits, the Bidder shall consider all pressure losses at suction, interstage and discharge at the specified capacity (with no -ve tolerance) for compressor and indicate the same on the data sheets. Venting of the gas is not allowed at any point during operation.
5. The compressor driver, Flame Proof (FLP) electric motor, shall be capable of running the compressor under loaded condition with each stage pressurized to its respective specified pressure and final pressure up to Pressure Safety Valve set pressure.
6. The Flame Proof (FLP) electric motor shall be suitable to start the compressor against the suction pressure of the specified range. A gas recovery vessel of suitable capacity shall be provided to collect the gas at each stage of compression. The operating pressure of gas recovery vessel shall be 8 kg/cm<sup>2</sup>(g) or 30 kg/cm<sup>2</sup>(g) or 60 kg/cm<sup>2</sup>(g) maximum, as applicable. Venting of gas is not allowed.
7. One number Safety Relief Valve shall be installed before the 1<sup>st</sup> Stage suction or blow down (if 1<sup>st</sup> stage suction and blowdown vessel are interconnected), discharge of each stage, vessel and priority panel. All SRV shall be vented to atmosphere through a common relief valve header. SRV shall be tested as per API 527.
8. Motor and allied facilities to be designed for the whole suction pressure range given in the data sheet meeting the guaranteed parameters specified in the tender document. Bidder has to ensure that
  - (a) Owner reserves the right to operate at higher pressure (within the suction pressure range specified) if available for getting benefit of more capacity utilization.
  - (b) When operated at higher pressure the life of the compressor/moving parts should not get affected.
  - (c) Data sheet of motor and other moving parts that take the load due to higher pressure has to be defined accordingly and the calculation sheet should be attached along with the documents submitted with the tender.
9. Allowable speeds, temperature and vibration levels



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- (a) The rotational speed of both compressor and motor (driver) shall be limited to maximum of 1500 rpm.
  - (b) The linear piston speed shall be limited to 4 m/sec for non-lubricated compressors and 4.5 m/sec for lubricated compressor.
10. The maximum final discharge gas temperature after the final stage cooler of the package shall not exceed maximum 10° C above the ambient temperature.
11. Compressor maximum vibrations of cylinders shall not exceed 10 mm/sec. unfiltered peak velocity. Maximum Vibration level of installed compressor frame shall not exceed an unfiltered peak velocity of 5 mm/sec. or 200 micron unfiltered peak to peak vibration whichever is less. The Bidder shall provide for all structural support within the package so that these levels can be achieved. However, manufacturer shall maintain Vibration levels to meet the industry standards and will be complying to the manufacturer's standards.
12. Piston Rod, Bearings and Cross Heads (General specifications)
  - (a) The surface hardness of Rockwell C 50 minimum is required on piston rods in the areas that pass through the packing.
  - (b) Crosshead shall be as per manufacturer's standard material and designs. Adequate openings for removal of the crossheads shall be provided.
  - (c) Piston rod and cross head pin loading at any specified operating condition including the relief valve set condition shall not exceed 80% of the maximum design rod load of the offered compressor. Rod loads shall have sufficient reversals in direction for all specified operating conditions including PSV Settings and part load operation. Piston rod and cross head can be provided as per manufacturer standard. However, Bidder shall ensure that all the requirement mentioned in the Statutory Regulations and relevant Standards are complied.
  - (d) Packing Cases and Pressure Packing
    - All oil wiper intermediate gas cylinder pressure packing shall be segmental rings with stainless steel garter springs. The pressure packing case shall be provided with a common vent and drain routed outside the package enclosure. ERW steel, seamless steel tubing conforming to ASTM A-192 or series 300 SS tubing conforming to ASTM A-269 with minimum thickness as specified in Cl. 7.11 of API-11P shall be used for vent piping.
    - If applicable, then packing vent piping inside of the distance piece shall be designed for the maximum allowable working pressure of the cylinder. Packing vent piping shall be separate from the Safety Relief Valve piping.
13. Compressor Frame Lubrication
  - (a) Compressor frame lubrication shall be pressurized system, with main oil pump driven directly by the compressor shaft.
  - (b) All lube oil piping after oil filter shall be 300 series stainless steel conforming to ASTM A 269.
  - (c) Heating shall be provided for reservoir when the minimum ambient temperature is less than the Bidder's required minimum start up temperature.
14. Distance Pieces: Compressor manufacturer's standard Type-1 or Type-2 of API 11 P shall be provided as a minimum.
15. Cylinder and Packing Lubrication
  - (a) Single plunger per point force feed mechanical lubricator or divider block system shall provide lubrication to compressor cylinders.



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- (b) Lubricators shall be driven by crankshaft and Bidder shall highlight any pre lubrication requirements of the cylinders and the method of achieving the same.
- (c) Divider block type Lubricators shall have a sight flow indicator with Brass NRV for each lubricator point.
- (d) Digital no flow switch (DNFT) shall be provided to stop the compressor in case of loss of cylinder lubrication in all stages.
- (e) Lubricator reservoir capacity shall be adequate for 50 Hrs of normal operation, and shall be equipped with low-level alarm.
- (f) The Bidder shall furnish along with their bids the details of the recommended Lubricating oil type, International Grades & Specifications along with their quantity and changing frequency/ schedule. The recommended oil shall be compatible with gaskets, 'O' rings, seals, packing, lubricating parts and other parts coming into contact.

### 16. Cooling System

- (a) Compressor cylinders shall be air cooled.
- (b) Inter/After Gas Coolers
  - Air-cooled Interstage and Final stage discharge coolers shall be provided which shall limit the gas temperature after the after cooler to maximum 10<sup>o</sup> C above the ambient temperature. For calculating the surface area of the air cooler, the ambient air temperature of 50 °C and 90% RH shall be considered. Cooler design shall be on the basis of 20% extra design based on the thermal duty at most severe condition corresponding to suction pressure. Gas sections of coolers shall be designed as per API-11P requirements and shall be inspected by any approved 3rd party inspection agency as appointed by the Bidder.
  - The fans for air-coolers shall be direct motor driven. The reduction gear box or any other mechanical speed reduction system shall not be provided to run the electric motor driven fan.

### 17. Separators and oil removal system

- (a) Carbon Steel separators / KOD at suction and Inter-stage and with SS 300 series, mist extractors, auto and manual drain system (level/time based) shall be provided for the capacity as required.
- (b) All pressure vessels shall be designed as per ASME VIII Div 1.
- (c) The offered scrubber and mist removal shall restrict the oil level to < 5 ppm in the discharge gas of compressor and the equipment shall be designed accordingly. All vessels including pulsation dampers shall be fully (100 %) radiographed as per ASME VIII UW (a)
- (d) Minimum design temperature for separators shall be 100°C and minimum design pressure shall be maximum operating pressure plus 15% for interstages and plus 10% for final stage.
- (e) Gas Recovery System: The Bidder shall provide gas recovery system with gas recovery vessel of sufficient capacity and pressure. The gas recovery vessel shall be provided with pressure relief valve and necessary instrumentation to avoid cold flaring of gas. Gas recovery vessel shall be designed as per the ASME code.
- (f) All separators / KOD's shall be provided with 3 mm corrosion allowance.

### 18. Pulsation, Vibration Control and Analog Study

- (a) The Bidder shall provide pulsation, suppression devices at each suction and discharge of compressor cylinders.
- (b) The design of pulsation suppressing devices shall be based on the acoustic and mechanical evaluation carried out as per API 618-design approach 3.



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

- (c) These devices must reduce pressure pulsation in piping within 3%. These pulsation dampers shall be designed to limit pressure drop to 1%. The minimum acceptable volume of pulsation suppression device shall be 10 times the cylinder swept volume.
  - (d) The Bidder shall get the acoustic and mechanical evaluation study carried out for one compressor package (from inlet flange to discharge on skid edge) by an agency who should have conducted TEN such simulation studies. The Bidder shall be totally responsible for all the coordination with the agency carrying out the study. The Bidder shall submit acoustic and mechanical evaluation report to the Owner for review.
19. Coupling: The first preference is for directly coupled driver-compressor arrangement. However a V-Belt driven compressor is also acceptable.
  20. Common structural steel skid for the compressor, electric motors, control panel, all other stationary and rotating equipment and auxiliary systems such as electrical systems and cascades etc. Auxiliaries like CO<sub>2</sub> to be supplied loose & to mounted apart from package to ensure that all the requirement mentioned in the Statutory Regulations and relevant Standards are complied.
  21. Break-away Coupling with pressure rating 3600 PSI shall be part of supply of LCV fill post and it shall be installed when the LCV fill Point is installed at Site. Break-away coupling shall have adequate flow capacity to meet site requirement.



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### 3.2 Datasheet for Compressor

- The datasheet shall be read and completely filled data sheet shall be furnished separately for each of Five types of compressor as per operating parameters.
- Indicates data to be furnished by the bidder/ supplier/ Bidder

Sr. No.	Description	Specification/ detail
	Capacity	Refer Scope of Work
	Qty	Refer Scope of Work
	Suction pressure kg/cm <sup>2</sup> (g)	Refer Scope of Work
	Discharge pressure kg/cm <sup>2</sup> (g) Compressor Make	Refer Scope of Work
	Driver	Flame Proof Electric Motor
	Motor Make	*
	Installation	Outdoor
	Service	Continuous
	Gas Handled	Compressed N.G (CNG)
	Gas Characteristic	Sweet, Odorized, Non- Corrosive and
	Gas composition (% by volume)	Sweet Gas
	- Methane	91.9132 (May vary up to 97)
	- Propane	1.18705
	- I-butane	0.1993
	- n-butane	0.28415
	- I-pentane	0.0143
	- n-pentane	0.00685
	- Ethane	5.8181
	- c6+	0.00745
	- N2	0.54685
	- CO2	0.02085
	- Neo pentane	0.0019
	Molecular weight of gas at suction	17.38 at NTP condition
	Cp/Cv at suction	1.18 at NTP condition
	Pressure	Maximum _*
	Std. condition referred to	1.1013 bar(a) & 15.56 °C
	<i>Suction temp.:</i>	
	Normal	35 °C
	Maximum	50 °C
	Flow meter type	Coriolis
	Discharge Pressure of Compressors: Normal/Min./Max. kg/cm <sup>2</sup> (g)	255/ * / *
	No. of Compressor /per Refueling Station	1
	No. total of units	*
	No. of stages of compressor	*



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	Stroke / Compressor Crank RPM	* (Pressurized crank case preferred)
	Actual Suction Pressure kg/cm <sup>2</sup> (g)	Variable
	Final Discharge Temperature	* (Maximum 10°C above the ambient temperature)
	Guaranteed Shaft Power (1KB/BKW)	* / *
	Driver power rating selected	*
	Driver RPM	*
	Direction of rotation from driving end	Clockwise/ Anti Clockwise
	Driver make & Frame size	*
	Drive Arrangement - Direct coupled or V-Belt, guard (Anti-Static)	*
	Nozzles at Supply & Discharge Limit	*
	Suction	*
	Discharge	*
	Cylinder Bore (mm)	*
	Single Acting/Double Acting	*
	Type of Cooling	*
	Jacketed or Dip finned	*
	Inside Liner Yes/No	*
	Piston Displacement	*
	Mean Piston Speed	*
	Inlet/Discharge Temp.	*
	Inlet/Discharge Press.	*
	Max. Allowable Cyl. Temperature	*
	Max. Allowable Cyl. Pressure	*
	Hydrostatic test Pressure	*
	Helium Test Pressure	*
	Type of Cylinder Valves	*
	No. of Suction / Discharge valve	*
	Valve Un-loaders	*
	Piston Rod Diameter	*
	Piston Rod Load (Nom./Max.)	*
	Packing Lubricant	*
	Packing Vent to	*
	Distance piece type	*
	Distance piece purging	*
	Discharge relief Valve setting	*
	Lubrication system	*
	Type of system Mfgr.	*
	Oil filter type & make	*
	Oil pump type	*
	Electric motor	*



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

	Oil pump make	*
	Oil cooler Type & make	Air/Water cooled
	Detail of piping & valves	*
	System oil capacity	*
	Grade of oil to be used	*
	Heat Exchanger (I/C & A/C)	Air cooled
	Frame	Cast iron / Structural Steel
	Cylinder & head	Cast iron / Spheroidal grey iron / Steel
	Liner	Cast iron
	Piston	Cast iron
	Piston Ring	Malleable Cast iron
	Valve Seat	Stainless steel
	Valve Plate / Ring	Stainless steel
	Valve Spring	Stainless Spring Steel
	Crank Shaft	Spheroidal grey iron / steel
	Connecting Rod	Steel
	Piston Rod / Piston Rod	Steel / Stainless Steel
	Location	M/c Mounted/ Off Mounted
	Cooler type	Air cooled Fin Fan type
	Overall size of cooler	*
	Code of design & construction	*
	Heat Transfer area provided	*
	Tube / Fin size	*
	Tube / Fin Material	*
	Header Material	*
	Inlet Nozzle	*
	Outlet Nozzle	*
	Drain	*
	Vent	*
	Volume Bottle / Pulsation Dampeners with manual drains (double isolation valves) and automatic drain system, lube oil system, Air cooled as required to be Provided at each stage	Yes/No
	Qty.	1 each
	Capacity	
	Design & Construction Code	ASME Section VIII Div.1
	Design Pressure	*
	Qty./refueling station	1
	Type	Dry
	Make / Model	
	Design & Construction code	ASME Section VIII Div.1





## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

Operating Pressure	*
Pressure drop across the filter	*
Micron rating (Filtration level)	3 Microns
Filtration Efficiency	99.50%
Cartridge Material	*
Bonnet / Casing Material	*
Inlet Nozzle	*
Outlet Nozzle	*
Drain	*
Vent	*
Qty./refueling station	1
Type	Dry
Make / Model	
Design & Construction code	ASME Section VIII Div.1
Operating Pressure	
Pressure drop across the filter	
Micron rating (Filtration level)	3 Microns
Filtration Efficiency	99.50%
Cartridge Material	*
Bonnet / Casing Material	*
Inlet Nozzle	*
Outlet Nozzle	*
Drain	*
Vent	*
Qty.	1 each
Capacity	
Design & Construction code	ASME Section VIII Div.1
Design Pressure	*
Design Temperature	*
Hydrostatic Test Pressure	*
Material of Construction for:	*
Shell	*
Heads	*
Inlet Nozzle	*
Outlet Nozzle	*
Drain	*
Vent	*

### 3.3 Specification of Enclosure / Canopy of Compressor Package

- The Compressor package shall be housed in separate GI powder coated (with 0.03 mm to 0.05 mm thick epoxy) acoustic enclosure including all paneling. The equipment shall be mounted on one common skid. Enclosure shall restrict maximum noise level to 75 dBA at 1 meter from the enclosure.



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

2. The maximum temperature within the enclosure shall be limited to 55°C based on the ambient temperature of 50°C. Adequate ventilation fans shall be provided to meet the above & also to account for heat dissipation of the coolers as well as maintaining the positive pressure inside enclosure.
3. Suitable interlocks shall be built in for clearing the entrapped gases (if any) within the enclosure before the startup of the compressor package. The owner shall review the vent requirements to meet the above and interlocks during detailed engineering.
4. Enclosures shall be weather proof and provided with adequate ventilation system.
5. The enclosure shall be fabricated in such a way that it is completely sealed so as no gas of fire travels from one enclosure to another.
6. The enclosures shall have doors for normal access and removable wall panels for ease of maintenance. The acoustic material should be fire resistant with fire retardant rating of 30 minutes. Necessary documents to be submitted for the material selected.
7. The Bidder shall ensure that the enclosure is designed and provided to withstand the static and dynamic loads of 3000 litres of the storage cascade to be mounted on the enclosure, the canopy have sufficient space surrounding the storage cascade for safe operation of cascade and with safety railing. All 4 sides hand rails and toe guard to be provided and the same will be review and approved by during details engineering.
8. Vendor to provide the inclined ladder with flat steps, hand rails etc. and the same will be approved by GGL EIC during details engineering. The ladder shall be grouted properly by bidder at site and ensure proper support with them as per instruction given by GGL EIC.
9. All the indicators for pressure, temperature, gas flow, oil level, lube oil pressure, coolant temperature, coolant level etc. shall be visible from outside of enclosures and can be viewed from PLC/locally. However, bidder can provide oil level, gas flow meter inside the compressor without visibility from outside but proper accessibility should be provided for the both.
10. Enclosure shall have internal flame proof lighting arrangement.
11. For handling of all heavy parts for maintenance purpose lifting arrangement i.e. beam fitted with chain hoist shall be provided in the enclosure. Certificate of chain hoist is to be provided. However If the equipment design are such that the hoist are not required, then certificates not needed.  
  
In case, if the design of the package does not permit the arrangement of chain hoist in the enclosure, the Bidder must provide suitable arrangement for ease of lifting of heavy items.
12. All Coolers, Knock Out Drums, Scrubbers, Cooling System, lubrication system along with interconnecting piping shall be inside the enclosure. Enough headroom shall be made available for easy access and maintenance of all equipment in the enclosure. The piping layout with respect to the compressor, intercoolers, KOD and auxiliaries location shall be subject to Owner's approval during detailed engineering stage.
13. Components such as pressure gauges, temperature and pressure switches etc., which require in-situ adjustment and reading shall be easily accessible.



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

14. Conduits and tubing shall be arranged in orderly and systematic manner and shall be routed neatly to enter the back of display or monitoring panels
15. Routine service item such as, but not limited to, crank case oil filters, inter stage gas filters, inlet and outlets gas filters and drive belt shall be located to facilitate easy one-man servicing.
16. A person should be able to access crank case oil inlet and drains to allow addition or drainage of oil without removing panels or adjacent components and without the need of the pump.
17. Items which must be operated & monitored during operation shall be readily accessible without opening the door.
18. Suitable gradients shall be provided on the enclosure roof for rain drainage and to avoid water pockets.
19. The structural members of enclosure shall be provided with two coats of primer and two coats of epoxy paints duly applied after appropriate surface treatment with minimum ten years maintenance free life.
20. The enclosure shall be provided with door limit switches, two numbers Gas detectors and two numbers flame detectors per enclosure as a part of gas and flame detection system and CO2 flooding system. The specifications for the CO2 flooding system shall be as mentioned in the following clauses.
21. The compressor canopy shall be pre-fabricated trail/ Tray arrangement for installation of SS tubing from priority panel to CNG storage Cascade, welding/cutting/tacking of compressor canopy at site shall not be allowed
22. Stability certificate for each compressor canopy to be witness during the FAT.

### 3.4 Specification for Priority Panel

#### 3.4.1. Content

Five bank priority fill system including inlet and outlet valves, non-return valves and by-pass valves with all interconnecting piping/tubing shall consist of following but not limited to:

1. Free standing welded and powder coated (0.03 mm to 0.05mm thick epoxy) steel frame structure. To save on space, priority panel may be wall mounted on canopy.
2. Interconnected SS tubing and manifold
3. Isolation valves, Bleed valves, Non return valves, end plugs and vent system
4. Connections of all isolation valves with the emergency switch for closure of isolation valves in case of emergency
5. Pressure Transmitter along with Pressure gauges for Remote Operation and ease of maintenance.
6. Actuators for control of flow to dispensers / cascade / LCV point
7. Solenoid Valves
8. Clamps to fit the pipes & valve to the main frame
9. Any accessories which Bidder feels necessary for better performance.



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### 3.4.2. Specific Requirements

1. The priority panel allocates gas from the compressor to the storage or dispenser in the optimum sequence. It may also have compressor "top off" facility so that gas may be pumped direct from the compressor to the dispenser.
2. The gas must flow from the storage cascade to dispenser through the priority panel. The direct flow from the cascade, by-passing, the priority panel shall not be allowed.
3. Priority Panel shall be located outside the package to avoid gas leakages due to high operating frequency of actuator and for ease of operations and supervision.
4. Priority panel shall be provided with weather proof GI powder coated enclosure (0.03 mm to 0.05 mm thick epoxy) and the same shall be attached to the main enclosure of the compressor package.
5. When the compressor first starts and the storage system is empty, the priority fill system diverts the compressor discharge gas to the first on priority to the high bank of the dispenser. Once the pressure of the high bank of dispenser is ensured above 200 kg/cm<sup>2</sup>(g), the gas is diverted to the high bank of the cascade. As soon as the high bank of the cascade is filled to a pressure > 220 kg/cm<sup>2</sup>(g), the gas is diverted to the medium bank of the cascade ensuring that during this period the high bank of cascade and dispenser are always above 220 kg/cm<sup>2</sup>(g). Now, when the medium bank of cascade reaches to predetermined pressure of 220 kg/cm<sup>2</sup>(g), the low bank of the cascade starts receiving the gas till the discharge pressure reaches 250 kg/cm<sup>2</sup>(g). Once the pressure in the low bank reaches to 250 kg/cm<sup>2</sup> (g), the gas is diverted to mobile cascade filling (LCV point). As soon as the pressure in the mobile cascade reaches 250 kg/cm<sup>2</sup> (g) or auto shut down pressure of compressor, the compressor stops. With the directions of the NRV of priority panel, so configured that all banks of the cascades reaches 250 kg/cm<sup>2</sup> (g) or auto shut down, before the compressor goes to standby state.
6. In short, priority sequence would be 1st to high bank of dispenser, 2nd to high bank of cascade, 3rd to medium bank of cascade, 4th to low bank of cascade and finally to mobile cascade. Before the compressors goes to shut down state, it ensures that all the cascade banks are filled upto a pressure of 250 kg/cm<sup>2</sup>(g).
7. Actuator ball valves (Gas actuated) shall be provided between priority panel and dispenser as well as stationary and mobile cascade to control flow.
8. When a vehicle is connected to the dispenser for refueling, the dispenser auto sequencing system allocates gas from the cascade to the vehicle cylinder in the reverse sequence to which it is filled. The dispenser sequencing system is instigated by flow rate drop off which indicates equalization between each bank of the cascade and the vehicle cylinder. In this manner the gas from the largest storage volume, which may have already been drawn off to a pressure less than its initial fill pressure, fills the vehicle cylinder from its low pressure. Power is not wasted in compressing gas to high storage pressure and then reducing it again to match an empty or near empty vehicle cylinder, which is already at a low pressure.
9. Likewise the medium and high-pressure storage banks only top off the vehicle cylinder above certain pressures; the stored gas does not have to be unnecessarily reduced in pressure. This system is known as multi-refueling. To minimize the station power consumption, multi-line systems are nearly always used. In practice it has been preferred to go for 3 line dispenser system for high efficiency of 60%.

### 3.4.3. Basic Datasheet

\*: Indicates data to be furnished/ confirmed by the supplier/ Bidder

Sr. No.	Description	Specification/ detail
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## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

1	<p>Priority sequence for transfer / allocation of the gas shall be as under.</p> <ul style="list-style-type: none"> <li>(a) Fore-court high bank dispenser</li> <li>(b) Fore-court medium bank dispenser</li> <li>(c) Fore-court low bank dispenser</li> <li>(d) Stationary cascade high bank line</li> <li>(e) Stationary cascade medium bank line</li> <li>(f) Stationary cascade low bank line</li> <li>(g) Mobile cascade (Vehicle mounted)</li> </ul>	
2	Control System	PLC/ SCADA Based (refer clause J)
3	Location of priority panel	Outside and on the enclosure of compressor package
4	Set Pressure for Bank filling	250 kg/cm <sup>2</sup> (g) (must be settable)
5	Flow Rating Cv	*
6	Maximum Flow Rate	*
7	Priority Valve Type	Solenoid operated actuator ball valve
8	Inlet / Outlet Connection	¾ " (0.095" thk) OD SS 316 Tube
9	Size of inter connecting tubes	¾" for all compressor packages
10	Mounting Type	Suitable for Wall mounting, Preferably with Outside enclosure body
11	Material of Construction	SS 316 seamless and annealed (tubing, fittings).
12	Actuator	One between priority panel & each dispenser, one between priority panel and each bank of stationary cascade and each bank of mobile filling line.
13	Enclosure	GI - Powder coated (0.03 mm to 0.05mm thick powder coated)



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### 3.5 Compressor Instrumentation

1. All instrumentation and control shall be natural gas base (Natural gas actuated) with all necessary regulators and other items.
2. The control panel shall be the integral part of the compressor package and shall be mounted on the same skid as the compressor to avoid any on site cabling. The only cabling that shall be allowed will be in the case of 750, 1000 & 1200 SCMH compressor with separate starter panel.
3. The compressor panel shall be housed in an enclosure which should form part of the main acoustic enclosure, and be protected from rain and sun.
4. Each compressor package shall be provided with following indicators:
  - (a) Pressure indicator at Inlet and each stage discharge.
  - (b) Temperature indicator at each stage suction and discharge.
  - (c) Oil pressure indicator on each pressure lubrication system. Oil cooler outlet temperature.- - DPI for oil pressure considered
  - (d) Oil levels.
  - (e) Hour meter.
5. Each package shall be furnished with following tripping circuit:
  - (a) Low lube oil pressure.
  - (b) Forced feed lubricated failure.
  - (c) Excessive discharge temperature at each stage.
  - (d) Excessive discharge pressure at each stage.
  - (e) Low/High discharge pressure at each stage.
  - (f) Low suction gas pressure.
  - (g) Low cooling water flow (If compressor is water cooled).
  - (h) On high vibration-on activation of vibration switch/ trip of vibration transmitter.
  - (i) Door Limit switch for all door entries
6. Common trips
  - (a) On actuation of gas detector alarm. Gas detection alarm to be set at 10% of LEL.
  - (b) On actuation of flame detectors alarm. Audible alarm shall be available upto a distance of 15 mtr. from package.
  - (c) On pushing of emergency stop device.
  - (d) Each package shall be furnished with an audible and visual alarm system for annunciation on compressor trip.



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### 3.6 Compressor Package Operation Philosophy

1. The compressor package control system shall be designed for unattended safe operation in automatic mode and perform functions like unload, start, load safely. The compressor shall start in auto mode if high bank storage pressure falls below 220 kg/cm<sup>2</sup> and stop once the pressure in all three banks of stationary cascade reaches 255 kg/cm<sup>2</sup>. The priority fill system shall ensure the filling of vehicle, high bank of cascade, medium bank of cascade and low bank of cascade in correct order. The priority fill panel shall be designed to ensure filling of vehicle, storage cascade in correct order. Five bank priority panels are envisaged.
2. The compressor package control system shall be designed in such a way that the first to go into alarm condition shall lock out to indicate the cause of the trip though the cause of the trip may have disappeared. The lock out condition shall be manually reset. A change over set of contacts shall be provided for the Owner's use to give a remote indication of alarm and trip. This set of contacts shall be common to all trip conditions.
3. Compressor Control System shall be designed in "Fail-Safe" manner so that in case of any fault, discrepancy or abnormality, it will go in safe mode. All controls shall be made in fail safe mode & failure of any control shall not lead to operation of equipment / system in unsafe condition. The control system must ensure safety of equipment as well as personnel.
4. In case of fault, a warning hooter shall operate, the sound, which should be audible at distance of at least 15 meter. Further the fault alarm and emergency stop PB shall be duplicated in the office of CNG stations. Acknowledgement/Resetting of fault shall be possible only from compressors panel. Emergency stop PBs shall be mushroom head turn lockable type.
5. Once the fault is acknowledged or the motor, compressor, etc. are down for any normal maintenance, the valves of priority panel shall take the position so that gas available in the cascade can be dispensed.
6. The Bidder shall provide Emergency Shutdown System and switch in control room as well as locally mounted on the compressor panel. Upon energising the same, all the operations of the compressor must stop including running of motor and supply / discharge of gas.
7. Fail-safe system shall be designed and incorporated to isolate cascade storage from Compressor, stop compressor, isolate the compressor suction line on activation of Emergency Shut Down (ESD) switch. ESD switch shall have to be manually reset to restart the compressor package again.
8. All control logic, interlock, monitoring and annunciation shall be achieved using programmable logic controller. The controller and associated equipment shall be designed to work satisfactorily in the environment expected to be prevailing at site.
9. Compressor Package shall be provided with a Programmable Logic Controller (PLC) of approved make which shall be housed in weatherproof Panel conforming to IP55 and shall be certified suitable for specified hazardous area classification Class-I, Division-1, Group IIA/ IIB, Temperature Class T3 or Class 1, Division 1, Group D, Temperature T3. PLC shall be integral with the package with necessary compliance.
  - (a) PLC shall incorporate all process parameters (specified elsewhere) and status of compressor, priority panels and shall be modular in construction with 100% redundancy with respect to CPU, Power supply, Interface. PLC components/system shall be tropicalised, MIL standard adopted with complete wiring and necessary terminals. Wiring to be colour coded with cross ferruling in position. In case, redundancy is offered for CPU



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

and power supply only, Bidder to ensure that all the requirement mentioned in the Statutory Regulations and relevant Standards are complied.

