



TECHNICAL SPECIFICATION FOR GAS ENGINE DRIVEN CNG COMPRESSOR PACKAGES

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1. INTRODUCTION

Gujarat Gas Limited intends to set up CNG refueling stations across GGL authorized locations. Although details about each site shall be furnished as and when it is finalized, the brief general site details shall be as under.

Location	All PNGRB Authorized area to Gujarat Gas Limited
Nearest Railway Station	Shall be informed later
Nearest Airport	Shall be informed later
Altitude of nearby Railway Station	Shall be informed later
Air Temperature	
Maximum	48°C
Minimum	4°C
Wet Bulb	29°C
Temperature Relative Humidity	
Maximum	85-90 %
Minimum	40 %
Rainfall	
Annual Average	1100 mm
Period	June-July-August-Part September
Seismic Zone	As Per IS -1893 (CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES)

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:



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- 2.1. **Compressor& auxiliaries design:** ISO 13631 (Petroleum and natural gas industries -- Packaged reciprocating gas compressors), API - 11P (Specification for Packaged Reciprocating Compressors for Oil and Gas Production Services), API 618 (Specification For Packaged Reciprocating Compressors for Petroleum, chemical and Gas industry Services).
- 2.2. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
- 2.3. NFPA-52 (Vehicular Natural Gas Fuel Systems Code)
- 2.4. NFPA-12 (Standard on Carbon Dioxide Extinguishing Systems)
- 2.5. **Design / Construction Code for Heat exchanger:** TEMA (Tubular Exchanger Manufacturers Association), API 661 (Petroleum, Petrochemical, and Natural Gas Industries—Air-cooled Heat Exchangers)/API 660 (Shell-and-Tube Heat Exchangers)
- 2.6. **Design and construction code for Pressure vessels:** ASME Section VIII (ASME Boiler and Pressure Vessel Code) & ASME Section IX (Welding Procedure and performance qualification), BS 5500 (Specification for unfired fusion welded pressure vessels)
- 2.7. **Gas Inlet Battery Limit Piping:** ASME B31.3 (Piping Process Code)
- 2.8. Pressure Safety Valve Design Code: API-520 (Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries).
- 2.9. **Design and layout:** OISD 179 (Safety Requirements on compressor, storage, handling & refueling of NG for use in Automotive sector)
- 2.10. IS: 6382(Code Of Practice For Design And Installation of Fixed Carbon Dioxide Fire Extinguishing System)
- 2.11. Gas Cylinder Rule-2016; Indian Explosives Act, 1884; Factories Act, 1948
- 2.12. PNGRB T4S Retail Outlet, Bidder may enhance compressor design for reduction of gas loss post compliance of PNGRB T4S Retail Outlet.

3. SCOPE OF WORK

3.1. BACKGROUND

3.1.1. 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, 72 hours field/site trial run tests, site acceptance test within 30 days of delivery or as per requirement of EIC, commissioning, handing over, training of owner's personnel, guarantee/warranty and



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operations during the