- (b) The PLC shall have provision of 100% redundancy to avoid downtime and loss of data in case of any problem. In case, redundancy is offered for CPU and power supply only, Bidder to ensure that all the requirement mentioned in the Statutory Regulations and relevant Standards are complied.
- (c) PLC shall be capable of carrying out on line routines for at least ten separate loops without affecting the scan, cycle & up dating time etc.
- (d) PLC shall be capable for display of flow meter data (i.e. Gas Suction, Gas Vent and Gas Discharge, LCV and Dispensers mass flow meters) various trips/abnormal conditions, compressor running hour etc. in following manner:
  - Shift wise (for 3 shift operation i.e. 06:00-14:00, 14:00-22:00 & 22:00-06:00)- shall be available for at least last 96 hours
  - Daily basis- shall be available for atleast last 31 days
  - Fortnightly basis- shall be available for atleast last 3 fortnights
  - Monthly basis- shall be available for atleast last 2 months
- (e) PLC shall be configured as a remote terminal unit of supervisory computer and data acquisition system complete with internet connectivity. One card for transferring and accessing data from minimum twenty devices with RS 485 port / USB shall be provided.
- (f) All the field instrument signals (except local pressure gauge, temperature gauge) shall be connected to RTU/SCADA in future. Hence necessary provisions (like supply & mountings of barriers, repeaters, etc.) shall be made available in the panel by the Bidder. PLC shall support standard protocol like MODBUS RTU, DNP, Ethernet NTP and it shall have interface facility with mass flow meter, F&G system and CO2 flooding system and with local monitoring system and GGL SCADA system. Local gauges shall be connected neither to local monitoring system nor SCADA system.
- (g) Bidder to provide automation through PLC as per (As per point 53 of clause 2.1).If any computer/laptop is required for maintenance of compressor, shall be in bidder's scope.
- (h) PLC shall be provided with integral keyboard and display for configuring, programming and to view process & machine parameters. Suitable communication port shall be provided to download programs & view etc from PLC. Necessary interface software shall be provided.
- (i) All source and object codes including logic flow chart, ladder diagram etc shall be furnished by the Bidder and PLC shall be capable of incorporating function Block diagram, sequence function chart, ladder diagram and structural text as per IEC 61131. The PLC program shall be configurable and expandable. PLC I/O shall be 15% to 20% spare and expandable slots.
- (j) The Bidder shall provide 3 sets of Application programming software for PLC, HMI (Human Machine Interface) on LCP (one set) along with all interfacing adaptors and cables. The Bidder shall also provide 2 sets of source and object codes for PLC, HMI on LCP (in both forms, hard & soft).





## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

- (k) PLC License software shall be provided with each compressor.

### 3.7 CO<sub>2</sub> Flooding System

The package shall be protected against fire with automatically operated CO<sub>2</sub> flooding system designed as per NFPA-12 and consisting of two cylinders, piping, valves and control systems etc. The minimum requirements of the system shall be as under.

1. Installation of hydrocarbon gas detector (IR type) with self-check function and transmitter with adjustable alarm levels (0-100%) with preset of 10%, 20% and 50%. Each enclosure should have at least 2 nos. gas detectors.
2. Installation of flame detector (UV-IR type) with self-check function and transmitter, alarm on detection of flame. Each enclosure shall have minimum 2 nos. of flame detectors.
3. CO<sub>2</sub> flooding system will consist of 2 nos. of adequately sized CO<sub>2</sub> cylinders and grouted properly at site. One cylinder will act as main cylinder & other as stand by, which shall have identical arrangement and connected to the system. The cylinders shall be placed outside the package enclosure and in a shed to protect from weather and direct sunrays as per Gas Cylinder Rules, 2016. Cylinders shall be fitted with automatic actuated Valves, Solenoid valves etc. Ensure proper tagging as well as details of hydro test due etc. on the Co<sub>2</sub> flooding system.
4. Calculation of each cylinder capacity wrt to requirement as well as nozzles etc. to be furnish during the details engineering
5. The System shall be designed to operate on 24 V DC supply.
6. FRLS (Fire resistant low smoke) cables shall be used for the wiring of the system.
7. Bidder shall provide flame proof manual call point with hammer at fencing for manual operation of CO<sub>2</sub> flooding system. Also supply and connectivity with compressor supplier, CO<sub>2</sub> flooding system is in the scope of bidder.
8. Interlock of CO<sub>2</sub> Flooding system with respect to compressor shall as per following sequence:
  - (a) Compressor shall trip on detection of gas at preset level.
  - (b) Compressor shall trip on detection of flame at preset level and automatic discharge of CO<sub>2</sub> gas shall take place from the main cylinder simultaneously.
  - (c) Compressor shall not start if the CO<sub>2</sub> Flooding System is faulty, not working, Switched OFF etc. The compressor shall be able to start only when the CO<sub>2</sub> Flooding System is in healthy working condition.
  - (d) Maintenance Override Switch shall be provided to keep the system off during maintenance. This feature shall be in compliance to the point no. ( c ).
  - (e) Selector switch shall be provided to put Main/Stand by Cylinder in line at the turn of a switch as per requirement.
9. Alarm panel for CO<sub>2</sub> Flooding System shall be integral with the main compressor panel.



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

Necessary displays as system ON, OFF, FAULT, RESET, Gas/ Flame indication, Remote actuation of solenoid valve, distinguished hooter etc., shall be provided for CO2 flooding system.

10. CO2 cylinders shall be provided outside the package at a safe place, minimum 4.5 meters away (aerial distance), where it is not exposed to fire in case of fire in the compressor. Facility shall be made to operate the system both manually from remote with the help of a switch/ call point and with help of pull down lever on cylinders.
11. The Bidder shall provide suitable weighing arrangement to facilitate weighing of the cylinders without requiring the cylinders to be detached from the installation. For this lever operated lifting arrangements shall be made.
12. All installation shall be compatible for hazardous area, Temperature T6 1, Division 1, Group-D for Methane Gas.
13. The system designed by the Bidder shall be duly approved by GUJARAT GAS LTD.
14. Technical specifications, Operation and Maintenance Manual, CCOE Certificate, Approval/ Manufacturing certificates for cylinders and cylinder valves, gas detectors, flame detectors, solenoid valves etc. shall be furnished by the Bidder along with system. Software and hardware, calibration procedure shall be provided by the Bidder along with the supply sufficient enough to handle the system independently.
15. System shall be offered for testing to GUJARAT GAS LTD by the Bidder after commissioning at site by simulation using test torch for flame detectors and actual discharge of CO2 Gas from the Cylinders. This shall form a part of performance test and thereby acceptance of the package. The cylinders have to be refilled by the Bidder at no extra cost to GUJARAT GAS LTD after performance test. If the system fails during testing, subsequent testing and refilling would be at Bidder's cost.
16. CO2 flooding system piping of the compressor shall be properly clamped and Hydro tested after installation at site. Colour code of piping shall be as per relevant standard.
17. Bidder to provide adequate size of SS tubing and fitting for connecting CO2 flooding system and compressor package canopy.

#### 4. General Specifications for Pressure Vessels

##### 4.1 Scope

This Specification gives general requirements for material selection, design, manufacturing, inspection, testing and erection of various pressure vessels used in CNG REFUELING station. The Bidder shall select suitable type and size of vessels as per the system requirement.

##### 4.2 Design and Construction Code

1. All vessels shall be designed, constructed & inspected in accordance with ASME code section VIII, div. 1 / IS 2825 code for unfired vessels & ASME code section IX for welding.
2. Wind loads and earthquake forces shall be calculated in accordance with relevant Indian Standards, unless otherwise specified.

##### 4.3 Statutory Requirements



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

National laws and regulations together with local and international by laws for the country or state where vessels are to be erected must be complied with. The documents for the same shall be supplied by the Bidders. If required, approval of design & drawings from statutory authorities like C.C.O.E. (Chief Controller of Explosive) shall be suppliers / vendors' responsibility. The foreign The Bidders shall have to get the itemised local approval with the help of certified documents of origin country regulations. However total approval of the station facility shall be carried out by Gujarat Gas Ltd.

### 4.4 Design Basis

1. Vessel shell and heads shall have minimum wall thickness calculated with design pressure, temperature, in accordance with codes.
2. Design pressure shall be equal to maximum operating pressure at the top of vessel plus 10% (or minimum of 1.0 kg/cm<sup>2</sup>) more than operating pressure.
3. Design Temperature shall be equal to operating temperature plus 15°C.
4. Minimum corrosion allowance for all vessels shall be 3.0 mm minimum unless otherwise specified elsewhere.

### 4.5 Materials

Material to be used shall conform to

- ASME Section II.
- Indian Standard / other international standard of equivalent grade.

Following guidelines are given for selection of carbon steel materials

1. For Pressure part:
  - (a) The material of C.S. plates shall conform to SA-516 Gr. 60/70 or as per IS:2002
  - (b) The material of forging shall conform to SA-105.
  - (c) The material of Nozzle pipes shall conform to SA-106 Gr.B.
  - (d) The material of Fittings shall conform to SA-234 Gr. WPB.
  - (e) The material of Bolting shall conform to SA-193 Gr. B7.
  - (f) Gasket shall be 2 mm thk. Non Asbestos steel wired reinforced suitable for pressure and temperature condition.
2. For Non pressure part:
  - (a) The material of construction of plates shall be SA-283 Gr.C or as per IS: 2062.
  - (b) The material of pipes shall conform to SA-53 or as per IS: 1239.
3. Specifications of Carbon Steel plates
  - (a) Plates used shall conform to latest addition of SA-20 with additional requirements mentioned herein:
  - (b) Only normalised plates free from injurious defects with workman like finish to be used. Reconditioning/repair of plates by welding shall not be permitted.
  - (c) One product analysis of each heat shall be carried out and reported. Chemical analysis shall conform to as per applicable specifications with carbon content not exceeding 0.25%.



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

- (d) Plates having thickness of 15mm to 50mm (both inclusive) shall be examined ultrasonically as per SA-435 for inner defects and lamination. Ultrasonic examination shall preferably be done after the specified heat treatment of plates.

### 4.6 Heads

Shape of Heads, dimensions proposed by the manufacturer must be stated in offer. All carbon steel dished heads less than 16 mm thickness shall be stress relieved and more than 16 mm thickness shall be normalised if cold pressed or formed. However, in case, hot forming is carried out with in normalising temperature range, no stress relieving is necessary.

### 4.7 Hand Holes and Nozzles

1. Small vessels shall be provided with two pad type inspection opening of 150 NB size if possible or as per standard engineering practice. For vessels with diameter less than 900 mm and having removable internals, shell flanges are to be provided.
2. The reinforcement for the nozzles opening shall be integral type when required by the applicable code/standards. Self-reinforcement type nozzles 80 NB and above shall be set in type.

### 4.8 Flanges

1. All flanges shall conform to as per ANSI B-16.5.
2. All flanges above 150 lbs rating should be provided as per below:
  - Below 2' NB: SORF flange
  - 2" NB and above: WNRF flange

3. Studs and Nuts :

All studs and nuts shall be hot deep galvanized and as per ASTM A193 Gr. B7 and ASTM A 194 Gr. 2H

### 4.9 Inspection

All vessels shall be offered for stage wise as well as final inspection mentioned in approved QAP to owner or third party inspector. Inspector shall have free access to all workshops of Bidder or his sub-Bidders. Hydro-test witnessing by third party inspection agencies (as per list attached) owner or consultant shall be carried out prior to shipment or dispatch.

### 4.10 Testing

All vessels shall be hydrostatically or pneumatically tested. Necessary precaution shall be taken to guard against the risk of brittle fracture during hydrostatic test. The water temperature shall not exceed 30° C. (85 ° F). After testing the vessel shall be thoroughly dried by blowing dry air

### 4.11 Welding

Pressure parts joined by butt welds shall have full penetration welding. Where both sides welding are not accessible, root run shall be with tungsten inert gas process to ensure full penetration welding.

### 4.12 Post Weld Heat Treatment (PWHT)

Vessels shall be heat-treated whenever It is required due to service requirement or due to code



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requirements. Vessels shall be post weld-heat treated as a complete unit and no welding is permitted once PWHT is done.

### 4.13 Radiography

Vessels shall be 100% radio-graphed as per ASME code. Defective welding found through radiography, shall be chipped out, re-welded and re-radio-graphed, plus any other additional radio-graphs or test required by applicable design/construction code are to be carried out. All Fillet welds should be DP/MP tested.

### 4.14 Cleaning and Painting

Vessels shall be cleaned internally and externally to remove scale, rust, dirt, foreign material by wire brushing before painting. Cleaned carbon steel surface to be given two coats of protective primer and machined surfaces to be greased/oiled to prevent rusting. Painting shall be as per the manufacturer's standards.

### 4.15 General Requirement

1. Manufacturer to supply additional two sets of gaskets for every hand-hole and nozzles provided with blind flanges. The final gaskets shall not be used for conducting tests in shop.
2. Nozzles up to 50 NB size to be stiffened with 2 Nos. Stiffeners of 40 mm wide x 6 mm thk. Flats, welded at 90 degree apart.
3. Vessels of diameter 300 NB & below shall be made from seamless pipe.
4. Rolling of plates for making of shell shall be lengthwise.
5. Guarantee of the vessel.

### 4.16 Data Sheet for Pressure Vessel

(To be completed by The Bidder for each applicable vessel & submitted along with offer)

1. Item
2. Package
3. Code for design and Construction
4. Operating Conditions
  - Pressure (kg/cm<sup>2</sup>(g))
  - Temperature(°C)
5. Design conditions
  - Pressure (kg/cm<sup>2</sup>(g))
  - Temperature(°C)
6. Corrosion allowance
  - Type of vessel



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- Diameter(MM)
- 7. Height TL-TL(MM)
- 8. Skirt / Leg height
- 9. Post Weld Heat Treatment
- 10. Material of Construction of all parts

### 5. Specifications for Tubing and Piping

1. All gas tubing shall be Stainless Steel series –316 conforming to ASTM-A269 with maximum hardness of Rb80.
2. All high-pressure double ferrule fitting and 2/3 way valves shall be from manufacturers approved by GGL for SS tube fittings and shall be SS 316 material only.
3. The instrument gas tubing material shall be Stainless Steel series –316/SS 304 of 6 mm OD conforming to ASTM-A269.
4. All lube oil piping down stream of filter shall be Stainless Steel 304.
5. All carbon steel piping shall be seamless in accordance with ASTM A- 53 Gr. B or ASTM A - 106 Grade B and not less than 1" nominal size. The piping work shall conform to ANSI B 31.3. B 31.8. On all vent & drain line to be provided double valve combination as per std.
6. All the elements of tubing and/or piping shall be designed for the full range of pressures, temperatures and loading to which they may be subjected with a factor of safety as per engineering practices.
7. All high pressure stainless tubing shall be installed with heavy duty clamp at an interval of distance not more than 1500 mm. and shall be clamped at all joints.
8. All bank tubing shall be installed with 3 Nos. of isolation valve on each line as per OISD-179
9. Open ends on fittings and vents shall be provided with caps.
10. One number lockable isolation valve on each bank shall be provided at outside the fencing area of compressor package.
11. While carrying out the work at site, the Bidder shall take all necessary precautions to prevent any damage to the tubing work.
12. **Inspection and testing at site:** All tubing work shall be hydrotested at a pressure of 1.5 times the maximum working pressure. After completion of the hydrotest, all the lines shall be flushed and dried with Nitrogen (certified N2 cylinders).

#### 5.1 General Specification Stainless Steel Fabrication

##### 1. Cutting, fit-up and laying out

- a. Template shall be used for laying out headers, laterals and other irregular details to ensure accurate cutting and proper fit up.



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- (b) Machine cut bevels to form the welding grooves are preferred. However, edges beveled with a file or grinder followed by stainless steel wire brushing is acceptable in this section.
- (c) Spacers shall be used to maintain a uniform weld gap to ensure adequate weld penetration.
- (d) Stub end faces shall be in a plane perpendicular, true and square to the centre line of pipe to which the same is attached.
- (e) Only small tack welds which penetrates to the root of the weld gap shall be allowed to form part of the finished weld.
- (f) The pipes shall be aligned correctly within the existing tolerance on the diameter, wall thickness and out of roundness. The same alignment shall be preserved during welding.

### 2. Bending

- (a) Completed bends shall have a smooth surface and free of flat spots and corrugations.
3. Hot bending is not permitted.
  4. Cold bends to radius of three (3) times the pipe diameter or more may be made without subsequent stress relieving.
  5. The bends shall be free of buckles, cracks, wrinkles, bulges and other visible defects.
  6. The following tolerances on bending shall be maintained -
  7. Cold bends to a radius of three (3) times the nominal pipe diameter or greater may be made without subsequent stress relieving. No cold bending is allowed on pipe larger than 50 mm nominal diameter. For good quality bends three (3) times the nominal pipe diameter bends shall be made subject to the approval of owner / Engineer-in-charge.
  8. The flattening at any cross section shall not exceed 8% and 3% of nominal outside diameter for internal and external pressure respectively. Similarly, reduction in wall thickness as measured by the difference between nominal thickness and minimum thickness shall not exceed 10% of nominal pipe thickness.

### 9. Welding

- (a) Welders and welding procedure shall be qualified in accordance with ASME Sec. IX qualification for overhead and/or vertical shall be shown on qualification papers.
- (b) Pipes up to 2 mm thick may be welded without any root gap. Pipes of wall thickness between 2 mm and 4.76 mm may be welded with a root gap of half the wall thickness and pipes above 4.76 mm thick shall be bevelled to get good weld penetration.
- (c) Welding shall be done only using inert gas shielded tungsten arc process. Metal arc welding using coated electrodes shall not be carried out.
- (d) All welding shall have full thickness penetration.
- (e) Tack welds lacking penetration shall be chipped out completely. Each weld shall be cleaned off all scale, slag and other matter, before subsequent welding is done. Use stainless steel chipping tools and wire brushes for cleaning.
- (f) Pipe shall be brushed with stainless steel wire brushes and then cleaned for a distance of at least 50 mm from the weld area using an acceptable Halogen free solvent. Filler material shall also be cleaned in the similar manner.
- (g) Permanently welded backing rings are not permitted.
- (h) Penning of welds shall not be done.
- (i) The completed welds shall be thoroughly cleaned and shall project 1.5 mm to 3 mm from



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the outer surface of the pipe.

- (j) Under cutting of pipe adjacent to finished weld shall not be carried out.
- (k) In order to get optimum benefit carbide precipitation has to be avoided. Also it is essential to retain the high strength resulting from cold work. It is, therefore, extremely important to control the temperature and duration of welding very effectively. By using purging and trailing gas in TIG welding and large current for extremely short periods of time in MMA (Manual Metal Arc) welding, the desired optimum results may be achieved.

### 10. Filler wires, and electrodes etc.

- (a) For stainless steel to stainless steel TIG welding, use Niobium stabilized Chromium Nickel corrosion resisting steel filler wires as per IS 2680 or equivalent. The product shall be from a reputed approved manufacturer.
- (b) For stainless steel to carbon steel welding and for MMA welding use 25/20 Chromium Nickel steel coated electrode in accordance with AWS-ER-309 or equivalent. The electrode shall be from a reputed manufacturer already approved.

### 11. Pickling of weld joints

- (a) All welded joints of stainless steel shall be free from any adhering weld spatter, slag, oxidation, swarf, dirt or any other foreign material. This can be achieved by brushing off or rubbing with emery paper so as to have a bright metallic surface.
- (b) All stainless steel weld joints shall be pickled. This pickling solution shall be made by mixing 45 parts by volume of hydrochloric acid ( $d = 1.19 \text{ gms/cc}$ ), 3.5 parts by volume of nitric acid ( $d = 1.4 \text{ gms/cc}$ ) and 51.1 parts of volume of water. This shall be applied on the discolored section for a period of about 1 minute. Suitable inhibitor (Hexaethylene tetramine) shall be used. For internals, pickling solution shall be circulated through a closed pumping system for period of about 5 minutes.
- (c) The pieces treated shall then be rinsed thoroughly with water. Last traces of pickling paste shall be neutralized by rinsing with water containing caustic soda (about 3 table spoon fulls of soda to 1 pint (0.5683 lit.) of water). The disposal of the effluent shall be done carefully and after ensuring that the same is neutral.

### 5.2 Painting

1. The Bidder shall properly paint CNG Compressor, piping and other accessories.
2. Compressor, piping & accessories shall be painted with heat resistant paint of approved make after sand blasting as per Sa 2 1/2. The Bidder shall furnish the details of paint to be applied on compressors and its accessories, priority panel and dispenser in technical offer.
3. The external steel surfaces of equipment and piping shall be painted as per The Bidder standard. The paint shall be chosen, primed and applied as to have a service life of ten years. The exterior of equipment and container is required to be corrosion free for ten years and to have fade free life without oxidation of paint surface for five years in an environment of bright sunlight with an intense UV content.
4. Name plate, moving parts of machinery, finned tube surfaces; v-belts sheave grooves and temporary shall not be painted.
5. The headers of air-cooled exchanger shall be epoxy painted.

All other un-machined exterior surfaces shall be given 2 coats of Zinc Chromate red oxide primer paint followed by 2 coats of superior quality synthetic enamel finish paint approved by Owner.





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### 6. Fire and Safety

- (a) This Specification gives requirements for fire extinguishers as per OISD 179.
- (b) All portable extinguishers shall be as per the specified Indian standard IS: 2190 code of practice – ‘Selection, installation and maintenance of fire extinguishers’ and amendments thereof or equivalent NFPA, BS EN standards.

Sr. No.	Type	Location	Quantity
1	75 kg, DCP Type, Trolley mounted as per IS10658	Near CNG Compressor	1 No.
2	10 kg, ABC DCP type as per IS 13849	Near Dispenser	1 with each dispenser
3	10 kg, ABC DCP type as per IS 13849	Storage Cascade & Compressor	2 No.
4	4.5 kg, CO2 type as per IS 2878	1 each in control room, transformer room and near compressor panel	3 Nos.
5	6 Nos. 16 gauge GI, Red coloured buckets filled with fine sand. The buckets shall be provided with MS bucket hanging on the dedicated Epoxy Powder coated (0.03 mm to 0.05 mm thick epoxy) MS stand with weather proof roof duly painted with red colour	Near the approach and exit of CNG station	2 sets

- (c) Bidder shall check/ Calibrate flame detector with UV torch or appropriate instruments.
- (d) Bidder shall calibrate the Gas detector with calibration GAS bottle or cylinder
- (e) Bidder shall carry out inspection & maintenance of fire extinguisher as per relevant standards and GGL AOMP (Annual Operation & Maintenance Plan)

### 7. General Specifications for Electrical Work

#### 7.1 Scope/ Introduction

1. This Specification gives the minimum requirements for electrical equipment and work to be carried out as part of scope of work. The Bidder shall be responsible for the provision of complete electrical work in accordance with the specifications and in compliance with applicable codes and standards.
2. All the materials shall comply with the local statutory regulation.
3. No CCOE approval/liaison shall be in the scope of Bidder for the CNG station layout. Only the documents/certificates of individual equipment such as cascade, dispenser, tubing piping and compressor package for the purpose shall be provided to the owner for getting the approval departmentally.
4. “DGMS” is not required in this work & for the construction and execution work.

#### 7.2 Applicable Codes, Standards and Statutory Requirements



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All equipment and services supplied shall comply with the latest revision of relevant Indian and international codes, standards and regulations. Particular reference shall be made as a minimum but not limited to the following:

IS 309	Plugs, socket-outlets and couplers for industrial purposes
IS 12615	Line operated three phase a.c. motors(IE code) Efficiency classes & performance specification
IS 694	PVC insulated cables for working voltages up to and including 1100V
IS 732	Code of practice for electrical wiring installations
IS 1231	Dimensions of three-phase foot mounted induction motors
IS 1271	Thermal evaluation and classification of electrical insulation.
IS 1293	Plugs and socket outlets of 250 watts and rated current up to 16 amps
IS 1554	PVC insulated (Heavy duty) electric cables
IS/IEC 60079-1	Explosive Atmospheres. Part-1 Equipment protection by flameproof enclosures "d"
IS 2223	Dimensions of flange mounted AC induction motors
IS 2253	Designation for types of construction and mounting arrangement of rotating electrical machines
IS 2968	Dimensions of slide rails for electric motors
IS 3043	Code of practice for Earthing
IS 3961	Recommended current ratings for cables
IS 4029	Guide for testing three phase induction motors
IS/IEC 60034-5	Degree of protection provided by enclosures for rotating electrical machinery
IS 4722	Rotating electrical machines
IS 4728	Terminal marking and direction of rotation for rotating electrical machinery
IS 4889	Method of determination of efficiency of rotating electrical machines
IS 5422	Turbine type generators
IS 16724	Explosive atmospheres - Electrical installations design, selection and erection
IS 5572	Classification of Hazardous areas (other than mines) having inflammable gases and vapours for electrical installation
IS/IEC 60079-11	Explosive atmospheres, Part 11: Equipment protection by intrinsic safety 'I'
IS 6362	Methods of cooling for rotating electrical machines
IS/IEC 60079-	Explosive atmospheres, Part 7: Equipment protection by increased safety'e'
IS 6665	Code of practice for industrial lighting
IS 7098	Crosslinked polyethylene insulated PVC sheathed cables
IS 7132	Guide for testing synchronous machines
IS 7389	Specification for pressurized enclosures of electrical equipment for use in Hazardous areas
IS 7689	Guide for the control of undesirable static electricity
IS 7816	Guide for testing insulation resistance of rotating machines
IS 8144	Multiple purpose dry batteries
IS 8223	Dimensions and output series for rotating electrical machines
IS 8270	Guide for preparation of diagrams, charts and tables for electrotechnology
IS 8623	Specification for low voltage switchgear and control gear assemblies



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IS 8789	Values of performance characteristics for three phase induction motors
IS 9537	Conduits for electrical installations
IS 9628	Three phase induction Motors with type of protection “n”
IS 9676	Reference ambient temperature for electrical equipment
IS 9814	Lead acid storage batteries for marine use
IS 9968	Elastomer insulated cables
IS 10118	Code of practice for selection, installation and maintenance of switchgear and control gear
IS 10810	Methods of test for cables
IS 10918	Vented type Nickel Cadmium batteries
IS 11955	Preferred current ratings
IS 12032	Graphical symbols for diagrams in the field of electrotechnology
IS 12065	Permissible limits of noise level for rotating electrical machines
IS 12075	Mechanical limits of vibration of rotating electrical machines
IS 12309	Code of practice for installation and maintenance of aerodrome lighting fittings
IS 12762	Photovoltaic devices
IS 12943	Brass glands for PVC cables
IS 13234	Guide for short circuit current calculation in three phase AC systems
IS/IEC 60079 : PART 0	General requirements for electrical apparatus explosive gas atmospheres
IS 13408	Explosive Atmospheres Part 0 Equipment — General Requirements
IS/IEC 60947	LV switchgear and control gear
IS14218	Sealed cylindrical type rechargeable Nickel Cadmium cells

5. Where there is no applicable Indian code or standard, codes or standards published by the following international organization shall be used:

6. International Electrical Commission (IEC)

IEC 60034	Rotating electrical machines
IEC 60072	Dimensions and output series for rotating electrical machines
IEC 600364	Electrical installations in buildings
API RP 540	Electrical installations in petroleum processing plants, 3rd ed., 1991.

### 7.3 Service Conditions

#### 7.3.1.Environmental

Equipment and materials shall be suitable for service under the environmental conditions given in the applicable data sheets and specification for site and utilities data of specific equipment specifications.

#### 7.3.2. Hazardous Areas

- Equipment installed in a hazardous area shall be for Class 1 Zone 1, Gas Group IIA, IIB. Temperature T6, unless otherwise detailed on specific data sheets or specifications.
- Equipment intended for hazardous areas shall conform to the requirements and be selected and installed in accordance with the Codes and Standards referenced herein the specification.



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3. Isolating devices for equipment located in hazardous areas shall switch all poles of the supply including the neutral.

### 7.4 General Design Requirements

1. Equipment shall be capable of meeting its rated output continuously at system voltage variation of  $\pm 10\%$  and frequency variation of  $\pm 3\%$ .
2. Voltage depressions to 85% of system voltage at consumer terminals during motor starting shall have no detrimental effect on equipment operation.
3. All equipment shall be designed to facilitate inspection, cleaning and maintenance with due care to safety in operation and personnel protection.
4. The rating and size of all electrical equipments and motor shall be designed based on minimum 10 % margin after considering all its (motor) design de-rating factors. The Bidder shall produce all the design calculations to owner and shall go ahead on execution of the work and procurement only after getting approval from owner.
5. All equipment shall run without undue vibration and within the noise level specification.
6. All equipment shall be designed to prevent the risk of accidental short-circuit or open circuit.
7. All materials shall be new and of good quality.
8. Electrical windings and apparatus subject to dust and moisture shall be suitable for the working conditions without distorting or deterioration, or the setting up of undue strain in any part that would affect the efficiency and reliability of the package unit.
9. Connections and all wiring shall be so arranged and/or protected to prevent them being damaged. Connections shall terminate at terminals of correct rating and size for the circuit and conductors.

### 7.5 Specifications for Electric Motors

#### 7.5.1. Starting

1. The allowed Maximum capacity of Motor in 650 SCMH (three stage) compressor shall be 90 KW (star delta), for 1700 SCMH (three stage) compressor shall be 235 KW (with VFD), for 1000 SCMH (three stage) Compressor shall be 132 KW (with VFD), for 400 SCMH compressor shall be 90 KW (with star delta) and for 1200 SCMH compressor shall be 160 KW with VFD.
2. Motors shall be capable of starting and accelerating the load with the applicable method of starting without exceeding permissible winding temperature, when the supply voltage is 85% of the rated motor voltage.
3. The motor design shall normally allow at least 3 starts in quick succession from cold against full load torque (motor coasting to rest in between starts) without injurious heating of the insulated windings. (Two consecutive starts shall be possible within 6 minutes after final steady working temperature. Further one additional (hot) start shall be possible after an



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interval of 30 minutes form the previous hot start.)

4. Motors shall be designed for restart under full load, after momentary loss of voltage and with possibility of restoration in few cycles. Supply voltage being 100% out of phase with motor residual voltage, motors shall be capable of withstanding transient torque's associated under such reaccelerating conditions.

### 7.5.2. Direction of Rotation

1. Motors shall be suitable for either direction of rotation except for 2-pole motors in frame sizes 280 and above, which may have unidirectional fans. In the latter case, the direction of rotation for which the motor is designed shall not be permanently indicated by means of an arrow. A painted arrow shall not be acceptable.
2. Normally, clockwise rotation is desired as observed at (facing) the driving (coupling) end when the terminals marked as per IS: 4728 are connected to a supply giving a terminal phase sequence corresponding to the alphabetical sequence of the terminal letters. (Counter-clockwise rotation of the motor shall be provided at the terminal box for interchanging any two external leads for obtaining the reverse phase sequence.)

### 7.5.3. Constructional Details

1. The rotor shall be of squirrel cage type, dynamically balanced to provide a low vibration level and a long service life for the bearings. The accepted values of peak to peak vibration amplitudes for a motor at rated voltage and speed on a machined surface bedplate with the motor levelled and with a half-key or coupling fitted shall not exceed those given in IS :12075.
2. Windings -insulation and bracing
3. Motors shall be provided with Class 'F' insulation with temperature rise limited to Class 'B'. The permissible temperature rise above the specified ambient temperature by thermometer method shall be limited to these specified in the applicable Indian standards for class 'B' insulation.
4. The windings shall be treated so as to resist the action of corrosive agents or substances (solids, liquids or gases) as may be present in the atmosphere of chemical, petrochemical and fertiliser plants which may tend to adversely affect the insulation. Sulphur vapour may be present in the atmosphere. The windings shall be tropicalised. The windings shall be suitably varnished, baked and treated with epoxy gel for operating satisfactory in humid and corrosive atmosphere.
5. The windings shall be adequately braced to prevent any relative movement during operation and, in this respect, particular attention is drawn to the stator windings of full voltage started squirrel cage motors insulation shall be provided between coils of different phases which lie together
6. In case of motors driving equipment with pulsating loads, special attention shall be paid to the joints of rotor bars and end rings to avoid failure due to induced fatigue stress.



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7. Phase connections.
  - (a) The windings shall preferably be connected in delta. However, for motors rated 1.5KW and below, star connection may be accepted.
  - (b) If star-delta starting is required, this will be specified in the data sheet and the motor windings shall be fully insulated for delta connection.
8. Winding terminations
  - (a) The ends of the windings shall be brought out into a terminal box. They shall be terminated by means of terminals mounted on an insulating base made of non-hygroscopic and nonflammable material.
  - (b) Preferably, all motors shall be with six terminals and suitable links to connect them in star or in delta. However, motors rated up to and including 2.2KW may be accepted with three terminals.
  - (c) The terminals shall be adequately designed and thoroughly insulated from the frame using material resistant to tracking.
9. Terminal box and cable entries
  - (a) The terminal box shall be located on the right hand side viewed from the driving (coupling) end. It shall be routable in steps of 90° to allow cable entry from any direction.
  - (b) The terminal box shall be of sturdy construction and large enough to facilitate easy connection of the cables.
  - (c) An adequately sized earth terminal shall be provided in the motor terminal box for termination of the fourth core of cables.
  - (d) The terminal box shall be provided with bolted terminals, cable lugs and entries for suitable cable glands corresponding to the number and size of specified cables. If specified in the requisition, nickel-plated brass (or aluminium if specifically required) double compression type cable glands shall be supplied along with the motor for the mentioned cable sizes.
  - (e) Equipment and accessories provided should conform to the area classification and the environmental conditions specified in the motor data sheet.
  - (f) The terminal box shall be capable of withstanding the full internal short-circuit conditions without danger to personnel or plant from the emission of hot gases or flame or due to excessive distortion or damage to the terminal enclosure. Unless otherwise specified, the fault level to be considered shall be 31 MVA for 415V System, (For motors rated below 55KW, the fault energy to be considered shall depend upon the back-up fuse rating).
  - (g) A separate terminal box shall be supplied for space heater as specified
10. Phase marking
  - (a) Appropriate phase markings as per IS: 4728 shall be provided inside the terminal box. The Markings shall be non-removable and indelible.

### 7.5.4. Motor Casing and Type of Enclosure

1. Motors for use in safe areas shall be normal industrial types meeting the specified ambient conditions and operating requirements. The minimum degree of motor enclosures, including terminal boxes and bearing housing, shall be IP-55 for outdoor duty motors.



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2. Motors for use in hazardous area (Zone 1 or Zone 2) shall have type of protection Ex (d) or ex (p) or Ex (e) or ex (n) as specified in the data sheet and shall meet the requirements of applicable Indian standards. The minimum degree of motor enclosure, including terminal boxes and bearing housings, shall be IP-55 as per IS/IEC 60034-5 for all motors, used in hazardous areas.
3. Motors for outdoor use shall be suitable for installation and satisfactory operation without any protective shelter or canopy. In case of manufacturer's view that the motors for outdoor duty should have a canopy at any particular site, the same shall be deemed to be included in manufacturer's scope of supply. Motor casing shall be provided with a suitable drain for removal any of condensed moisture.
4. Vertical motors with downward shaft shall be provided with fully covering rain canopies. Vertical motors with upward shaft, e.g. on fin-fan coolers, shall be adequately protected, (such as with cowls/canopies) against ingress of water into the enclosure or the bearing housing, even when standing still for long periods of time.
5. All internal and external metallic parts which can come into contact with cooling air, (piping, air supply and discharge conduit, protective grills, air deflectors, filters and supports) shall be of corrosion-resistant material or appropriately treated to resist the corrosive agents which may be present in the atmosphere. Screws and bolts shall be hot- dip galvanized or zinc passivated to protect against corrosion.
6. Unless otherwise agreed, industrial and non-sparking type Ex (n) motors shall have standard frame sizes for various output ratings as stipulated in IS:1231.
7. Acoustic enclosure should be fabricated in such that it is completely sealed so that gas or fire should not travel from one enclosure to another with two number L.E.L detectors and two UV detectors in each enclosure.

### 7.5.5. Bearings and lubrication

1. Motors shall have grease-lubricated ball or roller bearings. In all cases, the bearings shall be chosen to provide a minimum operating life of around 40,000 hours. Unless otherwise specified the bearing shall be adequate to absorb axial thrust in either direction produced by the motor itself or due to shaft expansion. Vertical motors shall be provided with thrust bearings suitable for the load imposed by the driven equipment. In cases such as pumps for hot liquids, the driven machine operates at high temperatures and the bearings, particularly of vertical motors, which are exposed to high temperature, shall be cooled by an impeller fan mounted on the shaft. This shall ensure efficient ventilation of the bearing and disperse the heat transmitted from the driven object by conduction or convection.
2. Bearings shall be capable of grease injection from outside without removal of covers with motors in the running condition. The bearing boxes shall be provided with required seals, to prevent loss of grease or entry of dust or moisture, where grease nipples are provided, these shall be associated, where necessary, with appropriately located relief devices which ensure passage of grease through the bearing. Pre-lubricated sealed bearings will be considered provided a full guarantee can be given for 4 to 5 years trouble-free service without the necessity of re-lubrication.

### 7.5.6. Cooling system

1. All motors shall be self ventilated, fan cooled. The fans shall be of bronze, brass, aluminium,





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mild steel, stainless steel or of plastic. Plastic fans shall be “antistatic” type. i.e. they shall not permit the accumulation of electric charge on the fan surface. Brass or bronze fans shall not be used for motors installed in fertiliser plants. In all cases fans shall be corrosion-resistant or appropriately protected against corrosion. They shall be suitable for rotation in either direction without affecting the performance of the motor. If this is not possible for large outputs, it shall be possible to reverse the fan without affecting the balancing of the motor.

2. Motors for installation in dusty atmospheres or in the presence of sand, fuel or other solid particles in suspension in the air, shall be fitted with filters for the cooling air. The filters shall be easily accessible for inspection and removable for cleaning and re-use.
3. The material of the filter and support trays shall be rustproof or protected against oxidation or corrosion.

### 7.5.7. Other requirements

1. Anti-condensation heaters
  - (a) All motors rated above 75KW shall be provided with 240V anti-condensation heaters, sized and located so as to prevent condensation of moisture during shutdown periods. Motors rated below 15KW may be provided with anti-condensation heaters, if specified in the requisition. Motors meant for humid locations such as cooling tower fans, sump pump, etc. shall be provided with space heaters irrespective of the motor rating. The heaters shall permanently remain ‘ON’ when the motor is not in service and as such shall not cause damage to the windings.
  - (b) For motors installed in hazardous atmospheres (Zone 1 or Zone 2) such heaters shall conform to the provision of applicable Indian standards and temp. Classification specified in the data sheet.
  - (c) The heater leads shall be brought out to a separate terminal box of the same specification and grade of protection as the main power terminal box excepting that the cable glands provided shall be suitable for three core 2.5 Sq.mm. copper conductor, armoured cable.
2. Motors shall be provided with a single shaft extension with keyway and full key.
3. All motors above 25Kg of weight shall be provided with lifting hooks of adequate capacity to facilitate safe lifting.
4. Two earth terminals located preferably on diametrically opposite points shall be providing for each motor. Necessary nuts and spring washers shall be provided for earth connection.
5. A warning with indelible red inscription shall be provided on the motor to indicate that isolation of the power line alone is not sufficient and that the heater supply should also be isolated before carrying out any work on the motor.
6. Fixing Bolts: All motors shall be supplied with fixing bolts.
7. Special tools and spanners
  - (a) Each motor shall be provided with a set of spanners and special tools, required for dismantling and maintenance of the motor.
  - (b) Triangular spanners required for explosion-proof or increased safety motors are





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considered as special tools.

8. A name plate as required under specification IS: 12615 shall be provided on each motor in addition to the motor rating plate A separate motor plant equipment number plate shall be fixed in readily visible position. This number is indicated on the attached data sheets. Additional information as stipulated in applicable Indian standards shall be included in the nameplate for motors meant for use in hazardous atmospheres.
9. The permissible noise level shall not exceed the stipulations laid down in IS: 12065.
10. Motor vibrations shall be within the limits of IS: 12075 unless otherwise specified for the driven equipment.
11. Bearing and Winding temp. of Main motor, sensor to be integrated with PLC and it shall trip the compressor after the set point is reached. This requirement will not be applicable for flameproof motor enclosure. However, Bidder to ensure that all the requirement mentioned in the Statutory Regulations and relevant Standards are complied.
12. Internal and external parts of the casing and all metal parts likely to come in contact with the surrounding air shall be protected with anti-acid paint that will resist the particular ambient condition. All external surfaces shall be given a coat of epoxy based paint.

### 7.5.8. Performance

1. The pull out torque at the rated voltage shall be not less than 175% of the rated load torque with no negative tolerance. In the case of motors driving equipment with pulsating loads (e.g. reciprocating compressors) the minimum value of pull out torque at 80% of the rated voltage shall be more than the peak value of the pulsating torque. Unless otherwise agreed, the pull out torque shall not exceed 300 % of the rated load torque.
2. All the motors shall be meet efficiency class IE3 IS 12615:2011 and IEC 60034-30:2008 as minimum.

### 7.5.9. Drawings and Data

1. Minimum information shall be furnished along with the bid as per enclosed datasheet duly certified by the manufacturer.

Subsequent to completion of satisfactory inspection and testing, duly signed Test Certificates and installation, operation and maintenance manuals shall be furnished by the Bidder to complete the contractual obligations.

### 7.5.10. Data Sheet for Induction Motor

1	Type	TEFC-Sqr. cage Induction Motor of Flameproof construction
2	HP/KW Rating	* KW(for 1200 sm <sup>3</sup> /hr )
		* KW (for 650 sm <sup>3</sup> /hr )
		* KW (for 1000 sm <sup>3</sup> /hr)
		* KW (for 400 sm <sup>3</sup> /hr)
		* KW (for 1700 sm <sup>3</sup> /hr)
		* KW (for 1000 sm <sup>3</sup> /hr)-VIP
3	Frame Size	Bidder to furnish



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4	Voltage rating & acceptable tolerance limit	415 V $\pm$ 10 %
5	Frequency & acceptable tolerance limit	50 Hz $\pm$ 3 %
6	No. of poles	Bidder to furnish
7	Full load speed	1500/1475
8	Insulation Class	F with temp. rise as per B
9	Type of rotor	Squirrel Cage
10	Type of starting	VFD for 1200 sm <sup>3</sup> /hr
		VFD for 1700 sm <sup>3</sup> /hr
		VFD for 1000 sm <sup>3</sup> /hr
		VFD for 100 sm <sup>3</sup> /hr- VIP
		Star –delta for 650 sm <sup>3</sup> /hr
		Star –delta for 400 sm <sup>3</sup> /hr
11	Space heater rating	Bidder to furnish.
12	Type of duty	Continuous
13	Type of enclosure	TEFC
14	Class of protection	IP 65/IP55
15	Type of mounting	Foot Mounted
16	Starting torque	Bidder to furnish
17	Pull out torque at rated voltage	Bidder to furnish
18	Efficiency	
	- At 100% load	Bidder to furnish
	- At 75% load	Bidder to furnish
	- At 50% load	Bidder to furnish
19	Power Factor	
	- At 100% load	Bidder to furnish
	- At 75% load	Bidder to furnish
	- At 50% load	Bidder to furnish
20	Type of winding connection	Delta Connected
21	Type of Cooling	Air Cooled
22	Noise level in dB	85-90 dB(A) in open
23	Dimension ( L X W X H)	Bidder to furnish
24	Weight	Bidder to furnish

### 7.6 Specification for Control Equipment (Panel Board)

1. Unless otherwise specified, motor starters will be located in motor control centres / control panels provided by the Bidder. These starters will accept inputs from field control stations and protective devices and provide supplies to anti-condensation heaters located in the packaged equipment. They will also provide signals back to the Purchasers Control System and Safety System.
2. Bidder shall consider standard control scheme which incorporates start stop and trip operations of soft-starter, local & remote operation, auto and manual selection mode, indication of various mode like 'ON' 'OFF' 'TRIP' etc. and trip conditions of the starter. Proposed control method shall be submitted to Owner for approval before implementation.



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3. The supply of all auxiliary control equipment located within and on the package unit together with interconnecting cable shall be the responsibility of the Bidder.
4. The enclosure shall be of flameproof type, made of cast aluminium alloy (LM6) and suitable for indoor/outdoor installation as indicated in the schedule of quantities.
5. The panel shall have external fixing lugs and shall be suitable for mounting on vertical face such as wall / column or steel pedestal.
6. All outgoing feeders shall be provided with adequately rated MCCB / ACB. In no case the SFU shall be used.
7. The VFD (Variable Frequency Drive) shall be provided for the motor of 1700, 1000 and 1200 SCM/H compressor. The VFD panel shall be placed in the electrical panel room. All cables between the VFD panel and compressor package shall be provided by the Bidder. All cables shall be FRLS, armoured type as per the specification stated elsewhere in the tender.
8. The Bidder shall clearly identify by diagrams and schedules:
  - (a) Interfaces between package equipment to be supplied by the Bidder and that to be supplied by the 'owner' including any interconnecting cable.
  - (b) Circuits, equipment and utilities, which the Bidder requires to be supplied by the Owner in order to provide a fully integrated and operating unit.
9. When push button enclosures, isolators, air circuit breakers (ACB) / moulded case circuit breakers (MCCB) or electrical trace heating circuits are to be supplied by the Bidder then they shall comply with the following requirements:
  - (a) Start/stop push buttons or emergency stop push buttons shall be certified for hazardous area operation if applicable
  - (b) Emergency stop push buttons shall lock themselves in the 'stop' position when pressed and shall be protected to prevent their accidental operation. Padlocking facilities in the 'OFF' position shall be provided.
  - (c) If emergency switch is on, all the output from the compressors such as low, medium, high, direct and Mobile and dispenser shall be shut off.
  - (d) Minimum 02 numbers emergency switch to be provided at non-hazardous area that is easily accessible for any of the user at the time of emergency. Additionally, 1 No. of ESD on the compressor panel to be provided.
  - (e) All isolators shall be rated for load break duty. Isolators in motor circuits shall be rated to interrupt the stalled motor current. Off-load isolators shall not be used.
  - (f) ACBs / MCCBs shall be rated for the system voltage, current and fault level, they shall be trip free and have positive indication of contact position.
  - (g) Electrical trace heating circuits located in hazardous areas shall be fitted with residual current protection devices (e.g. earth leakage circuit breakers).
10. All control wiring terminals and components shall be clearly labelled with the item number or



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designation and must be easily identifiable with those shown on the drawings.

11. All terminal blocks, connectors and wires shall be numbered and identified with core markers.
12. The bus bars receiving the incoming supply and outgoing feeder elements shall be housed in separate compartments. The separation between the compartments should be such that no flame propagation is possible.
13. Incomer circuit shall have mechanical ON/OFF indication and facility for padlocking the operating handle in off position. A flameproof cable gland for the incoming cable shall be provided suitable for the incoming cable size. Crimping type lugs shall be provided for incoming cable.
14. Bus bars shall be made of high conductivity copper or aluminium and supported by non-hygroscopic insulators. Individual compartments shall have separate inspection covers secured by screws/ bolts requiring special tools for opening.
15. All outgoing circuit shall also have ON / OFF indicators.
16. Terminals shall be provided in an independent compartment for connection of outgoing cables. Terminals should be anti-loosening type and suitable for 2.5 / 4 / 6 sq.mm. Copper conductor or of size. In addition to the required terminals for each outgoing circuit, provision shall be made for connection of an extra core of the outgoing cable to be used for earthing. Power terminals shall be suitable for ring type crimping lug. All the cables shall be FRLS type.
17. Flameproof cable glands shall be suitable for cable size as indicated in schedule of quantities. Flameproof threaded plug to block unused cable entry shall also be provided as specified in schedule of quantities. All cable entries (Incoming and outgoing) shall be so designed, that no water enters the enclosure when panels are installed outdoors, and if this can-not be met all the entries should be necessarily from the bottom.
18. Caution plates shall be provided on the inspection covers warning against opening without isolation. Nameplates shall be provided for each outgoing circuit and for the complete panel indicating circuit number and panel number. All nameplates shall be fixed by screws and shall be made from laminated plastic with white letters on black background.
19. The panel shall be painted with epoxy type, acid / alkali resistant paint, while hardware shall be zinc passivated / electro galvanised.
20. The supply of the panel shall be complete with all components and devices required for full and proper operation of the equipment even though such component or devices may not be stated in detail in this specification. Two sets of complete set of special tools for opening / closing of enclosure bolts, screws, shall also be supplied with the panel.
21. Copies of certificates from the certifying agencies shall be furnished for all the equipment used in hazardous areas. Necessary approvals from CCOE, DGMS as applicable shall be obtained by the Bidder for all equipment installed in hazardous areas.
22. All non-current-carrying metallic parts of the panel shall be inherently bonded together. Two 10mm dia. studs should be provided on the main housing for external earthing connection. Earthing terminals for outgoing circuits should also be bonded to main housing.



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23. All PLC, elec. Instruments shall be isolated from the panel body with proper isolator material, isolation of body earthing between instrument earthing, same to be demonstrated and ensured during FAT and one of the check point of QAP.
24. The minimum protection required in electrical panel shall be under voltage, over voltage, phase reversal, over current, short circuit and earth fault etc.

### 7.7 Specification for Soft Starter:

1. The VFD should have up sized one size of the compressor motor power ratings.
2. The VFD should have various safety trips like :

<b>Undercurrent</b>	Trips when line current drops below the preset level for the preset time.
<b>Undervoltage</b>	Trips when line voltage drops below the preset level for the preset time.
<b>Overvoltage</b>	Trips when line voltage increases above a preset level for a preset time
<b>Phase loss</b>	Trips if 1 or 2 phases are lost
<b>Frequency loss</b>	Trips if frequency is not in the range of 40-66.6Hz
<b>Phase sequence</b>	Trips if line phase sequence is wrong
<b>Slow speed time</b>	Trips when operating at slow speed for extended periods
<b>Wrong connection</b>	Trips the Soft starter when one or more motor phases is not properly connected to soft starter's load terminals or if there is an internal disconnection in the motor winding
<b>Over temperature</b>	Heat-sink over-temperature. Trips the Soft starter when the heat-sink temperature rises above 85°C
<b>Earth Fault / Earth Leak</b>	Alarm/ Trip for earth fault protection / earth leak detection in motor

### 7.8 Equipment Enclosures

1. Equipment Enclosures shall be of heavy-duty construction and shall provide the following minimum degrees of ingress protection.

enclosed indoor locations -	IP 42
open outdoor locations	IP 56
electric motor frame -	IP 65
Electric motor terminal box -	IP 65

2. With enclosures open, all live parts shall be shrouded as a minimum to IP21.
3. If applicable, as the fire water system uses hydrants and monitors, all equipment, other than inside dry enclosed buildings, shall be designed to tolerate this without detrimental effect
4. If applicable, cable entry to enclosures shall be via removable gland plates, where enclosures are certified Exd then entries shall be drilled and tapped with a suitable ISO metric threaded entry.

### 7.9 Cabling and Wiring

1. The Bidder shall provide all inter-connecting wiring and cabling within the packaged unit or equipment skid.



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2. When a package contains a number of small power consumers, the Bidder shall provide a distribution board / control panel complete with circuit breakers, starters, earth and neutral bars. etc., of a type approved by the Owner and provide all the distribution feeders required so that only a single power supply cable need be connected to the package panel.
3. Interface cables connecting the packaged equipment to other plant equipment supplied by owner shall be supplied and installed by others.
4. The Bidder shall supply all cable size details for the approval of the Owner.
5. Top entry of cables or conduits into enclosures or equipment will not be accepted without prior approval.
6. Low voltage electrical wiring shall have multi-stranded copper conductors, 1.1 kV grade PVC insulation with round wire armouring and extruded PVC inner and FRLS outer sheaths with the marking of batch number.
7. All cables provided by the Bidder shall employ constructions utilizing galvanized steel wire armour and shall be routed and installed with due regard to minimizing the hazards associated with mechanical, heat, oil, and chemical and fire damage.
8. Control, instrumentation and power circuits shall be terminated in separate junction boxes for connection to the external cables. Motor circuits shall generally be wired direct to the motors. The position of junction boxes shall be agreed with the Owner before construction.
9. Minimum cable bending radius as recommended by the cable manufacturer shall be strictly adhered to.
10. All cables shall be identified by means of a unique cable number. The Bidder may use his standard numbering system within the package. Cable numbers shall be fixed to all cables, immediately adjacent to glands, using a corrosion and ultra violet resistant proprietary system (Grafoplast or Owner approved equivalent).
11. All internal junction box, enclosure or panel wiring shall be clearly identified by means of permanent core identification markers Grafoplast or Owner approved equivalent
12. Circuits and terminals, which operate at different voltages and those that perform different functions, shall be physically segregated.
13. Terminals associated with external sources of supply shall be fully shrouded and shall carry a label warning personnel to isolate the supply at source before commencing work.
14. Cables will be terminated into enclosures using mechanical type compression glands.
15. The Bidder shall provide cable glands of a type specified by the Owner and terminate all cables within the scope of the Package Equipment
16. All glands shall be made of brass and soft sealing washers or approved sealant (as applicable) to maintain the integrity of the enclosure and to provide a degree of protection depending on type of enclosure.
17. Gland entries into enclosures made through clearance holes must be retained with two back



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nuts and shall include a neoprene or equivalent sealing washer on the gland body side of the entry into the enclosure. Where sealing washers are used in conjunction with external earth tags, the washer shall be placed between the earth tag and the enclosure.

18. Where required all bonding between glands shall be carried out internally (i.e. inside the enclosure) by means of earth-tag washers or bonding plates. Gland plates shall be separately earthed to the enclosure earth stud. All glands and end plugs shall be PESO approved type only.
19. Where the Owner or "others" are to supply cables and glands, the Bidder shall provide tapped ISO metric entries in the cable box or a removable un-drilled gland plate for drilling by others. Undrilled gland plates shall be suitably marked to facilitate correct line up with cables and terminal lug bolt or stud centres. Gland plates for single core power cables shall be non-magnetic.

### 7.10 Earthing

1. Earthing shall be carried out as per IS Code of Practice: 3043 and as shown in the relevant drawings
2. Minimum two M10 sizes earthing bosses, one at each end of the package unit, shall be provided.
3. All electrical equipment on the package unit shall be electrically bonded to the package unit skid. Compressor motor frame also shall be connected at different two point of earth grid.
4. Junction boxes, control units etc., shall be provided with an internal and external earth terminal, complete with locknut and washers. All non-conducting enclosures shall have an integral earth continuity system.
5. All metallic non-current carrying parts shall be made electrically continuous with the package unit skid, by welding or bolting, using bonding straps and/or star washers or equal to ensure good conductivity across paint layers and bolted joints.
6. Earthing and bonding conductors shall be adequately current rated for the duty and shall be a minimum size of 4 sq.mm for connections inside equipment and 16 sq.mm for external connections. Insulated Earthing cables shall be coloured green with yellow stripe.
7. Metallic part of all equipment not intended to be live shall be connected to earth as per provisions of IS: 3043/IEC recommendation. Grounding of all electronics shall be separately connected to earth using insulated copper wire. Grounding of electronic equipment shall not be connected to earthing for electrics or equi-potential bonding. Separate earthpit shall be provided for electronics / instrumentation
8. Bidder shall make the dual earthing point at single location and integral body earthing shall be done at their works.

### 7.11 Lighting

1. All exterior lighting and general area lighting shall be supplied and installed by the Owner.
2. Lighting within Bidder's enclosures, required for operation and maintenance of equipment shall be designed and installed in accordance with the requirements by the Bidder.





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### 7.12 Nameplates

All items of electrical equipment within the package shall have non-corrosive nameplates. Nameplate details shall be subject to approval by the Owner. Equipment nameplates shall be inscribed with the equipment number where appropriate.

### 7.13 Inspection and Testing

1. The Bidder shall carry out a string test to fully test the electrical operation of the package as a composite unit. If certain items, not forming part of the package, are necessary to carry out the string test then the Bidder shall provide simulated voltage references, signals, inter tripping and activating supplies as necessary.
2. All electrical equipment on packages shall have either documentation to show that type tests to the relevant Standards have been successfully completed or the Bidder shall perform these tests.
3. Mechanical string test procedure shall be submitted by the bidder during detail engineering for GGL approval.
4. The specific test procedures of key items shall be as follows.

#### i. Motors

1. Tests on the completely assembled motor shall be carried out in the presence of owner or his representative. The results shall be tabulated and signed by both Bidder and owner or their representatives. Though the motors shall be accepted on the basis of the satisfactory results of the tests at the works, it shall not absolve the Bidder from liability regarding the proper functioning of motor coupled to the driven equipment at site.
2. General Inspection
  - (a) Check for installation according to drawings.
  - (b) Check equipment for clean and dry conditions, proper lubrication of bearings, earthing and terminations.
3. The motors shall be tested in accordance with IS:12615 and IS:4029.
4. Before connecting power cables to motor, the insulation resistance of all motor windings shall be measured with 500 Volts megger for 415 Volts systems and with 5 KV megger for H.V system. Minimum megger reading shall be 10 Mega ohms. Measurements shall be repeated after power cable terminations are completed.
5. After checking the direction of rotation, all motors shall be run uncoupled for a minimum period of 4 hours before the driven equipment is placed in regular service.
6. Do not energise motors that are coupled to equipment without approval of Engineer-in-charge.

#### ii. Medium Voltage Switchgear / Control Panel

1. Following routine tests shall be carried out and test certificates shall be furnished.
  - (a) Visual inspection and dimensional check-up.
  - (b) High voltage test.





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- (c) clearance checking.
2. Before switchgear is energised, the insulation resistance of each bus shall be measured from phase to phase and from phase to earth. Measurements shall be repeated with circuit breakers in operating position and contacts open. Each test shall be held until constant reading is obtained. Minimum time shall be ten seconds. Minimum megger reading shall be 10 Mega ohms.
  3. Before switchgear is energised, the insulation resistance of all D.C. control circuits shall be measured from phase to earth. Minimum acceptable value shall be 1 Mega ohm.
  4. Each adjustable protective relay shall be set, calibrated and tested by using a cycle counter, load box, ammeter and voltmeter as required or by using a suitable relay test set having good wave form. Settings, calibration points and test points shall be in accordance with values given for the approved relay settings for the job.
  5. Test all current transformer secondary circuit by applying current (thro secondary injection test) to transformer secondary windings and verifying that relay(s) and/or meter(s) operate properly.
  6. Test all the relevant circuit breakers for proper interlocking operation. The sequence of interlocking is as indicated on single line diagram.
  7. The following tests shall be performed on all circuit breakers before they are operated:-
    - (a) Contact alignment shall be checked and adjusted where necessary in accordance with manufacturer's instructions.
    - (b) All adjustable direct acting trip devices shall be set using values given in the approved relay settings for the job.
  8. Before switchgear is energised, the following tests shall be performed on each circuit breaker in its 'test' position:-
    - (a) Close and trip circuit breaker from its control switch, push button or operating handle.
    - (b) Test operation of circuit breaker latch and check switch, where provided.
    - (c) Test proper operation of lockout device in the closing circuit, where provided, by simulating conditions, which would cause a lockout to occur.
    - (d) Trip breaker by manual operation or by applying current or voltage to each of its associated protective relays.
    - (e) All automatic control operations and interlocks shall be tested for correct operation.
  9. After completion of tests, all test results shall be recorded in standard format approved by Engineer-in-charge, witnessing site engineer and Bidder's representative.
  10. All test reports shall indicate the details of the instruments used for test with date and time of test.



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11. After commissioning of the equipments, all measuring and indicating instruments to be checked properly for operation. Any improper operation of these indicating lamps / instruments shall be corrected by checking fuse / connections, polarity, etc. If still these are found to be not in working condition, the Bidder should report the same to the Engineer-in-charge for suitable action for replacement.
12. Two copies of routine test certificates including of Chief Inspector of Explosives / IS certificate shall be furnished before dispatch.

### iii. L.T. Cable

1. A megger test shall be made for continuity and proper end-to-end connection and correct termination after installation, on all feeder cables including motor feeder cables.
2. Record test data between phase to phase and phase to earth.
3. The test voltage, duration of test and test procedure shall be in accordance with IS : 4288.

### iv. Earthing

1. Check that earthing system is installed as per drawings.
2. Check that all connections are tight and connections are protected from mechanical injury.
3. The resistance to ground shall be measured at the following locations:
  - (a) The resistance of the system/neutral earthing should be maintained preferably at less than 5 Ohms.
  - (b) At each earthing point provided for lightning protection, the earth resistance shall preferably not exceed 5 Ohms.
  - (c) At any one point of each system used to provide earthing to electrical equipment enclosures, resistance shall not preferably exceed 5 Ohms.
  - (d) Measurements shall be done before connection is made between the earth and the object to be earthed.

## 8. Specification of Instrumentation

### 8.1. General Requirements

1. Bidder shall be fully responsible for design, material selection, sizing and selection of the proper instruments for their system. The compliance to this specification does not absolve the Bidder of the responsibility towards contractual obligations with regards to completeness, proper selection, satisfactory operation and easy maintenance of unit.
2. All instrument supplied shall be of field proven quality both with respect to design and materials. Prototype instruments of an experimental nature shall not be offered or supplied.
3. No instrument requiring special maintenance or operating facilities shall be offered or supplied as far as possible.
4. In the event of any contradiction between this specification, data sheets, related standards, codes etc. the Bidder shall refer the matter to the owner for clarification and only after



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obtaining the same, Bidder shall proceed with the manufacture/engineering of the item in a question.

### 8.2. Applicable National / International Standards

1	Design and terminology shall be comply, as a minimum, with the latest edition prior to the date of owner's enquiry of following codes, standard practices and publications :	
2	<b>American Gas Association. Gas Measurement Committee</b>	
	Report No. 3	National Gas Measurement – Orifice Meterin
	Report No. 7	Measurement of gas by turbine meters
	Report No. 11	National Gas Measurement
3	<b>American National Standards Institute/American Society of Mechanical Engineers - ANSI/ASME:</b>	
	B 1.20.1	Pipe Threads.
	B 16.5	Steel Pipe Flanges and Flanged Fittings.
	B 16.20	Ring Joint Gaskets and grooves for Steel Pipe Flanges.
4	<b>American National Standards Institute/Fluid Control Institute - ANSI/FCI</b>	
	70.2	Control Valve seat leakage classification.
5	<b>American Petroleum Institute - API</b>	
	RP 520	Sizing, selection and Installation of Pressure Relieving System
	RP 521	Guide for Pressure Relief & De-pressurising Systems.
	RP 526	Flanged Steel safety Valves.
	RP 527	Commercial Seat Tightness of Safety Relief Valves with Metal-to-Metal Seat.
	RP 550	Manual on Installation of Refinery Instruments and Control System.
	S 1101	Measurement of Petroleum Liquid Hydrocarbon by Positive Displacement Meter.
	S 2000	Venting Atmosphere and Low Pressure Storage Tank.
	S 2534	Measurement of Liquid Hydrocarbon by Turbine Meter.
	ASME	American Society of Mechanical Engineers
	ASTM	American Society for Testing and Materials
6	<b>European Standards</b>	
	BS-1042	Measurement of Liquid Flow in Pipes.
	BS 5308 Part II	Specification for PVC insulated cables
	BS 7244	Breather Valves
	DIN 43760	Temperature Vs. Resistance Curves for RTDs.
	DIN 19234	Electrical Distance Sensors : DC interface for Distance Sensor and Signal Converter
	DIN 50049	Document on Material Testing
	DIN	PN sizes indicates Steel Pipe Flange Standards.
7	<b>International Electro-technical Commission.</b>	
	IEC 79	Electrical Apparatus for Explosive Gas atmosphere
	IEC 85	Thermal Evaluation and Classification of Electrical Insulation



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	IEC 332	Part III Cat A Test on bunched wires or cables
	IEC 529	Classification of degree of protection provided by enclosures.
	IEC 534-2	Industrial Process Control Valve-Flow Capacity
	IEC 584-2	Thermocouples - Tolerances
	IEC 751	Industrial Platinum Resistance Thermometer Sensors.
8	<b>Indian Standard</b>	
	IS 1271	Thermal Evaluation and Classification of Electrical Insulation
	IS 1554 Part I	PVS insulated (Heavy duty) electric cables-working voltage up to and including 1100 V
	IS 2147	Standard dealing with Weather proof Enclosures.
	IS/IEC 60079-1	Flameproof enclosures for electrical apparatus.
	IS 3624	Specification for Pressure & Vacuum Gauges
	IS 5831	PVC Insulation and sheath of electric cables.
	IS 7358	Specification for thermocouples.
	IS 8784	Thermocouple compensating cables.
9	<b>Instrument Society of America - ISA</b>	
	S.5.2	Standard for Ladder/Logic Diagram
	S-7.3	Quality standard for Instrument Air
	S-75.01	Flow equation for sizing of control valves.
10	NACE	<b>National Association of Corrosion Engineers</b>
11	NEC	<b>National Electric Code</b>
12	NEMA	<b>National Electrical Manufacturers' Association</b>
13	ICS 6	<b>Enclosures for Industrial Controls and Systems.</b>
14	NFPA	<b>National Fire Protection Association</b>
15	496	<b>Purged &amp; pressurised Enclosures for Electrical Equipment</b>
16	ISA 75.01	<b>Control valve Sizing</b>
17	SAMA	<b>Scientific Apparatus Manufacturers' Association</b>

### 8.3. Documents and Drawings During Detailed Engineering

The Bidder shall clearly define the operational philosophy suggested by them, which shall be in line with requirements specified in the job specifications. The Bidder shall also clearly indicate in their offer the provision of control panels, and control systems required for their package.

1. Bidder shall furnish the following information along with their offer:

- (a) Complete Scope of work.
- (b) Specification of Control Panel and Control System.
- (c) Configuration diagram for all programmable / configurable control system like Programmable Logic Controller (PLC).
- (d) Utility requirement like Power consumption
- (e) Sub Vendor List.
- (f) Information like Instrument list and typical specification if supplied by Bidder in their bid,



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shall be retained for information only. All such details shall be submitted only after the finalization of P&ID (Piping and Instrument Diagram). No implication shall be admissible on the basis of these documents.

- (g) Bidder shall enclose catalogues giving detailed technical specifications and other information for Control System and other special instruments.

### 8.4. Drawing and Document after Award of Work

1. Instrument index
2. Sub vendor list (for Instruments and Accessories) : This Document shall list out all instrument items and accessories including control system along with the name of the sub-vendors from whom the Bidder is likely to procure these items.
3. Instrument sizing calculation:
  - (a) Utility consumption calculation including power supply (UPS/Non UPS) etc.
  - (b) Cable calculations/ Sizes for Power cables.
4. Utility requirements
  - (a) This document shall list out the following information regarding utilities required by the Bidder
  - (b) List of utilities required i.e. Power (UPS, Non UPS), Nitrogen, etc.
  - (c) Location and estimated / actual requirement at each location.
5. Level sketches: Level sketches shall represent the nozzle elevation, nozzle sizes and rating, requirement of stand-pipe, type of level instrument etc. for all the vessels, columns, exchangers and tanks.
6. Material specification
  - (a) Material Specification shall contain all those information's which are necessary for a sub-vendor / vendors to submit their most competent offer. Separate MR shall be prepared for each item. Material requisition shall contain the following information, as a minimum.
  - (b) Instruments specifications including detailed instrument data sheet and special requirements, if any.
  - (c) Testing and Inspection requirements.
  - (d) Vendor data requirements.
  - (e) Other related documents like Standard Specifications, Quality Assurance requirement, etc.
7. Logic diagrams: Logic diagram is a logic representation of process interlock and shutdown system and details out the functionality in a schematic form, as either process cause and effect table shown on the P&ID or in a separate write-up. The schematic shall also be



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supplemented with operational requirements like start-up and process bypasses, reset and shut down push buttons, selector switches, status lamp etc.

8. Instrument Loop Drawings : Each loop shall have a separate Instrument Loop drawing which shall show each component from field device to final receiver including physical location; initiating device, its terminal number, junction box with its terminal number; cable number with pair number/polarity; receiver instrument terminals/cabinet terminals; system functional blocks of loop in simplified manner (without configuration details).
9. Panel Front Arrangement: This drawing shall show the arrangement of Panel mounted instruments like indicating instruments, alarm enunciator, indicating lamps, push buttons/switches etc. including their approximate sizes and their mounting locations.
10. Configuration Diagram: This drawing is a graphical representation of all major hardware required in a configurable control system which are necessary to meet all the expected functional requirements.
11. Input/ Output Assignment: This document shall indicate the physical assignment of various I/O modules and their respective channels to various physical inputs and outputs.
12. Instrument Tray/Trench Layout: Instrument tray layout drawing shall show the routing of main instrument tray layout in the CNG Station. The drawing shall be prepared on plot-plan and shall show the size, cross-section at various locations, general notes, symbols, reference drawings and the control room entry.
13. Instrument Cable Schedule: The instrument cable schedule shall show all instrument and power cables required for complete instrumentation. The document shall show tag number, cable number, type, length and size of cables, type of junction box, identity of local panel, etc.

### 8.5. Compressor Instrumentation

1. Compressor Bidder shall be fully responsible for providing adequate instrumentation for safe and efficient operation of the machine. The commonly used instruments are being detailed out in the following clauses, however this does not absolve the Bidder of providing additional instrumentation, if required.
2. Bidder shall supply all hardware and software related to the operation and safety of the compressor.
3. Vibration and Axial Displacement Monitoring including Vibration transmitter shall be provided to trip the compressor in case of high vibration.
4. Vibration and axial displacement monitoring system shall be based on non-contacting type sensing probe, unless otherwise specified. Vibration transmitter shall be provided to trip the compressor in case of high vibration. Bidder shall be responsible for performance of compressor as per tender requirement and if the compressor do not deliver/ perform, bidder shall change/ replace full or partial at bidder cost after installation/ during operation.
5. Vibration and displacement monitoring system shall be as per API-670. The extent and type of monitoring shall be as defined elsewhere. However, Bidder shall furnish any additional requirements for monitoring deemed essential by them with reasons. Two probes at 90 degree apart for each location shall be provided and connected to same dual channel monitor



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for vibration monitoring. However, Bidder can provide Vibration transmitter and mounting requirement as per manufacturer standard. Bidder shall be responsible for performance of compressor as per tender requirement and if the compressor do not deliver/ perform, bidder shall change/ replace full or partial at bidder cost after installation/ during operation.

6. Bidder shall provide continuous 4-20 mA dc isolated output for each channel of measurement for remote indication and potential free contacts for alarm/shutdown setting from the monitors.
7. The compressor loading-unloading scheme for reciprocating compressors shall be provided as per the minimum requirements specified in the job specifications. Manual as well as automatic schemes shall be provided.
8. Emergency switch shall be provided in the isolated room / office. All such switches shall have a protective cover to avoid inadvertent shutdown.
9. Bidder shall provide the following common alarms for owner:
  - Common machine pre-trip alarm.
  - Common machine trip alarm.

### 8.6. Electrical Power for Instrumentation

The Owner shall supply 230 VAC, 50 Hz  $\pm 3\%$  electrical power for instrumentation through UPS at the incomer of the panel supplied by the Bidder. All further distribution of electric power including provision of arrangements for 110 V AC power and 24 V DC power shall be carried out by the Bidder. The general features of electrical for instrumentation shall be as under.

1. All instruments, control systems (PLC) and analyser system shall be able to operate at the following UPS specification:
  - Voltage level : 220 V AC  $\pm 10\%$
  - Frequency : 50 Hz  $\pm 3$  Hz
  - Switch over time : 5 milli seconds
2. 24V DC - the necessary arrangement will be in Bidder's scope
3. Solenoid Valves, Relays, Lamps : 230V AC  $\pm 10\%$
4. If 110 V AC required for Solenoid, the necessary arrangement will be in Bidder's scope
5. Panel/Cabinets lighting : 240V AC  $\pm 10\%$
6. In case 24 V DC is required for Input interrogations, solenoid valves, relays and lamps etc., the same shall be arranged by the Bidder using dual redundant power packs (230V AC to 24V DC converter).
7. Instrument power circuits shall be individually protected from fault with the help of fuses. Power supply to the individual instrument shall be disconnected with the help of DPST switch and protected with the help of fuses. Miniature circuit breakers (MCBs) may be selected in place of switch fuse unit in case protection is provided for overload protection.



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### 8.7. Alarm Philosophy

1. Adequate alarms shall be provided to give audible and visual warning of any process and machine malfunction in the package.
2. All trips shall have a pre-trip warning alarm in addition to alarm at the trip condition.
3. All package alarms including pre-trip warning alarms and trip alarms (shutdown alarms) shall be annunciated on the local panel.
4. All rotating equipments shall have the status indication provided on the local panel.
5. Common pre-warning alarm and common trip alarm contacts for the package shall be provided for remote annunciation. Additional alarm contacts shall be provided when specified.
6. "Fail-safe" type with normally closed alarm contacts shall be used.
7. Location of process connections shall be from the side or from the top of the process equipment but not from the bottom. This requirement is applicable to both pipes and vessels. The location of lower side connection when necessary shall be high enough to prevent plugging due to dirt or other suspended solids. In addition, the connections shall be short, vertical or horizontal and without any pockets.
8. Material of construction of instruments shall be as per the material selection chart, attached as part of this specification. In any case Bidder to ensure that the selected material is consistent with temperature, pressure, corrosion conditions and other process equipments.
9. In case where suitable material of construction is not feasible/ possible, diaphragm seal shall be considered.
10. All process switches shall be provided with sealed micro switch contacts rated for the specified application. Contacts shall be SPDT type unless otherwise specified. Contacts used in intrinsically safe applications shall be gold plated.

### 8.8. Instrument Connections

1. Instrument connections for signal and gas supply shall be 1/4" NPT(F).
2. Electrical cable entry connection shall be 1/2" NPT(F). Suitable cable gland shall be used.
3. End connections shall meet the following, unless otherwise specified:
4. Threaded end connection shall be NPT as per ANSI/ASME B1.20.2
5. Flanged end connection shall be as per ANSI/ASME B16.5
6. Flange face finish shall be as per paragraphs 6.4.4.1, 6.4.4.2 and 6.4.4.3 of ANSI/ASME B16.5  
The face finish wherever specified in data sheets shall have serrations as follows:
 

- Serrated	:	250 to 500 AARH
- 125 AARH	:	125 to 200 AARH
- 63 AARH	:	32 to 63 AARH
7. Grooves or ring type joint flanges shall be octagonal as per ANSI/ASME B 16.20





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### 8.9. General Specification of Instruments

#### 8.9.1. Common Applicable Requirements

Major instrumentation shall be electronic type but all local loops and final control elements shall be pneumatic.

1. Instrumentation shall be complete in every respect and liberal to the extent of providing data on all operations and variables sufficient for the safe, efficient and easy operation, start up and shut down of the CNG Station.
2. The design and installation of instruments shall generally be in accordance with ISA/API recommended practices and other applicable standards like BIS, IBR etc. Material specifications and practices shall, in general, conform to appropriate ASTM or equivalent standards. All standards and code of practices referred to herein shall be of the latest edition prior to the date of owner's enquiry.
3. All instruments and equipments shall be suitable for use in a hot, humid and tropical sea-weather climate. As a minimum, all instruments and enclosures in field shall be dust proof and weatherproof to IP-65 as per IEC-529/IS/IEC 60947-1 and secure against the ingress of fumes, dampness, insects and vermin. All external surfaces shall be suitably treated to provide protection against corrosive Sea shore atmosphere.
4. The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC 801 "Electromagnetic compatibility for Industrial Process measurement and Control Equipment.
5. Instrumentation electronics shall be certified by a recognized authority such as BASEEFA, CENELEC, FM, PTB, CMRI, LCIE, CESI, INIEX, ATEX and SMRS. PESO (CCOE) certificate for electrical and instrumentation material used inside compressor is mandatory, as per statutory requirement.
6. Unless specified otherwise, all Instruments shall be suitable for an area classification of "Class 1, Division 1, Group D as per NEC" OR "Zone 1, Group IIA/IIB as per IS/IEC".
7. All package mounted transmitters/transducers and temperature element shall be intrinsically safe " IA" as per IEC 79-11 and solenoid valves, switches and related junction boxes shall be certified flame proof (Eexd) as per IEC 79-1 by a statutory body viz. FM, BASEEFA etc. for the specified hazardous area classification. Other special equipment's/instruments, where intrinsic safety is not feasible or available the same shall be flame proof (Eexd) certified suitable for the specified hazardous area by a statutory body as per IEC 70-1. All analog as well as digital input to PLC shall be connected through barriers. All analog barrier shall be isolator type.
8. The compressor package instrumentation and control is to be configured for manual as well fully automatic control system including starting, shutdown as applicable for unattended operation. Control system shall be PLC based with make and model number duly approved by the Owner.
9. All controllers shall have facility for bump-less auto-manual and manual-auto transfer and set point adjustment. Flow, pressure and level controller shall be provided with proportional plus



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integral action, while temperature controller with proportional plus integral plus derivative action.

10. All the instrumentation shall be capable of operating for full range of operation. Range for instruments shall be selected in general, such that in normal process operation the indication is between 40% to 60% of span for linear and 60% to 80% of span for square root inputs.
11. Ranges for process switches shall be selected, in general, such that the set point falls preferably in the middle 30% of full adjustable range i.e. the set point shall fall between 35% and 65% of adjustable range.
12. All instruments shall be provided with proper tagging w.r.t. tag of instrument cables
13. Junction boxes and accessories required for flameproof instruments shall also be certified flameproof.
14. Separate junction boxes shall be provided for each type of signal i.e. intrinsically safe signals, alarm, shutdowns, thermocouples, RTDs etc. for interfacing to local panel, analog, digital, solenoids, RTD, thermocouple and power supply. Instrument junction boxes shall not have any high voltage connection.
15. If LCP (With PLC) is mounted on package then separate JB's are not required. Separate JB for solenoid valve to be provided by the bidder. Transmitters shall be intrinsically safe these are routed thru barriers for additional safety. And also, Instrument junction boxes shall not have any high voltage connection. Bidder has meet all statutory requirement for applicability of this clause.
16. All pressure gauges (Glycerine filled) and pressure transmitters shall be provided with block & bleed valves and have accuracy of + or - 1% of Full Scale Deflection (FSD).
17. The temperature gauge shall be generally mercury in steel filled type, weatherproof & with capillary extension. Capillary tubing shall be minimum Carbon Steel with CS flexible armouring. The gauge shall have accuracy of + or - 1% Full Scale Deflection (FSD). The range shall be 1.5 times of operating temperature.
18. All field instruments power shall be limited to 24 VDC. Power conversion unit if required shall be in the scope of the Bidder.
19. Units of measurement shall be:

Gas flow	SM <sup>3</sup> /hr or kg/hr for compressor and other
Gas flow	kg/hr for dispenser
Pressure	Kg/cm <sup>2</sup> (g)
Temperatur	°C
Level	%
Liquid flow	M <sup>3</sup> /hr

### 8.9.2. Electronic Instruments

1. All electronic instruments requiring separate power supply shall generally operate on 230V 50 Hz. Instruments operating at 24 V DC shall also be acceptable.
2. Electronic transmitters shall generally be two wire type. These shall have transmission/



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output signal of 4-20 m.A DC and shall be capable of delivering rated current into external load of at least 600 ohms when powered with 24 V DC nominal voltage.

3. Smart transmitter when selected, shall be used in analogue output mode. Digital integration shall be avoided unless specified otherwise.
4. All receiver instruments shall be microprocessor based and shall operate on voltage input of 0.25 to 1.25 V, 1 to 5 V, or 0 to 10 V dc, in general.
5. The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC-801.
6. Pneumatic Instruments shall operate on gas supply of suitable pressure and shall have transmission and output signal of 0.2 to 1.0 kg/cm<sup>2</sup>g.

### 8.9.3. Panel Board Instruments

1. Panel board instruments shall generally be multi bin sub-miniature 6" x 3", except recorders, which shall preferably be 6" x 6". Instruments like microprocessor based recorders, temperature scanners, etc. shall be as per manufacturer standards.
2. Panel board instruments shall have the following graduations, in general:
  - Flow with DP cells : 0 to 10 square root
  - Pressure : Direct Reading
  - Level : 0 to 100 Linear
  - Temperature : Direct Reading
3. Multiplying factors for flow scales shall be specified on manufacturers name plate.
4. Recorder charts shall be dual graduated, in general, in 0 to 10 square root and in 0 to 100 linear.
5. Annunciator, in general, shall be solid state type with plug in modules, in a cabinet with back lighted engraved windows and integral power supply. Alarm logic module shall be single channel type. In case multi-input alarm module are selected, only one channel shall be used. Intrinsically safe annunciator circuit, when used, shall have power supply unit in a safe area.
6. The design of the alarm annunciator system shall be such that transient alarms of less than 330 milli seconds duration shall be automatically rejected.

### 8.9.4. Field Transmitters

1. All field transmitters shall have an accuracy of 0.5% of span and shall be provided with output meter/output gauge at the signal output. The accuracy level certification form 'OEM' shall be documented by the Bidder along with the supply.
2. Smart transmitters when used shall be used in analogue mode only unless specified otherwise. At least one number of hand held configuration shall be supplied as a minimum.
3. Smart transmitters if specified shall have accuracy  $\pm 0.1\%$  of span, as a minimum.

### 8.9.5. Temperature Instruments

1. Thermo-wells: All temperature elements shall be provided with Thermo wells fabricated out



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of bar stock of minimum SS-304 material. The base of the thermo well shall be chosen to fit the instrument without air gap for minimising measuring lag.

### 2. Temperature Gauges

- (a) Local temperature gauges shall be liquid/vapour/gas filled type in general and shall be manufactured as per relevant SAMA Class.
- (b) Bimetallic type dial thermometers shall be avoided where excessive vibration are encountered, such as compressors. Only filled type with capillary extension shall be used in such cases. Capillary tubing shall be of SS-304 with stainless steel flexible armouring, and PVC covering over armour. The temperature bulb shall be of stainless steel construction in any case.
- (c) All local temperature gauges shall have 100 mm dial size. The bulb size shall be selected to suit the thermo-well.
- (d) All gauges shall be of weatherproof construction.
- (e) Temperature gauges shall have accuracy of + 1% URV (upper range value).
- (f) Thermometer stem adjustable gland with union connection and bushing shall be suitable for 1/2" NPTF) connection.

### 3. Temperature Elements

- (a) For remote temperature indication/recording/control/switch etc. the thermocouples or resistance temperature detector (RTD) shall be used depending on the process requirements. Elements shall be spring loaded, mineral insulated and shall have stainless steel sheath.
- (b) Thermocouples shall be as per IEC-584-2/IS-7358 and shall have a wire of size 18 AWG for single and 20 AWG for duplex thermocouples. These shall be magnesium oxide (MgO) filled ungrounded type, unless necessary otherwise. The type of thermocouple shall be selected based on temperature. Following guidelines shall be followed:
 

- Copper-Constantan (ISA-Type-T)	:	(-) 200 to 200°C
- Chromel-Constantan (ISA-Type-E)	:	(-) 200 to 600°C
- Iron-Constantan (ISA-Type-J)	:	0 to 600°C
- (c) The design of thermocouple assemblies shall be such that replacement on line is possible
- (d) RTD (Resistance Temperature Detector) shall be platinum element 3 wire type with 100ohms resistance at 0°C calibrated as per IEC 751/DIN 43760. RTD shall be used within a temperature range of -200 to 650°C. Three wire system shall be adopted in connecting the element.
- (e) RTD shall be used where accuracies of the order of 0.25% or better and smaller measuring spans are required.

### 4. Temperature Transmitter

- (a) Temperature transmitters shall have a built-in line arising function to produce an output linear to temperature range.



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- (b) Temperature transmitters shall have an accuracy of + 0.25% of URV as a minimum.
- (c) Burn out protection must be provided with temperature transmitters and trip amplifiers. Upscale or downscale protection shall be decided based on its application to ensure fail safe operation.

### 8.9.6. Pressure Instruments

#### 1. Pressure Gauges

- (a) Liquid filled pressure gauge of diameter 4", (0-400 kg/cm<sup>2</sup>) with a 3- way isolating valve on each bank shall be used. Thus each cascade shall have three pressure gauges. Pressure gauges shall be securely mounted. Liquid fill shall be lockable.
- (b) Pressure gauge dial shall be white, non rusting plastic with black figures. The dial face shall be marked with pressure element material. Pointers shall have micrometer adjustment.
- (c) Pressure gauges shall be weatherproof with dial size of 100 mm and shall have features like screwed bezels, externally adjustable zero, over range protection and blow-out discs. Pressure gauge sensing element shall be of SS-316 and movement of SS-304, as a minimum.
- (d) Pressure gauges shall have an accuracy of + 1% of URV as a minimum. Differential pressure gauges may have an accuracy of + 2% of URV.
- (e) Over range protector and pulsation dampner, whenever used, shall be of SS-304 as a minimum. Pulsation dampner shall be used for all pulsating services. It shall be floating pin type, externally mounted and externally adjustable.
- (f) All pressure gauges with maximum operating pressure exceeding 60 kg/cm<sup>2</sup>(g) shall be solid front type.
- (g) Connection shall normally be 1/4" NPT , back mounted or 1/2" NPT(M) bottom
- (h) Cases shall normally be cast aluminium alloy or black phenol and weatherproof to IP-55 as per IEC-529/IS/IEC 60947-1. Blow-out discs shall be provided.
- (i) Ranges shall be so specified that the gauge normally operates in the middle third of the scale and shall conform to IS-3624 standard dials, wherever possible.

#### 2. Pressure/Differential Pressure Transmitters

- (a) Pressure/Differential pressure transmitter shall have electronic state-of-art capacitance or any other type of sensor meeting all functional specifications. Element material for transmitters shall be SS-316, as a minimum, and shall be able to withstand over pressure of at least 30% of range or maximum working pressure whichever is higher.
- (b) All transmitters shall have an integral output meter. Remote mounted meters may be provided if required in addition.
- (c) All transmitters shall have an accuracy of  $\pm 0.25\%$  of URV, as a minimum. Whenever smart transmitters are specified/supplied, accuracy shall be governed by clause 2.19 (c).

#### 3. Pressure Switches

- (a) Pressure switches shall have either diaphragm or bellow type of process element with SS-



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316 material of construction as a minimum.

- (b) Pressure switches shall be blind type with 1/2 NPT (F) process connection and shall be operative in full specified range. The switch differential shall be selected as per operating conditions.
- (c) Pressure switches shall have repeatability of + 0.5% of URV, as a minimum.
- (d) Receiver pressure switches shall have SS-316 bellows as measuring element with 1/4" NPT(F) connection.

### 8.9.7. Level Instruments

#### 1. Level Gauges

- (a) All gauge glasses shall be steel armoured reflex type or tubular with body and cover material of forged carbon steel as a minimum and shall have tempered borosilicate glass with asbestos or other suitable gasket. All gauge glasses must have a rating equal to or more than the vessel design pressure and temperature.
- (b) All gauges shall have top and bottom chamber connections, unless otherwise specified. In addition each gauge shall be provided with ball check valves and pipe union.
- (c) Gauge glass cocks shall be forged off-set type with an integral ball check and back seating stem. Primary isolation valves are normally required in addition to the gauge glass cocks

#### 2. Level Transmitter

- (a) External displacer type instruments with side-side connections and rotatable head shall normally be used for level measurement up to 1219 mm. Side-bottom connections are preferred where RTJ flanges are required. Internal displacer type of level transmitters shall be avoided unless application necessitates its use.
- (b) All displacer type of level transmitters shall be of torque tube type with torque tube material of inconel, as a minimum.
- (c) In general, displacer type instruments shall be used with displacer lengths of 356 mm, 813 mm and 1219 mm. For interface level measurement, displacer type instruments shall only be used.
- (d) Differential pressure transmitter shall be used for level measurement above 1219 mm, for services requiring purge or where liquid might boil in external portion.

#### 3. Level Switch

- (a) Level switches shall generally be external or internal ball float or displacer type with flanged head.
- (b) Switch shall be sealed micro type with contact rating suitable for the specific application
- (c) Level switch shall be furnished with SPDT contacts with adjustable differential, unless otherwise specified.

### 8.9.8. Mass Flow Meter

#### 1. CNG Compressor shall be equipped with The following Mass Flow Meters Viz:

- I. Suction Mass Flow meter – For measurement of Gas at the inlet point of the CNG



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- Compressor. Mass flow meters shall be of 'Coriolis' type.
- II. Discharge Mass Flow meter – For measurement of Gas at the outlet point of the CNG Compressor. Mass flow meters shall be of 'Coriolis' type.
  - III. Mass flow meter on LCV filling post, if applicable- For measurement of Gas at LCV. Mass flow meters shall be of "Coriolis" type
  - IV. Vent Mass Flow Meter – For measurement of Gas through the Common Vent line of the CNG Compressor. Mass flow meters shall be of 'Coriolis' type or 'Thermal' type.
2. Accuracy of the vent meter is +/- 1% and the gas measured in the vent meter is displayed on the PLC of the compressor package.
  3. Shall have Provision of local display and output must be communicated with PLC display
  4. Each Mass Flowmeter shall include a sensor with integral transmitter i.e. meter electronics certified intrinsically safe/explosion proof by statutory authority suitable for the required hazardous area as per IS/IEC 60079. Also the offered sensor and the transmitter shall be weather proof to IP 65 as per IS/IEC 60947-1/IEC-529. Statutory authority for local installation is CCoE. The meter electronics / Transmitter shall be provided with isolated Analog output and Digital output (AO/DO) for each process parameter for the purpose of SCADA inputs. SCADA protocol shall be Modbus standard.
  5. Allowable pressure drop for the flowmeter at the inlet and outlet of the compressor shall be 1.0 kg/ cm<sup>2</sup>. Offered mass flowmeter shall be necessary for Custody Transfer application but not exceeding 0.5% of span.
  6. Calibration for the offered mass flow meter from a recognized institute shall be in Kg/hr and SM<sup>3</sup>/hr. Pressure, Temperature compensation shall be provided by the meter.
  7. Flying lead type electrical termination is not acceptable. All electrical connections shall be NPTF. Cable glands shall be provided for electrical power, signal and control connections. Cable glands shall be double compression type and certified weatherproof and explosion proof for the required area classification as per IS/IEC 60947-1 and IS/IEC 60079. Additional gland shall be provided for AO/DO.
  8. Offered Mass flowmeter shall be completely free from corrosion of measuring tube due to alternating stresses continuously occurring in the tube. Also measuring tube shall be completely free from erosion, which may result due to fluid velocity.
  9. The design of meter electronics shall be in compliance with the electromagnetic compatibility requirements as per IEC-801. Meter Electronics shall include all the associated preamplifiers converters lineariser signal isolators etc.
  10. Installation details like straight run requirements, recommendation for horizontal /vertical installation, minimum distance between upstream and downstream pipe bends from Mass flowmeter to be provided.
  11. Bidder shall calibrate each Mass Flowmeter at his shop or any recognised test house with the fluid (Use design process conditions) for which it is to be used. In case it is not possible to calibrate the Mass Flowmeter with actual fluid. Bidder must indicate:
    - (a) Fluid used for calibration
    - (b) Correction factor/Adjustment required for actual process fluid. In any case, inaccuracy when extended to actual process shall not exceed the specified limits (as per





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manufacturer's standard).

12. Bidder shall submit the following test certificates and test reports for owner's review: -
  - (a) Material test certificate with detailed chemical analysis from foundry (MIL Certificate).
  - (b) Certificate of radiography / x-ray for any welded joint.
  - (c) Hydrostatic test report with pressure of 1.5 times the design pressure.
  - (d) Calibration report including calibration factors for each Mass flow meter certificate from statutory body for offered sensor and transmitter for required area classification

### 8.9.9. Control Valves

1. Control valves shall normally be globe type, single seated or double seated. Other valve types like butterfly ball, rotary plug, angle or 3 way etc. shall be selected as per service requirements.
2. Control valve sizing shall be carried out as per ISA S75-01. The valve shall permit up to 150% of normal flow or 110% of maximum flow, whichever is higher. In general, control valves shall be sized so that the valve opening is as noted below:
  - At maximum flow : about 90% open
  - At normal flow : about 75% open
  - At minimum flow : about 20% open
3. Flanged control valves shall be used. Body material, body rating and flange rating, shall be as per piping specifications as a minimum.
4. Material used for trim shall be SS-316, as a minimum. For higher pressure drops (greater than 10 kg/cm<sup>2</sup>g), trim shall be stellite. (wetted parts like set ring, valve plug, plug guide, plug stem, guide bushing and cage are being termed as trim).
5. Trim characteristics shall be equal percentage type unless required otherwise. Control valve plugs shall be top and bottom guided for double seated valves and heavy top guided for single seated valves.
3. Noise from control valve during operation shall be limited to OSHA specified level or better. The maximum allowable noise is 70 dBA (SPL - Sound Pressure Level).
6. Valve seat leakage shall be as per ANSI FCI 70.2 and shall be selected with due consideration to meet the requirement.
7. In general, block and bypass valves shall be installed with all control valves upto and including 2" size. No by-pass valve or hand wheel shall be used for shutdown valves.
8. Valve actuator shall be pneumatic spring opposed diaphragm type, in general. Piston type actuators may be used for very high shut off pressure requirements. Additional equipment necessary to meet fail safe condition shall also be included in case double acting piston type actuator is selected. In either case, actuator shall be able to withstand maximum shut-off pressure with the minimum instrument gas pressure specified.
9. Solenoid valves, shall be universal type and shall be continuous rated type with class F coil





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insulation as per IEC 85/IS-1271. These shall be of brass body with SS-316 trim, as a minimum.

10. Self-actuating regulators for flow, pressure and temperature shall be used where loads are constant and requirements of precision and accurate controls are not stringer.

### 8.9.10. Pressure Relief Valves/ Regulating Valve

1. Gas Inlet (approved make) Pressure Regulator with SSV of 150/300/600 # class rating should be suitable for 400, 650, 1000, 1700 & 1200 SCMH CNG compressor.
2. All pressure relieving devices shall be designed in accordance with ASME code for 'Boilers and Pressure Vessels', API-521 and Indian Boiler Regulations.
3. Pressure relief valves shall be full nozzle full lift type except for thermal relief valves.
4. 3/4" x 1" threaded (NPT) modified nozzle type valves with typically 0.38 cm<sup>2</sup> orifice size shall be specified for thermal relief.
5. The body material shall as a minimum be as per piping specifications. Nozzle and disc material shall be SS-316 as a minimum with machined stainless steel guide and spindle. Whenever semi nozzle design are unavoidable, body material shall be at least same as nozzle material.

### 8.10. Interlock and Shutdown System

1. Interlock and Shutdown System shall be an independent system with its own dedicated primary element except for flow. In which case common flow transmitter with separate receiver alarm card shall be used. However separate element with trip amplifier shall be used for temperature. in no case the initiating contacts shall be derived from indicators,, controllers, recorders, scanners, alarm annunciator or any such instrument.
2. The system shall be designed fail safe & shall meet the following requirements, as a minimum:
  - (a) All initiating contacts shall be close under normal conditions and shall open under abnormal conditions.
  - (b) All relays and solenoid valves shall be energized under normal conditions and shall de-energize under abnormal conditions.
  - (c) Emergency shut-down switch contacts shall be wired in series with the final actuating device to ensure positive shutdown.
  - (d) If desired, because of operational or maintenance requirements, adequate trip by-pass facilities are to be provided with warning lights to indicate that the trip has been bypassed. Trip bypass alarms shall be provided in local as well as in remote location. All such by-pass switches shall be key-operated type.
3. The system shall be designed using electromagnetic relays unless specified otherwise and shall be located locally or remotely as per the operational requirements.
4. Each shutdown circuit and solenoid valve shall be provided with a switch-fuse unit separately.

### 8.11. Control Panel

1. The local control Panel shall be flame proof with enclosure made from cast aluminium (LM6).



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2. Enclosed cubicle panels shall have removable hinged doors, generally at the side or back for easy maintenance and accessibility of the instruments. Doors shall be double leafed type with handle and shall be provided with lock and key. Adequate illumination shall be provided inside the panel. All light fittings shall be suitable for 230 V, 50 Hz ac.
3. No fluid of any kind, except instrument gas shall enter the control panel. Also power supply greater than 230 V shall not be taken in to local panel.
4. All cable entries to the local panel shall be from panel bottom only using cable glands of adequate size. All unused cable entries must be plugged.
5. The design of control panel shall incorporate provision for expansion by installing adequate spare capacity. Each panel shall be designed to accommodate the following additional items, as a minimum:
  - 20% of panel front/inside mounted instruments including lamps, push buttons, switches, relays etc.
  - 20% additional power feeders each provided with switch fuse assembly.
  - 20% additional spare windows in alarm annunciators.
  - 20% spare cable entry points.
6. The internal panel layout shall be designed considering proper approach for instruments, terminals and other accessories for maintenance, easy removal and on-line calibration. No instrument, terminals, power distribution box etc. shall be mounted on the panel side plates inside the panel.
7. All lamps, status as well as alarm, shall be provided with lamp test facility. One single lamp test push button shall be used for each panel.
8. All control panels shall be supplied in pre-tubed/pre-wired conditioned and shall be completely tested at manufacturer's works prior to dispatch.
9. A shed shall be provided above the control panel mounted on compressor canopy.

### 8.12. Programmable Logic Controller (PLC)

#### 8.12.1. General

1. The programmable logic controller (PLC) shall be micro-processor based system. The system shall in addition be of modular in construction and expandable in future by adding additional modules. Redundancy at I/O level is not required. Other redundancy shall be as per the tender specifications.
2. The PLC shall have provision of 100% redundancy to avoid downtime and loss of data in case of any problem.
3. On-line replacement of any module shall be possible in such a way that the removal and additional of any module shall be easily possible.
4. Programmable logic controller shall be able to operate satisfactorily from 15oC to 30oC and 20% to 80% non-condensing humidity. The system shall be installed in environmentally controlled control room unless specifically indicated otherwise.



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5. The system shall have extensive set of self-diagnostics hardware and software for easy and fast maintenance. Diagnostics shall be required at local as well as at console level.
6. Single/Separate power supply unit shall be provided for individual I/O rack and processor unless otherwise specified. Suitable battery back-up shall be provided for volatile memory protection.
7. Operation of PLC shall be completely unaffected by a momentary power loss of the order of 20 milliseconds.
8. The system shall be programmed in general as per the logic diagram or ladder diagram.
9. The system shall have provision for an additional tag for mass flow meter for mobile cascade filling and similarly an extra window to be provided in HMI/ MMI.

### 8.12.2. System Configuration

1. Bidder shall offer system configuration as per the respective job specifications. However, each sub-system offered shall meet the minimum requirements specified in the following paragraph.
2. Input/output Sub-system :
3. Each I/O shall be electrically isolated from external control circuit by suitable means. The minimum isolation level between I/O and logic circuit shall be 1000 V dc.
4. Each I/O shall be protected against the reversal of polarity of the power supply voltage to I/O.
5. Each module shall have a LED for each I/O per channel to indicate the status of each Input/ Output.
6. Each output shall be short circuit proof and protected by using fuse. Visual indication of fuse blown must be provided for each output.
7. PLC input card shall have the provision to incorporate minimum three (3) analogue inputs from Suction train package.

### 8.12.3. Processor Sub-System

1. The processor shall have capability to implement all the control functions required to programme instructions required by the logic schemes.
2. Memory shall be non-volatile. In case volatile memory is provided, battery back-up shall be provided for a minimum of three months to keep the storage intact. A battery drain indication shall be provided at least one week before the battery gets drained.
3. It shall be possible to generate the first out alarm output by the PLC.
4. PLC Console
5. The PLC console shall be used for programming, programme storage, fault diagnostics and alarm monitoring. It shall be possible to use this for plant operation, whenever specified.
6. The keyboard shall be easy to operate with each key clearly identified. It shall be provided



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with a lock and key to prevent any unintentional programme modification.

7. It shall be possible to modify, add or delete the application programme on-line without affecting the output.
8. PC based console when offered must be of current release and state-of-the art.
9. System Power Supplies
10. Programmable Logic controller shall operate on uninterrupted power supply with following specifications:
  - Voltage 230V  $\pm$  10%
  - Frequency 50 Hz  $\pm$  3 Hz
  - Switchover time 5 milliseconds
11. Each I/O rack shall be provided with a single/separate power supply.

### 8.12.4. Self-Diagnostics

1. The system shall have extensive set of self-diagnostic sub-routines, which shall be able to identify the system failure at least up to module level. At local level, failure of a module shall be identified by an individual LED.
2. Whenever auto-testing of I/O modules is specified, the testing software must be capable of detecting faults in case of normally open as well as normally close system.

### 8.13. Material Selection Chart

#### 8.13.1. General

1. The following "Material Selection Chart" defines the base material requirement for major instrument items. The material have been specified as per "Piping Class" in which these instruments are installed. Additional requirements like stelliting etc. shall be selected based on process conditions.
2. Although materials as specified in 'Material Selection Chart' shall be acceptable, in general, this does not absolve Bidder of the responsibility of proper selection of material as per the fluid being handled and process conditions.
3. Impulse pipe material shall be as per the corresponding piping class. However, for Impulse tubing material shall be SS 316, as a minimum. Better material shall be selected wherever required.

#### 4. MATERIAL SELECTION CHART

Sr.	PIPING CLASS	CONTROL VALVE		PRESSURE RELIEF VALVE		
No.		Body	Trim	Body / Bonnet	Nozzle / Disc	Bellow
1	A1a, B1a	A216 GrWCB	SS 316 Stellited	A216 GrWCB	SS 316	SS 316



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2	F2b	A217 GrWC1	SS 316 Stellited	A217 GrWC1	SS 316 Stellited	SS 316
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Sr.	PIPING CLASS	ORIFICE/SENIOR ORIFICE		FIELD TRANSMITTER	
No.		Flange / Body	Plate	Body	Sensor
1	A1a, B1a	A105	SS316	Carbon Steel	SS 316
2	F2b	A182 GrF1	SS 316	SS 316	SS 316

Sr.	PIPING CLASS	THERMOWELL		LEVEL INSTRUMENT		
No.		Flange	Well	Cage	Torque Tube	Displacer
1	A1a, B1a	A105	SS 304	A106 GrB	A106 GrB	SS 316
2	F2b	A182 GrF1	SS 304	A335 GrP1	Inconel	SS 316

Sr.	PIPING CLASS	LEVEL SWITCH		LEVEL GAUGE		
No.		Cage	Float	Chamber	Cock Body	Cock Trim
1	A1a, B1a	A106 GrB	SS 316	A105	A105	SS 316
2	F2b	A335 GrP1	SS 316	A182 GrF1	A182 GrF1	SS 316

### 8.14. Specification for Installation Material

The installation material for instrumentation and control work includes items such as, but not limited to, cables, cable glands, junction boxes, instrument valves, and manifolds, mounting accessories, impulse piping/tubing, pipe/tube fittings, pneumatic signal tubes, instrument gas line pipes and fittings, filter regulators, insulation materials, cable duct and trays, conduits, identification tags, structural material required for instrument supports and trays etc. Some of the salient features and minimum requirements for some of the main installation materials have described in the following clauses. However items for which specification have not been provided, Bidder may follow his own specification and applicable international standards.

#### 8.14.1. Cables

1. All cables shall have PVC/FRLS insulated/Armored/Screened primary insulation of 85°C PVC as per IS-5831 Type C and inner and outer jacket shall be 90°C PVC to IS-5831 Type ST-2. Oxygen index of PVC shall be over 30% and temperature index shall be over 250°C.
2. The insulation grade shall be 600V/1100 V as a minimum and shall meet insulation resistance, voltage and spark test requirement as per BS-5308 Part-II.
3. All cables shall be twisted and armored. Armor over inner-jacket shall be of galvanized steel wire/flat as per IS-1554 Part I.
4. Maximum DC resistance of the conductor of the completed cable shall not exceed the following
  - 12.3 ohms/km at 20°C for cables with 1.5 mm<sup>2</sup> conductor.



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- 39.7 ohms/km at 20°C for cables with 0.5 mm<sup>2</sup> conductor.
- 5. The mutual capacitance of the pair or adjacent cores shall not exceed 250 pF/m at a frequency of 1 kHz.
- 6. L/R ratio of adjacent cores shall not exceed 40 microhenry/ohms for cables with 1.5 mm<sup>2</sup> conductor and 25 µH/ohms for cables with 0.5 mm<sup>2</sup> conductor.
- 7. The drain wire resistance including shield shall not exceed 30 ohms/km.

### i. Signal Cables

1. Single pair shielded signal/alarm cables shall be used between field instruments/switches and junction boxes/local control panels.
2. Multipair individually and overall shielded signal/alarm cables shall be used between junction boxes/local control panels and control room, in general.
3. The single pair/triad cables shall be 1.5 mm<sup>2</sup> conductor size, made of electrolytic copper conductor of 7 strand each of 0.53 mm diameter, multipair cables with 0.5 mm<sup>2</sup> conductor size shall have 16 strand of annealed grade copper conductor with each strand of 0.2 mm diameter, multi triad cable or multipair cable with 1.5 mm<sup>2</sup> conductor shall have 7 strand each strand of 0.53 mm diameter.
4. Shield shall be aluminium backed mylar/polyester tape bonded together with the metallic side down helically applied with either side having 25 % overlap and 100 % coverage. The minimum shield thickness shall be 0.05 mm in case of single pair/triad and 0.075 mm in case of multi-pair/triad cable.
5. Drain wire shall be provided for individual pair and overall shield, which shall be 0.5 mm<sup>2</sup> multi stranded bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminium side of the shield.
6. All multi-pair cables shall have 6 pair/12 pairs only. White multi-triad cable shall have 6 triads/8 triads only.
7. Power, signal and control Cables, FLP glands including FLP gland for incoming cables to compressor package incoming electric panel, electric accessories for the package.

### ii. Control Cables

1. Single pair control cables shall be used between field mounted solenoid valves and junction boxes/local control panels and shall meet the requirements specified in paragraph above.
2. Multi-pair control cables shall be used between junction boxes/local control panel and control room mounted device in general. These cables shall have only overall shielding.
3. These control cables shall have 1.5 mm<sup>2</sup> conductor size with 7 stranded conductors of annealed electrolyte grade copper, with each strand of 0.53 mm diameter.

### iii. Thermocouple Extension Cables

1. Single pair shielded thermocouple extension cables shall be used between thermocouple head and junction boxes transmitter/local control panel mounted instruments.
2. Multi-pair individually and overall shielded thermocouple extension cables shall be used



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between junction boxes and control room mounted devices.

3. The cable shall have 16 AWG and 20 AWG solid conductors for single and multi-pairs respectively.
4. All thermocouple extension cable shall be matched and calibrated in accordance with IEC-584-2
5. Shield shall be aluminium backed by mylar/polyester tape bonded together helically applied with the metallic side down with either side having 25 % overlap and 100 % coverage. The minimum shield thickness shall be 0.05 mm in case of single pair/triad and 0.075 mm in case of multipair/triad cable. Drain wire shall be 0.5 mm<sup>2</sup> multi stranded bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminium side of the shield.
6. Inductance shall not exceed 4mH/km. However for J-type thermocouple inductance could be 8 mH/km.
7. All multi-pair cables shall have 6 pairs/12 pairs only.

#### iv. Power Supply and Other Cables

1. All power supply cables shall be as per IS-1554 part I and shall have copper/aluminium conductor depending on conductor size. Minimum conductor size shall be 2.5 mm<sup>2</sup> of copper conductor. For higher size, aluminium conductor can be considered. All these cables shall be PVC/FRLS, XLPE/PVC insulated and armored.
2. Any other special cable required for instruments shall also be supplied as per requirement.

#### v. All Ethernet/communications cables shall be PVC/FRLS, XLPE/PVC insulated and armored.

#### 8.14.2. Cable Glands

1. Bidder shall supply all cable glands required for glanding the cables both at field instrument and local control panel side, junction boxes side and at control room side.
2. All cable glands shall be nickel-plated brass and they shall be double compression type suitable for armored cables.
3. Flame proof glands shall be supplied with Ex(d) certification.

#### 8.14.3. Junction Boxes

1. Bidder shall supply junction boxes as per the cable selected, wherever required. These shall be of Die cast aluminium alloy (LM-6) body and shall be weather proof, as a minimum.
2. These boxes shall have terminals suitable for minimum or 4 mm<sup>2</sup> or less cable termination mounted on rails. 10 % spare terminals shall be supplied in each junction box.
3. Flame proof junction boxes shall be supplied with Ex(d) certification. All such boxes are weather proof also.

#### 8.14.4. Instrument Valve and Manifolds

1. Bidder shall supply instrument valves (miniature type) and valve manifolds wherever required.



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2. Body rating shall be as per piping class or better. However trim martial shall be SS 304, as a minimum. All valves and manifolds shall be forged type only.
3. Valve body and trim martial shall be SS 316, unless otherwise specified. Superior trim martial shall be selected as required by process conditions. Packing material in general shall be PTFE.

### 8.14.5. Impulse Piping/Tubing

1. Bidder shall supply 3/4" OD x 0.065" Thick ASTM A 269 TP 316 stainless steel seamless tubes as a minimum for impulse lines.
2. Where pressure (operating) exceeds 70 kg/cm<sup>2</sup>(g). or if piping is specified as impulse line, seamless pipes of size 3/4" NB x 0.083" thk. Required. Seamless tubes shall have a hardness of max. 80 RB as typical.

### 8.14.6. Pipe and Tube Fitting

1. The fitting/ferrule hardness shall be in the range of RB 85-90 so as to be ensure a minimum hardness difference of 5 to 10 between tube and fittings. The ferrule shall be of stainless steel material, in general.
2. Socket-weld type forged pipe fitting of suitable material and rating shall be supplied for pipe fittings. The minimum rating shall be 3000 lbs. Weld-neck flanges shall be used where socket weld type are not allowed by piping class.
3. Instrument gas fittings shall be suitable for use on SS tube confirming to ASTM 269 Hardness not exceeding RB 80.
4. All threaded fittings shall have NPT threads as per ANSI/ASME B 16.11 only.

### 8.14.7. Instrument Signal Tubes

1. Bidder The instrument gas tubing material shall be Stainless Steel series –316 conforming to ASTM-A269.
2. Bidder shall avoid use of intermediate connections and shall estimate single length for each instrument location.

### 8.14.8. Gas Filter Regulators

1. Instrument gas filter regulator of suitable size, range and capacity shall be supplied for each pneumatic instrument. SRV shall be provided in downstream of regulator, which is used for operation of actuators.
2. The body of the filter shall be anodised aluminium.
3. The filter shall have 5 Micron sintered bronze/ceramic filter element and shall be provided with manual drain and 2" nominal size pressure gauge.

### 8.14.9. Cable Trays

1. All cables in the cable trench shall be laid in cable trays.
2. These cable trays shall be made out of Galvanised mild steel sheets of 2.5 mm thickness. Ladder trays shall be of Mild structural steel and shall be painted with red-oxide primer. 50 mm x 50 mm angle shall be used as a minimum.





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3. The width shall be so selected that 50% of tray space is available for future use.
4. Suitable cable clamps shall be supplied for binding the cables/tubes at every 500 mm.

### 8.14.10. Instrument Support / Structural Steel

Bidder shall supply instrument stands, stanchions and other structural steel material required for supporting the cable trays, impulse lines and instruments.

### 8.15. Installation Work

1. Bidder shall be fully responsible for installation of all instruments within their battery limit, in line with the installation standards (typical) furnished along with this specification.
2. Whenever installation is beyond the scope of vendor / Bidder, the owner will install the instruments as per the detail/documents/drawings furnished by the Bidder/Bidder. However, in such case it must be ensured that complete installation material shall be supplied by the Bidder.
3. All direct mounted instruments like thermocouples, thermo wells, temperature gauges, pressure gauges, pressure switches etc. shall be installed in such a way that they have good readability and accessibility.
4. All pressure / differential pressure instruments shall be provided with block and bleed/bypass, drain/vent valves etc. as per the installation standards, and shall have accessibility. Bidder can provide needle valve for all pressure / differential pressure.
5. All primary piping/tubing (impulse lines) shall have a slope of 1 In 12 on the horizontal run.
6. All welding shall be carried out as per the relevant codes with proper electrodes. Any testing (non-destructive) like D.P. Test and radiography on root weld and final weld shall be carried out as applicable. All consumables shall be part of Bidder's scope of supply. Any pre/post weld heat treatment as required by the relevant codes shall be carried out.
7. All threaded joints shall be joined with PTFE tapes only.
8. All impulse lines shall be supported at regular intervals.
9. Instrument drain/vent connection shall be piped to safe area or connected to vent header to avoid accumulation of gas in the station.
10. All tubes/cables shall be properly laid on cable trays, which shall be supported at regular intervals.
11. Separate routing or physical separation shall be maintained between signal cable, shut down & power cables.
12. The cases of instrumentations shall be earthed by earthing wire to the nearest earth bus bar for safety runs.
13. Where cables are to be buried or laid in concrete trench, requirement of trenches shall be provided with prior intimation to client.



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### 8.16. Installation of PLC System

1. The system shall be installed by the system Bidder who would be responsible for installation and termination of interconnecting cables in the system racks/cabinets. All interconnecting cables shall be identified and the individual cores/wires shall be properly identified using ferrules. Direct-cross ferruling method shall be used for identification.
2. All system communication cables shall be laid in covered GI (Galvanized Iron) trays away from power cables. Prefabricated cables shall be avoided for interconnection if these are to be routed outside the cabinets. If unavoidable these should be laid in covered GI trays.
3. All panels/cabinets shall be properly levelled and secured firmly with the base supporting structure. However, the console and printer stands need not be secured to base structure.

### 8.17. Grounding

1. Each cabinet, console and other equipment supplied as a part of a system shall have earthing lugs, which shall be secured to the 'AC mains earthing bus'.
2. All circuit grounds and drain wires shall be connected to the 'system ground' bus, which is isolated from 'AC mains earth'. This bus shall typically be 25 mm wide and 6 mm thick of copper.
3. The total resistance of system ground shall be less than 5 ohms unless otherwise recommended by system manufacturer.

### 8.18. Testing and Calibration

1. All impulse lines shall be tested hydrostatically at 1.5 times the maximum operating pressure. Ensure that instrument and vessel/piping is isolated during this test.
2. In case of special instruments/items, where hydro-testing is not permitted due to service condition, the impulse lines testing shall be carried out by using gas or nitrogen.
3. All external cage type level instruments shall be drained and dried with dry air to remove any traces of moisture, oil and dust.
4. After pressure testing, all these impulse shall be drained and dried with dry air to remove any traces of moisture, oil & dust.
5. Instrument gas lines shall be duly tested with soap solution for any leak after pressurizing and isolating the main root valve. After isolation, the rate of fall in pressure shall be less than 1kPa for every 4.4 meter (1 psi for each 100 ft) of tubing for a test period of 2 minutes.
6. Signal tubes shall be flushed and tested with instrument gas for any leak at a pressure of 1.5 kg/cm<sup>2</sup>(g). After pressurising the line, the source of pressure is cut off and rate of fall in pressure shall be less than 1kPa for every 4.4 meter (1 psi for each 100 ft) of tubing for a test period of 2 minutes.
7. All instrument cables shall be tested for continuity and insulation. While meggering the cables for insulation testing, ensure that all instruments and barriers are isolated at both ends.
8. All instruments supplied by the Bidder shall be calibrated using proper test equipment.
9. All instruments shall be calibrated for 0%, 25%, 50%, 75%, 100% and vice versa.



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10. All temperature gauges shall be calibrated using temperature bath.
11. All thermocouple activated instruments shall be calibrated by generating millivolts by a potentiometer.
12. All transmitters shall be calibrated as per instrument ranges.
13. All displacer type level transmitters shall be calibrated with water or suitable fluids and corrected for specific gravity.
14. All alarm and trip switches shall be calibrated over the entire range and finally set and checked for alarm/trip points and reset points as per the alarm/trip set point schedule. After setting, these shall be sealed.
15. Bidder shall check/Calibrate flame detector with UV torch or appropriate instruments. Bidder shall calibrate the gas detector with calibration GAS bottle or cylinder
16. All control valves, prior to stroke checking, shall be externally cleaned thoroughly. The full stroke of valve shall be checked for opening and closing. Any adjustment required for obtaining full stroke and reducing hysteresis shall be carried out. The hysteresis shall not be more than 1% URV (upper range value) with positioners and 5 % URV without positioners.
17. Bubble tight shut off control valves & shut down valves shall be checked for leak test and gland leak test.
18. Solenoid valve shall be checked functionally for its operation.
19. Safety valves and relief valves shall be set/tested by using dry air/nitrogen. Leakage, if any shall be removed by proper lapping of seat & disc.
20. All electronic/pneumatic receiver instruments shall be calibrated as per the manufacturer's instructions. Controllers shall be aligned properly.
21. All special instruments like analyser shall be checked and calibrated as per manufacturer's instructions. Prior to testing, all analyser sample lines shall be thoroughly cleaned by carbon tetra chloride or any other cleaning liquid. After cleaning, these lines shall be thoroughly purged with dry nitrogen.
22. The accuracy of overall loop shall be within  $\pm 1\%$  for electronic and  $\pm 1.5\%$  for pneumatic loops.
23. After performing the calibration of all instruments, the entire loop shall be checked for proper operation.
24. The entire shut down scheme shall be simulated from the process trip switches and the scheme shall be tested for its proper operation prior to start up of the unit.
25. If no instrument gas is available, Bidder shall provide necessary dry N<sub>2</sub> cylinders to carry out the above activity.

### 8.19. Testing of System (PLC)

All the system function shall be checked thoroughly for proper functioning. These shall include but



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not limited to the following tests:

- (a) Visual & Mechanical.
- (b) Complete system configuration loading.
- (c) Demonstration of all system functions.
- (d) Checking of all system display.
- (e) Checking of correct functioning of all keyboards.
- (f) Demonstration of all system diagnostics.
- (g) Checking of proper functioning of all printers, hardcopy unit and printing of all reports.
- (h) Checking of all disc drives.
- (i) Complete checking of logic system, loading of user's program and checkout of results.
- (j) Checking of correct change-over of the back-up/redundant unit in case of failure of main units.
- (k) The input signals shall be simulated by disconnecting the field wires for all inputs. Wherever control room mounted Transmitter/Converters/Receivers switches are used, the functioning of same shall also be checked.
- (l) Checking for fail safe 100% redundancy

### 8.20. Loop Checking

1. Loop checking shall be carried out by Bidder, which shall include proper functioning and interconnection of all items in the loop.
2. All inputs signals shall be generated in the field and corresponding reading shall be checked at all corresponding displays.
3. All the outputs shall be checked in the field, by physical verification of valve stroke or operation of solenoid valve/pick-up of electric contactor.
4. After loop checking completed, Bidder shall connect back any terminals and connections removed during loop checking

### 8.21. Construction Philosophy

#### 8.21.1. LCP Arrangement

1. Higher of 10% or minimum one of each type (Range/Type/Material of construction) of complete instruments, unless otherwise indicated elsewhere in this specification. This shall include all instruments except control valves, safety valves, Displacer type of level transmitters, Displacer/Float type level switches, level gauges, analyzers, programmable logic controllers, , etc.
2. Installed spare modules of higher of 10% or minimum one of each type of Input/output modules (including termination panels, if applicable) to enhance the system functional



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requirement of Programmable Logic Controller.

3. A minimum of 20% spare windows with alarm modules shall be provided in alarm annunciator.
4. A minimum of 20% spare status lamps/switches/push buttons/terminals or one of each type, whichever is higher, shall be provided.

### 8.21.2. Commissioning Spares

- All spares required during commissioning of the package/system in the Bidders scope of instruments.

### 8.21.3. Normal Operational Spares

Bidder shall supply a list of spare parts for each instruments and system required for 2 years of continuous operation.

## 9. Inspection and Testing

### 9.1. General

1. Inspection and Test Requirements shall be as specified in respective equipment / item / work specification, unless specified hereunder.
2. Bidder facility will be equipped with test facility for carryout following test for compressors as per international standards API 618, API 11P etc.
  - Mechanical Run Test
  - Gas loss check as per Tender Requirement.
  - SCADA facility for remote monitoring and automatic operation of compressor including alarm to alert the operator, stop/ restart the compressor, Remote alarm reset facility.
  - Electric supply for PLC and other electrical equipment's.
  - Test Certificates.
3. Bidder shall confirm compliance to all inspection and testing requirements stipulated therein and include the inspection charges in the lump sum cost.
4. All tests which are required to be witnessed as per data sheet, this specification and mutually agreed and finally approved Quality Assurance Plan shall be witnessed by the Owner or authorised representatives of the Owner or the Third Party Inspection Agency as appointed by the Owner. The Bidder shall notify the timing of such inspection and testing to the Owner at least 7 working days in advance.
5. The Bidder shall submit detailed Test Procedure for Approval of the Owner in advance of the actual date of conducting each test.
6. A test procedure shall be established to demonstrate that items will perform satisfactorily in service. The object of the test procedure is to ensure that all the required testing is identified, performed and documented.
7. The test procedure shall include a schedule listing the proposed tests.



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8. Each item of the contract shall be tested and certified in the works where it is manufactured.
9. The Bidder shall arrange for the inspection and tests at their works /at their sub-vendors' works and at the project site, in the presence of representatives of the owner / third party inspection agency as per the approved QAP. All necessary arrangements for inspection and testing including supply of all material at the shop and at the site shall be made by the Bidder.
10. After completion of inspection and testing, Bidder shall provide requisite certificate in accordance with referenced specifications and Owner's document requirements. Certificates of approval for equipment for use in hazardous areas and test certificates confirming ratings of equipment (where appropriate) shall be required.
11. Bidder shall have facility for movement & fitting of cascade above compressor in their premises.
12. Bidder will appoint Third Party Inspection Agency for inspection of Cascade, UPS, Dispenser and Pressure Regulating Skid.
13. GGL will appoint Third Party Inspection Agency for inspection of compressor. Also, GGL appointed TPI agency will review inspection documents for cascade, UPS, dispenser and Pressure Regulating Skid.

### 9.2. Inspection and Testing of Compressor Unit

Inspection and testing of compressor and complete compressor unit shall be carried out as per the relevant codes and standards. Some major but not limited to, inspection stages are mentioned below.

- (a) Material Identification (Material composition & physical properties certificate to be furnished)
- (b) All important compressor parts shall be DP tested / MP tested /UT tested as mentioned in approved QAP.
- (c) Visual inspection of all parts of compressor & its accessories and other major equipment.
- (d) A bar over test of the frame & cylinders shall be made in the Bidder's shop to verify piston end clearances.
- (e) Hydro-test of pressure parts like cylinders, separators, heat exchangers, blow down recovery drum etc.

#### 9.2.1. Mechanical Running Test (MRT)

1. The MRT for the each compressors shall be carried out with job or shop driver including complete job driving system i.e., job driven V-belt, job pulleys etc., for 4 hours continuously at shop of compressor manufacturer. The compressor need not be pressure loaded for MRT test. MRT test to be conduct by OEM representative as per OEM procedure and the same report to be submit to GGL representative/ TPI during the inspection of compressor
2. If any of part found damaged, all similar components shall be stripped for inspection. The MRT test shall be repeated after replacement of such parts.

#### 9.2.2. Mechanical String Test

Mechanical String Test for 4 hours is a mandatory requirement to be performed at packager's shop



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in presence of the Owner or Owner's authorized representatives or a third party at all pressure range specified in the tender.

### 9.3. Package Performance Test

Complete performance run test, of all the equipment, items, accessories etc. within the enclosure of the compressor package unit, shall be carried out at both the places i.e. the Bidder's shop and at the site. The details, but not limited to, of test shall be as under

1. The Bidder shall send fully assembled package including auxiliary systems, instrumentation, safety devices within the enclosure to the site after carrying out the performance test at the assembly shop. The Bidder to make all necessary arrangements including the supply of gas for carrying out the performance test at the assembly shop.
2. Complete package shall be performance tested as a module whereby along with motor compressor performance the Bidder shall demonstrate all controls, shutdown, trips/alarms etc.
3. Inspection, testing and performance testing of package as a whole & individually (if required) itemized testing shall be carried out.
4. The parameters of performance test shall as follows with Min. Pressure, Max Pressure for suction and guaranteed discharge pressure:
  - Capacity
  - Gas Discharge Pressure and Temperature.
  - Power Consumption
  - Vibration (10/5 mm/sec for unfiltered/filtered peak velocity condition respectively) & Noise level 75 dBA @ 1m from the enclosure
  - Lube oil Pressures and Temperatures
  - Unloading of the compressors and it's auto-controls
  - All Instruments, Valves & PLC
  - All interlocks
5. The test shall be the basis of assigning penalties on the Bidder, acceptance/rejection of the package thereon. The Bidder shall submit the detail test procedure for the same, which shall be approved by the Owner.
6. Bidder shall perform 4-hour FAT of compressor at rated pressure (Guaranteed pressure). Bidder shall show variable suction pressure testing for 30 minutes. Bidder shall cover entire suction pressure range (i.e. 3 kg/cm<sup>2</sup>g to 5 kg/cm<sup>2</sup>g or 14 to 26 kg/cm<sup>2</sup>g (as applicable)) within 30 minutes of variable suction pressure testing.
7. The following points to be adhere by bidder and shall be part of QAP for witness by TPI during factory acceptable test:
  - A. Leak test @ 250 during the FAT
  - B. Ensure entire system leak check-compressor inlet to compressor discharge line including the priority panel align with the outlet end connections for dispenser and storage cascades
  - C. Ensure marking is done on all tube joints. Fittings and that all interconnected tubes are aligned properly as per recommendation of tube/fitting suppliers.



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- D. Prepare and submit a reference drawing for all tube joints fittings
- E. All 7 lines from priority panel to end connections for dispenser line, storage cascade lines and mobile cascade line need to be tested at operating pressure in all valves open condition.
- 8. All the above mentioned conditions for the performance test shall be applicable at site when the performance test shall be carried out at site before the commencement of 72 Hours Field Trial Run.
- 9. Site Acceptance Test (SAT) to be carried out for the compressor package within two months from the date of start of commercial operation of the CNG station. SAT will be witnessed against performance curve and FAT at works.

### 9.4. Inspection and Testing of Storage Gas Cylinders and Cascade

As specified in the equipment specification

### 9.5. Inspection and Testing of Priority Panel and Dispenser

As specified in the equipment specification

### 9.6. Inspection and Testing of Heat Exchangers and Pressure Vessels

- As specified in the general specification for the equipment and as follows.
- Material Identification (Material composition & physical properties certificate to be furnished).
- All pressure parts and weld joints shall be DP tested / MP tested /UT tested/ Radiography tested as mentioned in approved QAP.
- Heat treatment, if any.
- Hydrostatic test and leakage test.
- Visual inspection and dimensional checks.
- Inspection and tests for required as per the code of design & construction and statutory requirements like Cylinder Gas Rules 2004 / Oil Industries Safety Directorate (OISD 179).

### 9.7. Inspection and Testing of Electrical Items and Equipment

As specified in the specification of electrical work

### 9.8. Inspection and Testing of Instrumentation and Control Systems

As specified in the specification of instrumentation and control work.

### 9.9. Packing and Forwarding

- After the equipment's are tested, all exposed machine surfaces shall be suitably protected and painted with approved type of easily removable protective coating. Pipes shall be cleaned and suitably painted to prevent corrosion.
- All nozzle openings shall be covered by metal closures to prevent entry of dust and dirt.
- All delicate components/instruments shall be packed separately with proper tag marking.
- All other equipment except compressor package shall be packed in a wooden case.
- The Tag. No. of the item shall be prominently painted on the packing case.





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### 9.10. Minimum Requirements for Quality Assurance Plan

The Bidder shall develop Quality Assurance Plan (QAP) and get it approved from the Owner. hard copy of test reports/ data dossier – 2 sets proper (Including CDs) with O&M Manual for new Compressor package shall be provided at the time of delivery of compressor package at GGL site

The QAP shall as per the applicable codes / standards and manufacturer's standard. However, the minimum points shall be as follows.

R : REVIEW

W : WITNESS

Sr. No.	Particulars	Bidder's Scope	Scope of third party appointed by the Bidder	The scope of owner/ owner's representative
1	Chemical Analysis of Material of Construction of Gas compressor and its accessories.	R	R	R
2	Intermediate stage inspections	W	R	R
3	Non-destructive testing of pressure parts & welding	W	R	R
4	Hydrostatic Test of pressure parts	W	W	R
5	Visual Inspection of all major parts	W	W	R
6	Mech. run test of drive unit	W	W	W
7	Final Inspection / Dimensional Check	W	W	W
8	Performance Test at Bidder's / Vendor's (as applicable) works	W	W	W
9	Performance Test at site	W	W	W
10	Witness Tubing of the Compressor	W	W	R

All instruments / control provided by the Bidder shall be inspected by the Owner / Consultant.

### 10. Other Requirements

- Any item which is not included in the BOM/SCOPE but required for commissioning /operation/safety of the system shall be provided without any cost and time implication.
- The Bidder shall have to furnish the conceptual Equipment layout to be given along with his offer to enable the Owner to finalise plot size for the refueling stations.
- All documents required for HAZOP study to be submit within 15 days from the issued of LOA/ARC.
- The Bidder shall clearly mention the utility requirements of the equipment, including quality; quantity, temperature, and pressure and power requirement within the 15 days of receipt of contract to enable the Owner to make arrangements for the availability of the same as per the battery limit conditions.



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4. The foundation of the equipment shall be designed the Owner, based on the loading data and foundation plan furnished by the Bidder
5. Foundation bolts and vibration pads if any, shall be supplied by the Bidder well in time before casting of the foundation. Price of the same shall be included in the quoted price. If not supplied in time, cost of the same as paid by owner to others shall be deducted from the amount due.
6. The foundation of the equipment shall be constructed by other agencies. However this shall be checked by the Bidder for its correctness. At the time of erection, rectification required, if any, shall be pointed out sufficiently in advance to the owner. However, rectification of minor nature shall be carried out by the Bidder at his own cost, prior to the erection of the equipment.
7. Bidder shall provide loading data and foundation plan required for design of foundation. However, following activities are in GGL scope:
  - (a) Design of foundation (as per drawing submitted by bidder). If bidder deviates from the approved drawings, then rectification of foundation shall be in bidder's scope.
  - (b) Checking of foundation for correctness
  - (c) Rectification of foundation
8. Any equipment or component which fails to perform or gets damaged during transportation, installation, commissioning and performance guarantee test run, shall be replaced by the Bidder free of cost to the owner.
9. The Bidder shall clearly mention in detail about the transportation of whole CNG package unit.
10. The Bidder shall give the list of tools, tackles and components required for erection and alignment for CNG package. The same shall used during O&M contracting period. Afterward the same shall be handed over to the Owner at no extra cost.
11. Valid PESO License for the CNG Dispenser Model and
12. Valid Model Approval from Legal Metrology Department for the CNG Dispenser Model
13. Valid License from Legal Metrology Department for Manufacturing of the CNG Dispenser
14. Valid License from Legal Metrology Department for Servicing of the CNG Dispenser

### 10.1. Spares and Consumables

The rates and prices quoted by the bidder shall be inclusive of charges for spare parts and consumables required during the erection and commissioning, defect liability period and entire O&M period as per SOR.

### 10.2. Erection and Commissioning

The location reference and address of the site shall be informed by the Owner. It shall be the responsibility of the Bidder shall visit the site and acquaint with site conditions and facilities at and around the site.



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### 10.2.1. General

1. This specification describes a general outline for the installation of the equipment involved. The field circumstances shall be taken into consideration and methods suitable to the site conditions shall be adopted in consultation with concurrence of the Engineer-in- Charge and in line with manuals and instructions of respective equipments. The successful accomplishment of the project is greatly influenced by the team work, workmanship and skill of the workers and supervisors. The Bidder shall employ only such workers and supervisors who have considerable experience of similar work and who can work, temperamentally in good harmony and co-operation.
2. The bidder to install all equipment and readiness of equipment including tubing work etc. within 15 days from the intimation by GGL EIC. Any delay from the timeline can be consider as a delay and Rs. 1000/day delay charge will be deduct from the invoices.
3. The Bidder has to arrange & submit documents of competent manpower, certified crane, lifting plan, tools and tackles required for safe installation, erection in advance 1-2 days to GGL for review of CNG package.

### 10.2.2. Receiving and Handling of Equipments

1. All equipment received at site shall be checked by the Bidder for the equipment being intact, in the presence of Engineer-in- Charge and shall be unloaded and accepted by the Bidder for the storage and safe custody. The equipment shall be stored in the approved manner by Engineer-in-Charge and the Bidder shall be responsible for the storage and safety of the equipment.
2. Whenever the equipment is received in wooden crates the Bidder shall carefully dismantle these crates and store all timber and packing materials properly.
3. It shall be the responsibility of the Bidder to study the requirements of installation and instructions for commissioning of the same, by employing skilled technicians experienced in the type of services required. The Bidder shall be fully responsible for the safe custody of the equipment during the period from acceptance of the equipment to commissioning and handing over of the same to the GGL.

### 10.2.3. Precautions to be Taken by Bidder

1. The Bidder shall take adequate care and precautions to prevent loss/damage of material and equipment.
2. During the execution of the work the Bidder shall keep structures, materials and equipment adequately and safely braced by struts, guys, and any other approved means as required till installation work is satisfactorily completed. The Bidder shall design, provide and erect the struts, guys, shorting, bracing, planking support in such a way that they do not interfere with other work and shall not damage or cause distortion to other works executed by him.
3. Openings for level gauges, thermowells and other instruments shall be protected during and after erection.
4. All accessories like pressure gauge, temperature indicators, safety valves, etc. shall be tagged and separately kept till erection.
5. All flange connections and openings shall be kept blanked with wooden covers to prevent entry of foreign matter.



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### 10.2.4. Erection of Equipment

1. Bidder shall submit erection/installation procedure in advance , which shall be as per OEM guideline, Installation check list, installation schedule, list of spares, which required for installation before start the installation of equipment
2. The Bidder shall make careful checks of all the equipment received at site and ensure that protective greases and wrapping applied on the machined surfaces and other parts by the equipment supplier for protection during transportation and storage are intact. Any defects noticed shall be reported and corrective action shall be taken. Special care shall be taken by the Bidder for bearings, rotating parts etc., to prevent seizing. Generally, the packages shall not be opened until required for installation. Orientation of all the foundations, elevations, lengths, positions of anchor bolt and diameter of holes in base plates/supporting saddles of equipment, etc. shall be checked by the Bidder well in advance. Minor rectification work like chipping of foundation shall be carried out by the Bidder in time.
3. The Bidder shall also check the nozzle orientation on vessels and see their compliance with detailed drawings and specifications. Any discrepancy shall be brought to the notice of Engineer-in-Charge and start work only after his approval.
4. Rigging procedures of all major lifts above 5 MT and at maximum crane capacity shall be submitted by Bidder for approval of the Engineer-in-Charge. However, such approvals shall not relieve the Bidder from the responsibility of safe rigging and lifting of the equipment, machinery, etc.
5. Drilling and tapping of holes in base plates, fixing of couplings on shaft after enlarging the pilot bore to correct size with keyways etc. and doweling including provisions of dowel pins or similar arrangement for retaining the alignment shall be carried out by the Bidder with utmost care.
6. All joints shall be assembled without undue stresses. Flanges must be parallel and correctly aligned.
7. The Bidder shall execute the work with the help of relevant approved drawings, specifications and equipment supplier's special requirements as specified in his instructions manual. The Bidder shall prepare detailed procedures, outline sequence of operation, prepare time schedule for each operation and seek approval of Engineer-in-Charge, as mentioned in other clause of this tender.
8. Wherever necessary the Bidder shall remove the anti- corrosive coating applied on the machine/equipment by the supplier, carefully and completely with light oil/ Equivalent.
9. After checking orientation and overall dimensions of the foundations, location and sizes of anchor bolts, shape of foundation shall be checked as per foundation drawing with reference to the equipment centre line.
10. On the chipped and prepared foundation surface, the Bidder shall set up liners for installation and centering of equipment. Liners shall be so arranged that the load of equipment is uniformly and exactly distributed to the foundation. Liners shall be placed as near as possible to both sides of anchor bolts. Where distance between anchor bolts is too long additional liner shall be set up in between. The height of each liner shall be measured on the basis of standard level bench mark. The liners shall be fixed with appropriate grouting material.
11. The upper surface of the foundation shall be watered sufficiently, at least 24 hours prior to



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setting of liners, to ensure good adhesion of grouting material.

12. The Bidder shall assemble, couple, fix, fit, install, level, align and grout the equipment/materials on foundations, structures, platforms, floors etc., as the case may be. He shall bolt, weld, cut, drill, rivet and brace all components and fix them rigidly with one another on the foundation supports, etc.
13. All necessary shims scaffolding, temporary supports, staging, grouting cement, sand, etc., required for erection of the equipment shall be kept ready in advance.

### 10.2.5. Assembly, Levelling and Alignment

1. Some of the equipments may be shipped by suppliers in knocked down condition. All drive motors, agitators etc. may be shipped separately. The Bidder shall assemble all such parts and sub-assemblies as per the manufacturer's instructions/manuals, drawings etc.
2. The Bidder shall assemble position and fix all internals of the equipment.
3. Method of lifting and handling of equipment and its sub- assemblies shall be thoroughly discussed by the Bidder with the Engineer-in-Charge. The equipment wherever required shall be leveled for temporary setting using screw jacks at the lower parts of common bed.
4. The centering of alignment of the equipment is generally done in the factory. However, there are chances of this alignment getting disturbed during transportation of the equipment. The Bidder shall therefore, recheck the alignment and take remedial steps as per the instructions given in the installation manual of suppliers after discussing with Engineer-in-Charge, if any misalignment is observed. For motor driven equipment the driving and driven shafts shall be fully aligned, deflection and face deviation of the shafts shall individually be measured and it shall be confirmed that values are within the tolerances. All readings of the inspection shall be properly recorded and submitted to Engineer-in-Charge.
5. After completion of alignment, the equipment shall be assembled in accordance with approved procedure. After perfect alignment of driven shaft is achieved, these shall be coupled and base plates shall be cleared for grouting. Care shall be taken during grouting to see that the base plate level and alignment are not disturbed.

### 10.2.6. Erection of Rotary Equipment

1. Rotary equipments may be erected as separate units of driver and driven parts. Before erection, Bidder shall inspect the foundation for dimensions, locating size and condition of anchor bolts. He shall properly carry out chipping, fixing, cleaning of foundation, place liners, place base plate on the liner and set anchor bolts, align provisionally base plates and fix anchor bolts by pouring mortar into anchor boxes. Assemble the complete unit and align for grouting. After grouting recheck the alignment of the unit and couple the shaft after connecting piping as per the detailed engineering drawings. The installation of base plate and the unit shall be carried out in such a manner that the requirement of tolerance on height, position, level as specified on the Manufacturer's drawings/instruction manual are fully met with.
2. Leveling shall be carried out on four corners of the base plate ends for both directions of shaft and right angle to the shaft.
3. The alignment of the unit shall be carried out on the basis of the finished surfaces which are as nearest as possible to the centre of the shaft with the help of dial gauge.



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4. Where an adjustment between shaft and coupling is required for their fitting, the adjustments shall be carried out to the coupling and not to the shaft.
5. The alignment of the unit shall be carried out until complete alignment of driving and driven shaft is obtained. While aligning, the deflection and face deviation of the driving and driven shaft shall individually be measured with the help of dial gauge and should conform to the allowable limits specified by manufacturer.
6. After completion of alignment it shall be confirmed that the shaft can be rotated smoothly and freely by hand.
7. Dispensers, cascade, skid and UPS to be install properly by bidder as per instruction given by GGL EIC.
8. After connection of piping, the alignment of the pump and other rotary equipments shall be rechecked. Any misalignment induced by the piping connections shall be corrected by adjusting piping.
9. Running test of motor etc. shall be performed with no load and it shall be confirmed that vibrations, sound and temperature of motor are not abnormal.
10. After running test of motor, the surface of motor and the driven unit shall be coupled with confirmation of rotating direction of unit and motor.
11. Trial running of assembled unit shall be performed and it should be confirmed that vibration, sound and temperature readings are within the acceptable limits specified by the supplier.

### 10.2.7. Testing

1. The Bidder shall follow good engineering practice and/or the testing manuals supplied by the equipment manufacturer for the testing of equipment.
2. All pumps shall be tested hydrostatically by running on water.
3. No load running tests shall be carried out, where required.
4. The mechanical testing of all equipment shall be carried out to the satisfaction of Engineer-in-Charge and their signature shall be obtained on the test certificates.
5. The following points to be adhere by bidder and shall be part of site readiness/ commissioning of compressor before taking in operation:
  - Compressor installation and readiness to be done as per OEM recommendation and approved check list.
  - Compressor pre-commissioning to be done as per OEM recommendation as well GGL guidelines as well as simulation of all instruments, CO2 flooding system, Emergency switches etc.
  - Compressor testing to be done as per OEM recommendation as well as GGL guidelines with competent person.
  - Non sparking tools to be used during the compressor testing on gas.
  - Proper PPE to be ensure during the performing the activity on compressor based on GGL guidelines/procedure/ PPE matrix/ work permit etc.
  - Leak test @ 230-250 during the FAT



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- Ensure entire system leak check-compressor inlet and PRS to compressor discharge line including the priority panel align with the outlet end connections for dispenser and storage cascades till battery limit of supplier.
- Ensure marking is done on all tube joints. Fittings and that all interconnected tubes are aligned properly as per recommendation of tube/fitting suppliers.
- Prepare and submit a reference drawing for all tube joints fittings
- All 7 lines from priority panel to end connections for dispenser line, storage cascade lines, Mobile Cascade need to be tested at operating pressure in all valves open condition.

### 10.2.8. Miscellaneous Steel

All Studs and nuts, anchor bolts, nuts, lock washers, supports and other miscellaneous items shall be supplied by the Bidder. Before installing the equipment, the Bidder shall verify location of Studs and nuts.

### 10.2.9. Grouting

Grouting of Anchor bolts and nuts, holes, pockets and under base plates or under equipments have been broadly classified into two categories e.g. non-shrinking grout and ordinary grout. Non-shrinking grout shall consist of 1 part of ordinary Portland cement, 1 part of clean dry well grades sand and 1 part of Ferro-grout of similar additive (approved by the Engineer-in-Charge). Water should be kept minimum so that the mix can be applied adequately. The grouting material shall solidly fill the spaces to be grouted and permanently retain its original volume so that the base plate will be held firmly in the set position. The amount of water used in mixing shall be kept to a minimum such that the grout shall have a consistency to stiff to flow. The top of foundation shall be clean and free of all laitance loose particles, oil, grease, etc. and shall be wetted thoroughly leaving no puddles prior to grouting. All trapped pockets in the steel structures shall be prepared using ordinary grout. Under no condition neat cement shall be used for grouting.

#### i. Non-shrinking grout shall be used for grouting purposes in;

1. All vessels etc. having equipment height more than 6.0 meter from anchor base
2. All horizontal vessels having diameter 1000 mm and above
3. All compressor and engine foundations

#### ii. Ordinary grout shall be used for grouting purposes in:

1. All vertical vessels etc. having height less than 6.0 m from anchor base
2. All horizontal vessels having diameter less than 1000 mm
3. All structural frames or platforms having height less than 6.0 m
4. All pumps, horizontal or vertical
5. All other miscellaneous foundations or piles or on paving

### 10.2.10. Placement:

1. All anchor bolts holes shall be completely filled with grout





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2. The finished surface shall be floated smooth and shall slope away from base plate approximately 1:25
3. After the initial set is over, the grout shall be kept thoroughly wet for a minimum of 5 days
4. Care is to be taken during grouting so that the base plate level and alignment is not disturbed.
5. Over and above the grouting clearance shown in foundation drawings, grouting of pockets made by base frame for machinery, equipment, steel structures etc. shall also be completely filled with grouting as per direction of Engineer-in-charge.

### 10.3. Pre-commissioning and Commissioning

1. The Bidder shall inspect equipment within its battery limit after erection as per pre commissioning check list and submit the completion certificate, and arrange for pre-commissioning checks, functional tests of instrumentation and control before trial runs of 72 hours and commissioning.
2. On completion of erection and commissioning. The Bidder shall arrange for the performance and guarantee tests run of the CNG package.
3. The Bidder shall make provision of system flushing with nitrogen during the pre-commissioning and commissioning period. For this the Bidder shall arrange nitrogen through nitrogen cylinders with sufficient length of flexible hose pipe.
4. Bidder shall submit commissioning procedure, which include list of commissioning spares, pre-commissioning checklist.
5. This activity shall be carried out in a systematic manner so as to avoid any accident to operating personnel.
6. During the start up all the instruments calibration, controller alignment, trip point setting shall be trimmed so as to meet the operation requirements.
7. Prior to guarantee run of CNG Station, the vital instrument as required by Bidder have to be recalibrated and the results recorded. The tagging of each instrument to be display.
8. The following points to be adhere by bidder and shall be part of site readiness/ commissioning of booster compressor before taking in operation:
  - 8.1 Compressor installation and readiness to be done as per OEM recommendation and approved check list.
  - 8.2 Compressor pre-commissioning to be done as per OEM recommendation as well GGL guidelines as well as simulation of all instruments, CO2 flooding system, Emergency switches etc.
  - 8.3 Compressor testing to be done as per OEM recommendation as well as GGL guidelines with competent person.
  - 8.4 Non sparking tools to be used during the compressor testing on gas.
  - 8.5 Proper PPE to be ensure during the performing the activity on compressor based on GGL guidelines/procedure/ PPE matrix/ work permit etc.
  - 8.6 Leak test maximum working pressure for each unit
  - 8.7 Ensure entire system leak check-compressor inlet and PRS to compressor discharge line including the priority panel align with the outlet end connections for dispenser and





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- storage cascades till battery limit of supplier.
- 8.8 Ensure marking is done on all tube joints. Fittings and that all interconnected tubes are aligned properly as per recommendation of tube/fitting suppliers.
  - 8.9 Prepare and submit a reference drawing for all tube joints fittings
  - 8.10 All lines from priority panel to end connections for dispenser line, storage cascade lines, Mobile Cascade need to be tested at operating pressure in all valves open condition

### 10.4. Handing Over and Training

#### 10.4.1. Handing Over the CNG Package

The Bidder shall run CNG package for 72 hours continuous trouble-free operation in all aspects in presence of the Owner or the authorised representatives of the Owner before it is handed over to the owner for operation and maintenance.

#### 10.4.2. Training of Owner's Personnel

The Bidder has to impart the training to the staff attached with CNG station at the time of induction, which covers minimum of following aspects as per OISD-179:

1. Hazardous characteristics of CNG.
2. Familiarisation with operational procedures and practices.
3. Hands on experience on Operation of Equipment.
4. Routine maintenance activities of the facilities.
5. Knowledge of emergency and manual shut down systems.
6. Immediate and effective isolation of any CNG leak.
7. Accounting of product.
8. Safety regulations and accident prevention.
9. Evacuation and safe escape of vehicles.
10. The Bidder has to suggest type and time period of training programme in technical bid considering the above contents. The cost of the same shall be furnished in commercial bid.

### 10.5. Guarantees and Warranties

#### 10.5.1. Mechanical

- The Bidder shall furnish unconditional guarantee for design, materials of construction for entire life of the Package and for workmanship of the CNG package as 18 months from the date of supply or 12 months from the date of commissioning, whichever is earlier.
- All the equipment/items shall be capable of performing the duties specified in this specification without damage, distortion or failure of any component.
- The Bidder shall repair/replace any part of the equipment supplied by him at his own expense, in the event of failure during the guarantee period.

#### 10.5.2. Performance

1. Performance guarantee for capacity, pressure and power consumption.



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2. Performance tests shall confirm to relative standard for the compressor without negative tolerance on capacity
3. If the unit supplied by the Bidder fails to achieve the specified performance under the given condition, the Bidder shall carry out such modifications or replacement of the units as necessary to meet the required performance at his own cost within the time as mutually agreed upon.
4. The Bidder shall guarantee the power consumption at rated point and submit the performance curves. The guaranteed power consumption at the compressor shaft shall be verified during site testing by measurement of power input to the electric drive motor multiplied by motor test efficiency. The applicable tolerance on power consumption shall be +/- 1% with instrument tolerance. Bidder shall provide power consumption details in tabular format at different suction pressure range according to specification.
5. The completion of stipulated tests and issue of test certificates shall not relieve the Bidder of his ultimate responsibility of guaranteeing the equipment/ material and its performance.
6. In the event of non fulfilment of performance guarantees, (up to end of the defect liability period of 1 year) the Bidder, at his own cost, shall do modification, replacement and rectification to meet the guarantee requirement of the purchase order. If within reasonable time limit (as agreed to by both the parties), the Bidder fails to make the required corrections in the equipment or its component, the Owner may at his discretion reject the equipment and can ask the Bidder to supply and install new equipment of proper design and manufacturing to meet the performance guarantees, as per the Purchase Order.

### 11. Non-material Requirements (Drawings and Documents)

1. Bidders are advised to note the bids will be considered incomplete if the documents requested for bid stage are not submitted along with the bid.
2. Unless specified 4 copies each of below documents shall be submitted at the stages defined, except for the bid stage, which would be equal to the number of bid copies.
3. The bidder would need to specify the timeline when the documents requiring approval would be submitted in the PERT chart.
4. The Bidder to note that any routing of services and axillaries falling in The Bidder's scope of supply, outside the skid boundary and interfacing with the client facilities, such as cable routing, piping, etc would need to be first proposed in a general arrangement drawing for client's approval.

Item	Description	Document Required Stage			
		With Bid	For Approval	For Information	Final/As-Built
	<b>General</b>				
1	A specific statement that CNG compressor packages are in strict accordance with data sheet, technical specifications and applicable standards. In, case of any deviation, specific list with details and reasons for each deviation.	Yes			
2	Catalogue details for individual bid items such Compressor, Motor, Cascades, Dispensers, Controller, Ancillaries and Auxiliaries	Yes	Yes		Yes



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3	Utility and their consumption requirement at battery limit	Yes		Yes	Yes
4	Itemised electrical load data	Yes	Yes		Yes
5	Itemised bill of material for all equipment being supplied along with sub-assemblies.	Yes		Yes	Yes
6	A project schedule in form of a PERT chart outlining from the date of PO, the timeline for engineering, approvals, procurement, deliveries, inspection, erection and commissioning including milestone such as FAT and SAT	Yes	Yes		
<b>Design Documents</b>					
7	Process flow diagram	Yes	Yes		Yes
8	Process and Instrument diagram for each bid items as applicable along with composite P&ID from tie-in point of main gas line up to the dispensing point with inter-locks	Yes	Yes		Yes
9	Sizing calculation of all pressure and non-pressure parts such as compressor, coolers, cable sizing, piping, electrical system, instrumentation and control.		Yes		Yes
10	Estimated heat load for equipment located in control room		Yes	Yes	
11	Electrical single line diagram		Yes		Yes
12	Electrical wiring diagram			Yes	Yes
13	Starting time calculation at 100% and 80% of rated voltage	Yes		Yes	Yes
14	Itemised equipment list, listing all the sub-assemblies, capacities, rating and MOC	Yes		Yes	Yes
15	Lubrication schedule along with a statement on oil consumption and minimum allowable oil temp			Yes	Yes
16	V-belt , pulley with selection chart and calculation		Yes		Yes
17	Design calculations for pulsation dampener		Yes		Yes
18	Thermal and mechanical design calculation for cooler		Yes		Yes
19	Torque angle diagram, piston rod load VS crank angle	Yes		Yes	Yes
20	Torque speed characteristic	Yes		Yes	Yes
21	Acoustic / mechanical evaluation report			Yes	Yes
22	Structural loading details with dynamic and static load cases.			Yes	Yes
23	Control system architecture	Yes	Yes		Yes
24	Control philosophy and Alarm and shut down list with set point		Yes		Yes
25	Loop diagram	Yes			Yes
26	Packing list for compressor package (Including loose supply material like cables, Tubing & fittings, LCV fill post , Suction skid etc.)	Yes	Yes		Yes
<b>General Arrangement Drawings</b>					
27	Compressor Package	Yes	Yes		Yes
28	Motor	Yes	Yes		Yes
29	Cooler	Yes	Yes		Yes



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

30	Storage Cascade, Dispenser	Yes	Yes		Yes
31	Priority Panel	Yes	Yes		Yes
32	Electrical panels	Yes	Yes		Yes
33	Skid with mounting details		Yes		Yes
34	Foundation plan for all the items requiring civil foundation			Yes	Yes
35	Overall equipment layout showing compressor skid, cascades, panels location, dispensers and requirement for access platforms, drains, movement, clearances.	Yes	Yes		Yes
36	Piping GA from tie-in point to compressor skid to storage cascade and to dispensers		Yes		Yes
<b>List of Spares</b>					
37	Itemized price list of mandatory spares	-	-	Yes	-
38	Itemized list with price of spares for erection / commissioning	-	-	Yes	-
39	Item list of spares with price for 2 years running	-	-	Yes	-
<b>Testing and Certificates</b>					
40	Overall as well individual assembly quality assurance plan	Yes	Yes		Yes
41	Drawing for testing arrangement and test procedure to be adopted			Yes	
42	<b>Certificate for following</b>				
	a) Hydraulic testing				Yes
	b) Non destructive testing				Yes
	c) Material composition and physical properties				Yes
	d) Leak proofness list of frame				Yes
	e) Lube oil pump, frame oil pump, hyd. Oil pump				Yes
43	Design / Actual assembly clearance chart			Yes	Yes
44	Test records of following:				
	a) Mechanical running				Yes
	b) Performance test				Yes
	c) Noise level test				Yes
45	Dispenser communication protocol			Yes	Yes
46	Statutory documents			Yes	Yes
47	O & M manual	Yes		Yes	Yes



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### Appendix A: Guaranteed Parameters

\*Bidder to furnish the guaranteed parameters along with the bid.

#### A.1 650 SCMH Compressor Package

Sr.	Parameter	Bidder's Data
		Inlet Pressure 19 kg/cm <sup>2</sup> (g)
1	Compressor Capacity, SCMH	
2	Compressor BkW at Rated Conditions (No +ve tolerance), KW	
3	Compressor BkW at RV Set Conditions (No +ve tolerance), KW	
4	Net of all auxiliaries/package ventilation loads, KW	
5	Noise level 75 dBA @ 1 meter from enclosure	

#### A.2 1200 SCMH Compressor Package

Sr. No.	Parameter	Bidder's Data
		Inlet Pressure 19 kg/cm <sup>2</sup> (g)
1	Compressor Capacity, SCMH	
2	Compressor BkW at Rated Conditions (No +ve tolerance), KW	
3	Compressor BkW at RV Set Conditions (No +ve tolerance), KW	
4	Net of all auxiliaries/package ventilation loads, KW	
5	Noise level 75 dBA @ 1 meter from enclosure	

#### A.3 400 SCMH Compressor Package

Sr. No.	Parameter	Bidder's Data
		Inlet Pressure 3 kg/cm <sup>2</sup> (g)
1	Compressor Capacity, SCMH	
2	Compressor BkW at Rated Conditions (No +ve tolerance), KW	
3	Compressor BkW at RV Set Conditions (No +ve tolerance), KW	
4	Net of all auxiliaries/package ventilation loads, KW	
5	Noise level 75 dBA @ 1 meter from enclosure	



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### A.4 1000 SCMh Compressor package

Sr. No.	Parameter	Bidder's Data
		Inlet Pressure 19 kg/cm <sup>2</sup> (g)
1	Compressor Capacity, SCMh	
2	Compressor BkW at Rated Conditions (No +ve tolerance), KW	
3	Compressor BkW at RV Set Conditions (No +ve tolerance), KW	
4	Net of all auxiliaries/package ventilation loads, KW	
5	Noise level 75 dBA @ 1 meter from enclosure	

### A.5 1700 SCMh Compressor package

Sr. No.	Parameter	Bidder's Data
		Inlet Pressure 19 kg/cm <sup>2</sup> (g)
1	Compressor Capacity, SCMh	
2	Compressor BkW at Rated Conditions (No +ve tolerance), KW	
3	Compressor BkW at RV Set Conditions (No +ve tolerance), KW	
4	Net of all auxiliaries/package ventilation loads, KW	
5	Noise level 75 dBA @ 1 meter from enclosure	

### A.6 1000 SCMh VIP Compressor package

Sr. No.	Parameter	Bidder's Data
		Inlet Pressure 19 kg/cm <sup>2</sup> (g)
1	Compressor Capacity, SCMh	
2	Compressor BkW at Rated Conditions (No +ve tolerance), KW	
3	Compressor BkW at RV Set Conditions (No +ve tolerance), KW	
4	Net of all auxiliaries/package ventilation loads, KW	
5	Noise level 75 dBA @ 1 meter from enclosure	

Note:

- If suction pressure at the inlet of PRS is equal to or above the pressure define in Guaranteed Parameter, Than Bidder shall have to maintain suction pressure of compressor as per guaranteed parameter (i.e. 19 kg/cm<sup>2</sup>(g) for 650 SCMh, 1000 SCMh, 1700 SCMh and 1200 SCMh, 3 kg/cm<sup>2</sup>(g) for 400 SCMh during entire contract period.
- If above note is violated by the bidder than penalty of 1000/- per instant shall be levied on the bidder.



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### Appendix B: Datasheet for UV fire detectors

<b>TECHNICAL GENERAL</b>		
<b>1</b>	<b>PROJECT:</b>	
<b>2</b>	<b>OWNER:</b>	<b>SITE:</b>
<b>3</b>	<b>EQUIPMENT: UV FIRE DETECTION FOR CNG STATIONS</b>	
<b>4</b>	<b>NO.</b>	<b>FIRE DETECTION TYPE:</b>
<b>5</b>	NOTE: <input type="checkbox"/> SCOPE OPTION / INFORMATION SPECIFIED BY GUJARAT GAS LTD <input type="checkbox"/> INFORMATION REQUIRED FROM VENDOR.	
<b>6</b>	<input type="checkbox"/> MANUFACTURER:	<input type="checkbox"/> MODEL NO.:
<b>7</b>	<input type="checkbox"/> WAVE LENGTHS:	<input checked="" type="checkbox"/> TYPICAL RESPONSE TIME: < 3 SEC @ 50FT
<b>8</b>	<input type="checkbox"/> FIELD OF VIEW:	<input type="checkbox"/> MINIMUM SENSOR RESPONSE TIME:
<b>9</b>	<input type="checkbox"/> SENSITIVITY	<input type="checkbox"/> MAINTENACE SIGNAL:
<b>10</b>	<input checked="" type="checkbox"/> CLASSIFICATION: CLASS I, DIV 1, GROUPS B, C & D: Eexd IIC, T5, IP66	<input checked="" type="checkbox"/> CLASS II, GROUP E,F & GCLASS III, TYPE 4X
<b>11</b>	<input checked="" type="checkbox"/> APPROVALS: CSA, FM, ATEX, CENELEC, CE MARKING	
<b>12</b>	<input checked="" type="checkbox"/> ENVIRONMENTAL SPECIFICATIONS	
<b>13</b>	<input checked="" type="checkbox"/> OPERATING TEMPERATURE RANGE: -40 (0C) to 85 (0C)	
<b>14</b>	<input checked="" type="checkbox"/> STORAGE TEMPERATURE RANGE: -50 (0C) to 85 (0C)	
<b>15</b>	<input checked="" type="checkbox"/> OPERATING HUMIDITY RANGE: 0% TO 100% RH NON-CON-DENSING	
<b>16</b>	<input checked="" type="checkbox"/> ALTITUDE (M): 55 M FROM MSL	<input checked="" type="checkbox"/> AMBIENT TEMP: 110 OF (MAX.), 51 OF (MIN.)
<b>17</b>	<input checked="" type="checkbox"/> EARTH QUAKE ZONE V	
<b>18</b>	<input checked="" type="checkbox"/> INSTALLATION: <input checked="" type="checkbox"/> INDOOR	
<b>■ ELECTRICAL SPECIFICATION:</b>		
<b>19</b>	<input checked="" type="checkbox"/> INPUT POWER: 20 – 36 VDC, 24 VDC @ 150Ma max. <input type="checkbox"/> COPM FAULT	
<b>20</b>	<input checked="" type="checkbox"/> ANALOG SIGNAL: 4-20mA (600 Ohms Max.)	<input type="checkbox"/> READY SIGNAL
<b>21</b>	<input type="checkbox"/> FAULT SIGNAL: 0Ma	<input type="checkbox"/> UV SIGNAL:
<b>22</b>	<input type="checkbox"/> IR SIGNAL:	<input type="checkbox"/> WARN SIGNAL:
<b>23</b>	<input type="checkbox"/> ALARM SIGNAL:	<input type="checkbox"/> BAUD RATE:
<b>24</b>	<input checked="" type="checkbox"/> RELAY CONTACT RATING: 8A, 250VAC, 8A @ 24VDC	<input type="checkbox"/> RS-485 OUTPUT:
<b>25</b>	<input checked="" type="checkbox"/> RFI/EMI PROTECTION: COMPLIES WITH EN50081-2	<input type="checkbox"/> STATUS INDICATOR:
<b>26</b>	<input type="checkbox"/> FAULT MONITORING:	
<b>■ MECHANICAL SPECIFICATION:</b>		
<b>28</b>	<input checked="" type="checkbox"/> HOUSING:	<input checked="" type="checkbox"/> LENGTH:
<b>29</b>	<input checked="" type="checkbox"/> DIAMETER:	<input checked="" type="checkbox"/> MOUNTING:
<b>30</b>	<input checked="" type="checkbox"/> CABLE ENTRY:	<input checked="" type="checkbox"/> WEIGHT:
<b>SCOPE OF SUPPLY</b>		
<b>31</b>	<input checked="" type="checkbox"/> UV FIRE DETCTION SENSORS COMPLETE:	
	<b>REMARKS:</b>	



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### Appendix C: Datasheet for Gas Detection System

1	<b>TECHNICAL GENERAL</b>				
2	<b>PROJECT:</b>				
3	OWNER: <b>M/S</b>		SITE:		
4	EQUIPMENT: <b>GAS DETECTION FOR CNG STATIONS</b>				
5	NO.		GAS DETECTION TYPE:		
6	NOTE: <input checked="" type="checkbox"/> SCOPE OPTION / INFORMATION SPECIFIED BY GUJARAT GAS LTD <input type="checkbox"/> INFORMATION REQUIRED FROM VENDOR.				
7	<input type="checkbox"/> MANUFACTURER:		<input type="checkbox"/> MODEL NO.:		
	<b>SIGNAL TRANSMISSION</b>				
8	<input type="checkbox"/> ANALOG: TRANSMISSION BY 3CORE SHEILDDED CABLE				
9	<input type="checkbox"/> MEASUREMENT CONTROL: 4mA to 20Ma				
10	<input type="checkbox"/> SENSOR DRIFTS BELOW ZERO:				
11	<input type="checkbox"/> MEASURING RANGE EXCEEDED:				
12	<input type="checkbox"/> TRANSMITTER FAULT:				
13	<input type="checkbox"/> MAINTENACE SIGNAL:				
14	<input type="checkbox"/> HART COMPATIBLE:				
	<input checked="" type="checkbox"/> <b>SITE / ENVIRONMENTAL DATA</b>				
15	SITE DATA:				
16	AMBIENT TEMP. (°F):	MAX:	110		
17	RELATIVE HUMIDITY	MIN:	51		
18	(%):	MAX:	82		
	ALTITUDE (M):		55 M ABOVE MSL		
19	INSTALLATION: <input checked="" type="checkbox"/> INDOOR				
20	<input checked="" type="checkbox"/> <b>ELECTRICAL AREA HAZARD:</b>				
21	CLASS/ZONE: <b>CLASS I ZONE I</b>		DIVISION: <b>I</b>		GAS GROUP: <b>D, GROUP IIA, IIB</b>
	<input checked="" type="checkbox"/> <b>APPLICABLE CODES AND STANDARDS</b>				
22	<input checked="" type="checkbox"/> <b>GAS DETECTION APPROVALS: CENELEC :Exd IIC 6</b>		<input checked="" type="checkbox"/> <b>UL, CSA: Class 1, Div 1, Groups B,C,D</b>		
	<b>VOLTAGE OF SUPPLY</b>				
23	<input type="checkbox"/> OPERATING VOLTAGE:		A.C/D.C	V	Ph
24	<input type="checkbox"/> IN-RUSH CURRENT:		A.C/D.C		
25	<input type="checkbox"/> POWER INPUT		A.C/D.C		
	<input checked="" type="checkbox"/> <b>PHYSICAL SPECIFICATIONS</b>				
26	<input type="checkbox"/> ENCLOSURE: <b>NEMA 4+7 (IP55)</b>				
27	<input type="checkbox"/> SIZE				
28	<input type="checkbox"/> WEIGHT				
	<input checked="" type="checkbox"/> <b>INSPECTION AND TESTS</b>				
29	<input type="checkbox"/> Physical Tests on site:				
	<b>REMARKS</b>				

\*: Indicates data to be furnished by the bidder





## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### Appendix D: Specification – Natural Gas (compressor suction) and Nitrogen Service Piping:

PIPING MATERIAL SPECIFICATION												SPEC.NO. : MSD-1011 SHEET NO. : 1 OF 3											
BASE MATERIAL : C.S.      INSULATION : NIL TRACING :                    NIL												JOB NO: 249040 CLASS : B1a											
SERVICE : NATURAL GAS {COMPRESSOR SUCTION}, NITROGEN {OUT SIDE PACKAGE}																							
DESIGN CONDITIONS		MAX.PRESSURE :																					



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

<b>PIPING MATERIAL SPECIFICATION</b>					SPEC.NO. : MSD-1011 SHEET NO. : 3 OF 3	
BASE MATERIAL: CS		INSULATION : NIL TRACING : NIL		JOB NO : 249040 CLASS : B1a		
SERVICE : NATURAL GAS (COMPRESSOR SUCTION), NITROGEN (OUT SIDE PACKAGE)						
<b>VALVE</b>						
TYPE :		BALL	GLOBE		CHECK	
TAG NO. :						
SIZE RANGE : NB		15NB & ABOVE	15TO40	50&ABV	15TO40	50&ABV
RATING :		300#	800#	300#	800#	300#
END CONNECTIONS :		FLGD. RF	BW	FLGD. RF	BW	FLGD. RF
MATERIAL : -BODY		A216Gr.WCB	A 105	A216Gr.WCB	A 105	A216Gr.WCB
TRIM	SHAFT	SS-304	AISI 410		-	
	SEAT	PTFE	AISI 410		AISI 410	
	DISC/BALL/PLUG	BALL	DISC		PISTON	DISC
		SS-304	13% Cr. AISI 410.		A 216 GR. WCB	
CONST.	-TYPE :	3 PIECE	REN PLUG		LIFT	SWING
	-STEM :	M.S. LEVER	RISING OS & Y		-	
	-BONNET :	FULL BORE	BOLTED	BOLTED	BOLTED	
-DISC :		SOLID WEDGE	PLUG TYPE		-	-
-SEAT :		RENEWABLE	RENEWABLE		INTEGRAL	RENEWABLE
SPECIFICATION :		NOTE-2	BS 5352	BS 1873	BS 5352	BS 1868
<b>NOTE:-</b> 1.VALVES TO BE FIRE TEST APPROVED TO BS 6755 PART 2. 2.BS 5351 UP TO 40 NB, 50 NB & ABOVE AS PER API 60, FIRE SAFE TO API 6 FA/API 607. 3.BALL VALVES 150 NB & ABOVE TO BE GEAR OPERATED. 4.WELDOLET RATING SHALL BE 3000# & THK. SUIT TO PIPE THICKNESS. 5.HYDRO TESTING OF PIPING SYSTEM SHALL BE DONE AT THE, HYDROTEST PRESSURE MENTIONED IN THE LINE LIST.						



GUJARAT GAS

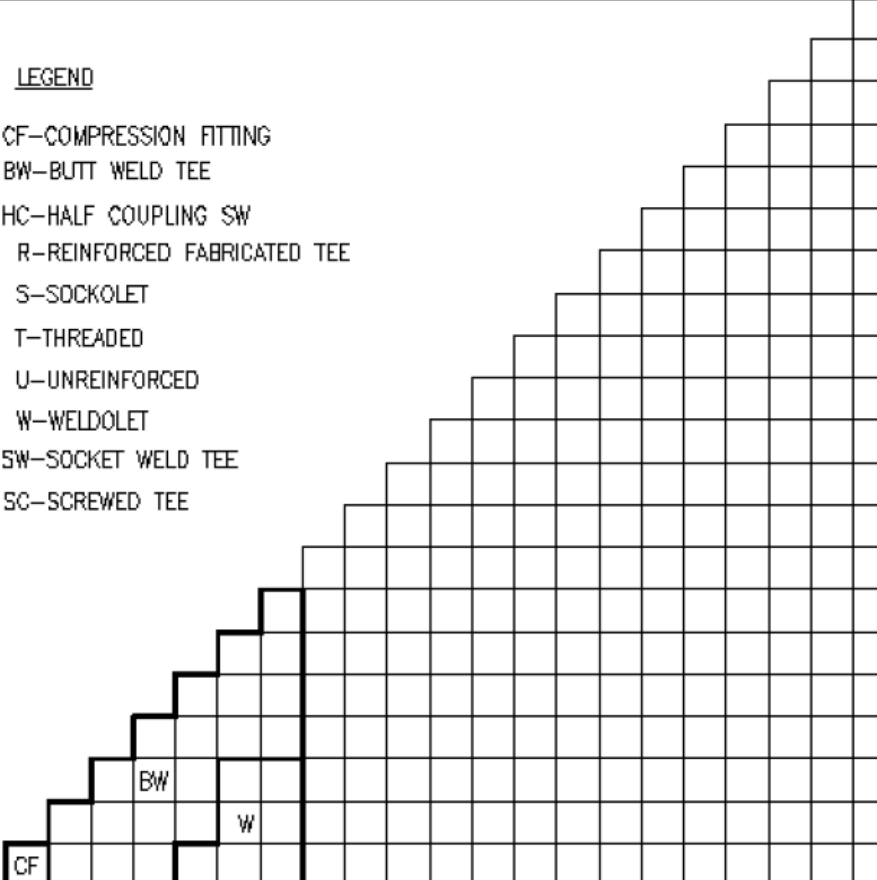
## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### Appendix E: Specification – Tubing/ Piping Natural Gas (Compressor Discharge) Service

PIPING ELEMENT SPECIFICATION				SPEC.NO. : MSD-1013 SHEET NO. : 1 OF 3						
BASE MATERIAL : SS-316    INSULATION : - TRACING : -				JOB NO. : 249040 CLASS : F2b						
SERVICE : NATURAL GAS (COMPRESSOR DISCHARGE), NITROGEN (TUBING)										
DESIGN CONDITIONS	MAX.PRESSURE :		kg/cm <sup>2</sup> (g)	310.0				RATING & FACING : 2500#, RTJ		
	MAX.TEMPERATURE :		°C	55.00						
	SYSTEM TEST PRESSURE :		kg/cm <sup>2</sup> (g)	420.75				CORROSION ALLOWANCE : NIL		
NOMINAL SIZE		IN	1/2 O.D. & BELOW	TUBE	3/4	1	1.5	2		REF. NOTE NO.
		mm	12.7 O.D. & BELOW		20	25	40	50		
TUBE/PIPE	THICKNESS (mm/IN) :				0.308	0.358	40	50		
	SCHEDULE NUMBER/THICKNESS :		14 SWG		SCH 160S					
	MATERIAL :		ASTM A-269 TP 316, SEAMLESS		ASTM A-312 TP 316, SEAMLESS					
	ENDS :		PLAIN		BEVELLED					
	PIPE TO PIPE JOINT :		UNION		BUTT WELDING					
	DIMENSION STANDARD :		ASTM A 269		ASME B-36.19					
FLANGES	TYPE :		-		WELDING NECK, RTJ					
	RATING :		-		2500 #					
	MATERIAL :		-		ASTM A-182 F 316					
	DIMENSION STANDARD :		-		ASME B-16.5					
BENDS	TYPE :		COMPRESSION TYPE		LR (1.5D) B.W.					
	RATING :		8000 #		SCH 80S		SCH 160S			
	MATERIAL :		ASTM A-182 F 316		ASTM A 403 Gr. WP 316, SEAMLESS					
	DIMENSION STANDARD :		EQUIVALENT TO SWAGE LOCK FITTINGS		ASME B-16.9					
FITTINGS	TYPE :		COMPRESSION TYPE		BUTT WELDED					
	RATING :		8000 #		SCH 80S		SCH 160S			*
	MATERIAL :		ASTM A-182 F 316		ASTM A 403 Gr. WP 316, SEAMLESS ASTM A 182 F 316 (ONLY FOR WELDOLETS)					
	DIMENSION STANDARD :		EQUIVALENT TO SWAGE LOCK FITTINGS		ASME B-16.9 / MSS SP-97 (ONLY FOR WELDOLETS)					
GASKETS	TYPE :		METALLIC OCTAGONAL RING TYPE							
	THICKNESS :		AS PER GROOVE NUMBERS							
	MATERIAL :		SS 316L (130 BHN MAX.)							
	DIMENSION STANDARD :		ANSI B-16.20, 2500 #							
BOLTING	STUD :		STUD FULLY THREADED							
	MATERIAL :		ASTM A-193 Gr. B8							
	NUT/WASHER :		HEAVY HEXAGONAL NUT WITH 3MM THK. RING TYPE WASHER (2 NOS.)							
	MATERIAL :		ASTM A-194 Gr.B8							
	DIMENSION STANDARD :		STUDS TO ANSI B18.2.1, NUTS TO ANSI B18.2.2							
* WELDOLET RATING SHOULD BE 9000 #, THICKNESS SUIT TO PIPE THICKNESS.										



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

PIPING ELEMENT SPECIFICATION				SPEC.NO. : MSD-1013 SHEET NO. : 2 OF 3																						
BASE MATERIAL SS-316		INSULATION : - TRACING : -		JOB NO. : 249040 CLASS : F2b																						
SERVICE : NATURAL GAS (COMPRESSOR DISCHARGE), NITROGEN (TUBING)																										
ITEM		SIZE		DESCRIPTION																						
PIPE JOINT		15NB & BELOW.		COMPRESSION TYPE FITTING.																						
		20NB TO 100 NB		BUTT WELDED WITH TIG																						
DRAINS		ON LINES ≤ 15NB		SAME AS LINE SIZE																						
		ON LINES > 15NB		15NB OR AS PER P & I DIAGRAMS																						
VENTS		ON LINES ≤ 15NB		SAME AS LINE SIZE																						
		ON LINES > 15NB		15NB OR AS PER P & I DIAGRAMS																						
TEMP. CONN		40NB		FLANGED.																						
PRESS. CONN.		15NB		WITH ISOLATION VALVE.																						
BRANCH CONNECTION	BRANCH SIZES	900	36	<div>LEGEND</div> <div>CF-COMPRESSION FITTING</div> <div>BW-BUTT WELD TEE</div> <div>HC-HALF COUPLING SW</div> <div>R-REINFORCED FABRICATED TEE</div> <div>S-SOCKOLET</div> <div>T-THREADED</div> <div>U-UNREINFORCED</div> <div>W-WELDOLET</div> <div>SW-SOCKET WELD TEE</div> <div>SC-SCREWED TEE</div> 																						
		800	32																							
		750	30																							
		700	28																							
		650	26																							
		600	24																							
		500	20																							
		450	18																							
		400	16																							
		350	14																							
		300	12																							
		250	10																							
		200	8																							
		150	6																							
		100	4																							
		80	3																							
		50	2																							
		40	1.5																							
		25	1																							
		20	3/4																							
		15	1/2																							
			IN			1/2	3/4	1	1.5	2	3	4	6	8	10	12	14	16	18	20	24	26	28	30	32	36
			mm			15	20	25	40	50	80	100	150	200	250	300	350	400	450	500	600	650	700	750	800	900
		HEADER SIZE																								



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

<b>PIPING ELEMENT SPECIFICATION</b>				SPEC.NO. : MSD-1013 SHEET NO. : 3 OF 3	
BASE MATERIAL : SS-316    INSULATION : - TRACING : -				JOB NO. : <b>249040</b> CLASS : <b>F2b</b>	
<b>SERVICE</b> : NATURAL GAS (COMPRESSOR DISCHARGE), NITROGEN (TUBING)					
<b>VALVE</b>					
TYPE :		BALL		CHECK	
TAG NO. :					
SIZE RANGE : NB		15NB	20-100	15NB	20-100
RATING :		6000# (NOTE-4)	2500#	2500#	2500#
END CONNECTIONS :		NOTE-3	B.W.	NOTE-3	RF.FLGD.
MATERIAL : -BODY		ASTM A-479 TYPE 316	ASTM A-182 F 316	ASTM A-182 F 316	
<b>TRIM</b>	SHAFT	AISI-316		AISI-316	
	SEAT	PTFE			
	DISC/WEDGE/BALL/ DIAPHRAGM/PLUG	BALL		DISC	
		AISI-316		AISI-316	
<b>CONSTRUCTION</b>	-TYPE :	3 PC, FULL BORE		LIFT CHECK	
	-STEM :	STEEL RUST PROOF HANDLE		-	
	-BONNET :	M.S. LEVER		BOLTED COVER	
-DISC :		-		AISI-316	
-SEAT :		PEEK	PTFE	RENEWABLE	
<b>SPECIFICATION :</b>					
		MFG. STD.	API 6D	MFG. STD.	NOTE-2
<b>NOTE</b>					
1.VALVES TO BE FIRE TEST APPROVED TO BS 6755 PART 2.					
2.VALVE DESIGN CONFIRM TO ANSI B 16.34 & VALVE END TO END DIMENSIONS TO ANSI B16.10.					
3.END CONNECTION TO SUIT DOUBLE FERRULE TYPE COMPRESSION FITTING.					
4.MAX. WORKING PRESSURE RATING OF VALVE.					
5.THREADS TO ANSI/ASME B 1.20.1					
6.HYDRO TESTING OF PIPING SYSTEM SHALL BE DONE AT THE HYDROTEST PRESSURE MENTIONED IN THE LINE LIST.					



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

### Appendix F: Specification – Drain and Vent Service Tubing/ Piping

PIPING ELEMENT SPECIFICATION										SPEC.NO. : MSD-1001 SHEET NO. : 1 OF 3											
BASE MATERIAL : M.S.    INSULATION : NIL TRACING :        -										JOB NO : 249040 CLASS : A1a											
SERVICE : DRAIN, VENT.																					
DESIGN CONDITIONS		MAX.PRESSURE :																			





## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

<b>PIPING ELEMENT SPECIFICATION</b>										SPEC.NO. : MSD-1001 SHEET NO. : 3 OF 3																							
BASE MATERIAL : M.S. INSULATION : NIL TRACING : -										JOB NO : 249040 CLASS : A1d																							
<b>SERVICE : DRAIN, VENT.</b>																																	
<b>VALVE</b>																																	
TYPE :		GATE		GLOBE		CHECK		BALL		BUTTER FLY		DIAPHRAGM		PLUG		NEEDLE																	
TAG NO. :																																	
SIZE RANGE : NB		15TO40 50&ABOVE		15TO40 50&ABOVE		15TO40 50&ABOVE		15TO40 50&ABOVE		80NB & ABOVE		15 & ABOVE		15 & ABOVE		15 TO 25																	
RATING :		800# 150#		800# 150#		800# 150#		150#		150#		150#		150#		800#																	
END CONNECTIONS :		SW RF.FLGD.		SW RF.FLGD.		SW RF.FLGD.		RF. FLGD.		WAFER		RF. FLGD.		RF. FLGD.		THREADED																	
MATERIAL : -BODY		A-105 A216WCB		A-105 A216WCB		A-105 A216WCB		A 216 WCB		IS:210 Gr.200		IS:210 GR. 200		A216 WCB		AISI 304																	
<b>TRIM</b>	SHAFT		13 % Cr AISI 410						SS304		AISI 410		AISI 410		-		-																
	SEAT								PTFE		EPDM		-		-		-																
	DISC/WEDGE/BALL/		WEDGE		DISC		PISTON		DISC		BALL		DISC		DIAPHRAGM		PLUG		-														
	DIAPHRAGM/PLUG		13 % Cr						AISI 410		A216 WCB		S.S.304		A351CF8		DUCTILE C.I. 6GG-40		NEOPRENE RUBBER		A-216 WCB		AISI 304										
<b>CONSTRUCTION</b>	-TYPE :		-		-		PISTON LIFT		SWING		3PIECE DESIGN		WAFER		WEIR		TAPER		-														
	-STEM :		RISING OS & Y		RISING OS & Y		-		-		STEEL RUST PROOF HANDLE		REFER NOTE NO.2		NON RISING		-		-														
	-BONNET :		BOLTED		BOLTED		BOLTED		-		-		-		BOLTED		-		-														
-DISC :		SOLID WEDGE		RENEWABLE		-		-		-		WITH NYLON COATING				-		-															
-SEAT :		RENEWABLE		RENEWABLE		INTEGRAL		RENEWABLE		RENEWABLE		NITRILE RUBBER				-		-															
SPECIFICATION :												API-602		API-600		BS-5352		BS-1873		BS-5352		BS-1868		BS-5351		API-609		BS-5156		API 599		-	
<p><b>NOTE</b></p> <p>1.BALL VALVE UP TO 40NB SHOULD BE FULL PORT,50NB &amp; ABOVE VALVE SHOULD BE REGULAR PORT.</p> <p>2.BUTTER FLY VALVES UP TO 200NB SHOULD BE WITH FLOW CONTROL LEVER.</p> <p>3.BUTTER FLY VALVES ABOVE 200NB SHOULD BE GEAR OPERATED.</p> <p>4.HYDRO TESTING OF PIPING SYSTEM SHALL BE DONE AS PER HYDROTEST PRESSURE MENTIONED IN LINE LIST.</p>																																	



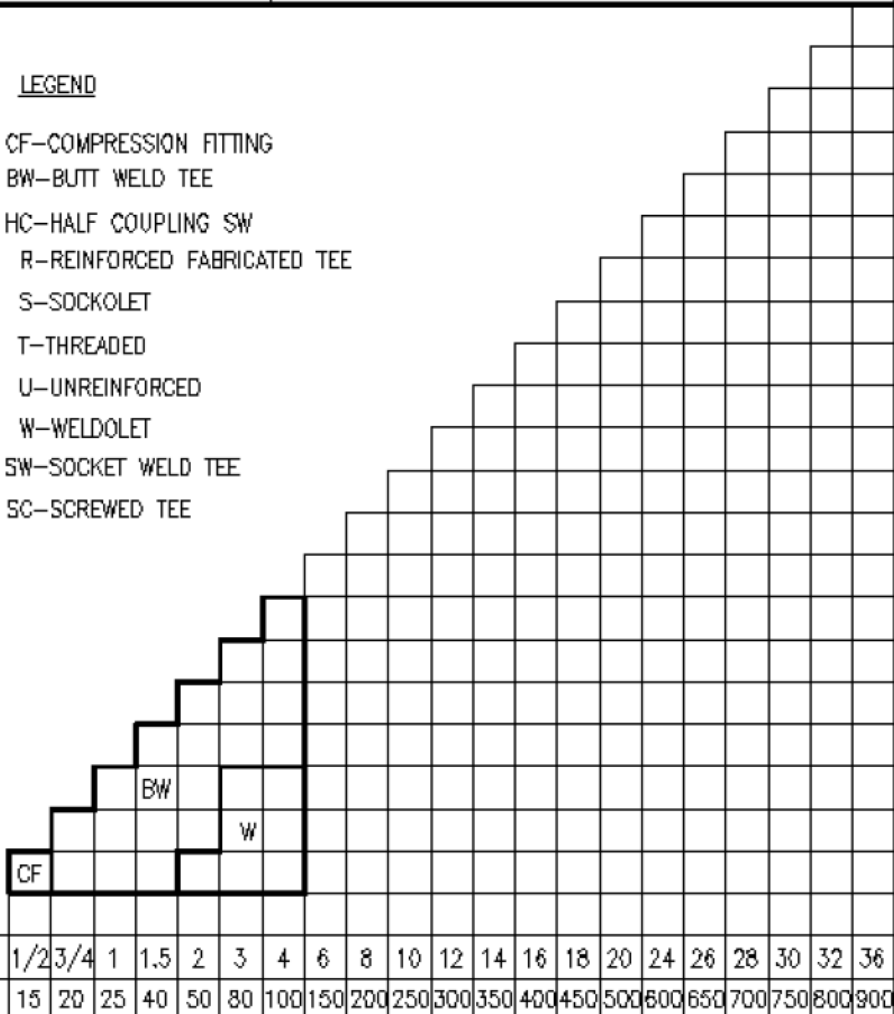


## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

<b>PIPING MATERIAL SPECIFICATION</b>				SPEC.NO. : MSD-1011 SHEET NO. : 1 OF 3									
BASE MATERIAL : C.S.      INSULATION : NIL TRACING : NIL				JOB NO: <b>249040</b> CLASS : <b>B1a</b>									
SERVICE : NATURAL GAS (COMPRESSOR SUCTION), NITROGEN (OUT SIDE PACKAGE)													
<b>DESIGN CONDITIONS</b>		MAX.PRESSURE :		kg/cm <sup>2</sup> (g)		25.0							
		MAX.TEMPERATURE :		°C		55.0							
		SYSTEM TEST PRESSURE :		kg/cm <sup>2</sup> (g)		37.5							
						RATING & FACING : 300#, RF							
						CORROSION ALLOWANCE : 1.5 MM							
<b>NOMINAL SIZE</b>		IN	1/2	3/4	1	1.5	2	3	4	6	8		REF. NOTE NO.
		mm	15	20	25	40	50	80	100	150	200		
<b>PIPE</b>	THICKNESS (mm/IN) :												
	SCHEDULE NUMBER/THICKNESS :	← SCH 80 →					← SCH 40 →						
	MATERIAL :	← ASTM A-106 Gr. B SEAMLESS →											
	ENDS :	← BEVELLED →											
	PIPE TO PIPE JOINT :	← BUTT WELD →											
	DIMENSION STANDARD :	← ANSI B-36.10 →											
<b>FLANGES</b>	TYPE :	← W.N.R.F. →											
	RATING :	← 300 # →											
	MATERIAL :	← ASTM A-105 →											
	DIMENSION STANDARD :	← ANSI B-16.5 →											
<b>BENDS</b>	TYPE :	← L.R. BUTT WELD →											
	RATING/THK. :	← SCH 80 →					← SCH 40 →						
	MATERIAL :	← A 234 GR WPB SEAMLESS →											
	DIMENSION STANDARD :	← ANSI B 16.9 →											
<b>FITTINGS</b>	TYPE :	← BUTT WELDED →											
	RATING/THK. :	← SCH 80 →					← SCH 40 →						
	MATERIAL :	A 234 GR WPB SEAMLESS / ASTM A 105 (ONLY FOR WELDOLETS)											
	DIMENSION STANDARD :	ANSI B-16.9 / MSS SP-97 (ONLY FOR WELDOLETS)											
<b>GASKETS</b>	TYPE :	← RING TYPE INSIDE BOLT CIRCLE →											
	THICKNESS :	← 4.5 mm THK. →											
	MATERIAL :	SPIRAL WOUND SS 304 + C.A. FILLER											
	DIMENSION STANDARD :	← ANSI B-16.21, 300# →											
<b>BOLTING</b>	STUD :	← STUD, FULLY THREADED →											
	MATERIAL :	← ASTM A-193 Gr. B7 →											
	NUT/WASHER :	HEAVY HEXAGONAL NUT WITH 3MM THK. RING TYPE WASHERS (2NOS.)											
	MATERIAL :	← ASTM A-194 Gr. 2H →											
	DIMENSION STANDARD :	STUDS TO ANSI B 18.2.1, NUTS TO ANSI B 18.2.2											



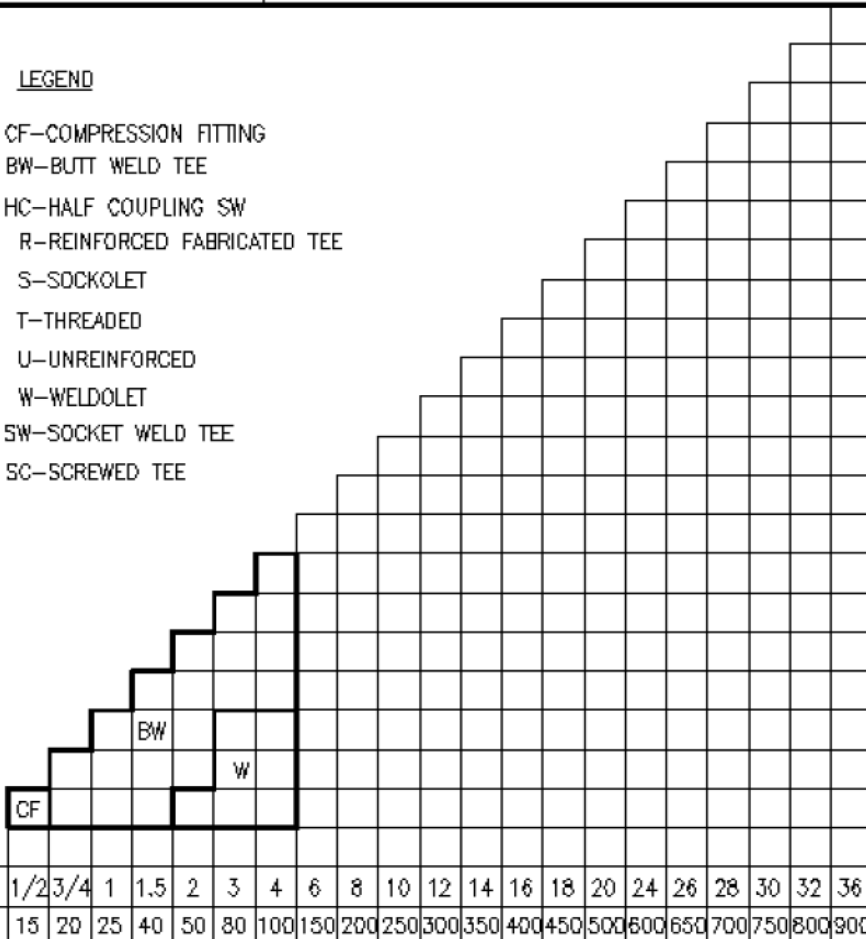
# TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

PIPING ELEMENT SPECIFICATION				SPEC.NO. : MSD-1013 SHEET NO. : 2 OF 3																				
BASE MATERIAL SS-316		INSULATION : - TRACING : -		JOB NO. : 249040 CLASS : F2b																				
SERVICE : NATURAL GAS (COMPRESSOR DISCHARGE), NITROGEN (TUBING)																								
ITEM		SIZE		DESCRIPTION																				
PIPE JOINT		15NB & BELOW.		COMPRESSION TYPE FITTING.																				
		20NB TO 100 NB		BUTT WELDED WITH TIG																				
DRAINS		ON LINES ≤ 15NB		SAME AS LINE SIZE																				
		ON LINES > 15NB		15NB OR AS PER P & I DIAGRAMS																				
VENTS		ON LINES ≤ 15NB		SAME AS LINE SIZE																				
		ON LINES > 15NB		15NB OR AS PER P & I DIAGRAMS																				
TEMP. CONN		40NB		FLANGED.																				
PRESS. CONN.		15NB		WITH ISOLATION VALVE.																				
BRANCH CONNECTION	BRANCH SIZES	900	36	<div>LEGEND</div> <div>CF-COMPRESSION FITTING</div> <div>BW-BUTT WELD TEE</div> <div>HC-HALF COUPLING SW</div> <div>R-REINFORCED FABRICATED TEE</div> <div>S-SOCKLELET</div> <div>T-THREADED</div> <div>U-UNREINFORCED</div> <div>W-WELDOLET</div> <div>SW-SOCKET WELD TEE</div> <div>SC-SCREWED TEE</div> <div></div>																				
		800	32																					
		750	30																					
		700	28																					
		650	26																					
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		500	20																					
		450	18																					
		400	16																					
		350	14																					
		300	12																					
		250	10																					
		200	8																					
		150	6																					
		100	4																					
		80	3																					
		50	2																					
		40	1.5																					
		25	1																					
		20	3/4																					
		15	1/2																					
			IN			1/2	3/4	1	1.5	2	3	4	6	8	10	12	14	16	18	20	24	26	28	30
	mm	15	20	25	40	50	80	100	150	200	250	300	350	400	450	500	600	650	700	750	800	900		
		HEADER SIZE																						

PIPING MATERIAL SPECIFICATION												SPEC.NO. : MSD-1011 SHEET NO. : 1 OF 3				
BASE MATERIAL : C.S.      INSULATION : NIL TRACING :                      NIL												JOB NO: 249040 CLASS : B1a				
SERVICE : NATURAL GAS (COMPRESSOR SUCTION), NITROGEN (OUT SIDE PACKAGE)																
DESIGN CONDITIONS		MAX.PRESSURE :						kg/cm <sup>2</sup> (g)		25.0		RATING & FACING : 300#, RF  CORROSION ALLOWANCE : 1.5 MM				
		MAX.TEMPERATURE :						°C		55.0						
		SYSTEM TEST PRESSURE :						kg/cm <sup>2</sup> (g)		37.5						
NOMINAL SIZE		IN	1/2	3/4	1	1.5	2	3	4	6	8	REF. NOTE NO.				
		mm	15	20	25	40	50	80	100	150	200					
PIPE	THICKNESS (mm/IN) :															
	SCHEDULE NUMBER/THICKNESS :	SCH 80					SCH 40									
	MATERIAL :	ASTM A-106 Gr. B SEAMLESS														
	ENDS :	BEVELLED														
	PIPE TO PIPE JOINT :	BUTT WELD														
	DIMENSION STANDARD :	ANSI B-36.10														
FLANGES	TYPE :	W.N.R.F.														
	RATING :	300 #														
	MATERIAL :	ASTM A-105														
	DIMENSION STANDARD :	ANSI B-16.5														
BENDS	TYPE :	L.R. BUTT WELD														
	RATING/THK. :	SCH 80					SCH 40									
	MATERIAL :	A 234 GR WPB SEAMLESS														
	DIMENSION STANDARD :	ANSI B 16.9														
FITTINGS	TYPE :	BUTT WELDED														
	RATING/THK. :	SCH 80					SCH 40					REF. NOTE-4.				
	MATERIAL :	A 234 GR WPB SEAMLESS / ASTM A 105 (ONLY FOR WELDOLETS)														
	DIMENSION STANDARD :	ANSI B-16.9 / MSS SP-97 (ONLY FOR WELDOLETS)														
GASKETS	TYPE :	RING TYPE INSIDE BOLT CIRCLE														
	THICKNESS :	4.5 mm THK.														
	MATERIAL :	SPIRAL WOUND SS 304 + C.A. FILLER														
	DIMENSION STANDARD :	ANSI B-16.21, 300#														
BOLTING	STUD :	STUD, FULLY THREADED														
	MATERIAL :	ASTM A-193 Gr. B7														
	NUT/WASHER :	HEAVY HEXAGONAL NUT WITH 3MM THK. RING TYPE WASHERS (2NOS.)														
	MATERIAL :	ASTM A-194 Gr. 2H														
	DIMENSION STANDARD :	STUDS TO ANSI B 18.2.1, NUTS TO ANSI B 18.2.2														



## TECHNICAL SPECIFICATION FOR SUPPLY OF MOTOR DRIVEN CNG COMPRESSOR

PIPING ELEMENT SPECIFICATION				SPEC.NO. : MSD-1013 SHEET NO. : 2 OF 3																						
BASE MATERIAL SS-316		INSULATION : - TRACING : -		JOB NO. : 249040 CLASS : F2b																						
SERVICE : NATURAL GAS (COMPRESSOR DISCHARGE), NITROGEN (TUBING)																										
ITEM		SIZE		DESCRIPTION																						
PIPE JOINT		15NB & BELOW.		COMPRESSION TYPE FITTING.																						
		20NB TO 100 NB		BUTT WELDED WITH TIG																						
DRAINS		ON LINES ≤ 15NB		SAME AS LINE SIZE																						
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		ON LINES > 15NB		15NB OR AS PER P & I DIAGRAMS																						
TEMP. CONN		40NB		FLANGED.																						
PRESS. CONN.		15NB		WITH ISOLATION VALVE.																						
BRANCH CONNECTION	BRANCH SIZES	900	36	<div>LEGEND</div> <div>CF-COMPRESSION FITTING</div> <div>BW-BUTT WELD TEE</div> <div>HC-HALF COUPLING SW</div> <div>R-REINFORCED FABRICATED TEE</div> <div>S-SOCKOLET</div> <div>T-THREADED</div> <div>U-UNREINFORCED</div> <div>W-WELDOLET</div> <div>SW-SOCKET WELD TEE</div> <div>SC-SCREWED TEE</div> 																						
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		15	1/2																							
			IN			1/2	3/4	1	1.5	2	3	4	6	8	10	12	14	16	18	20	24	26	28	30	32	36
			mm			15	20	25	40	50	80	100	150	200	250	300	350	400	450	500	600	650	700	750	800	900
		HEADER SIZE																								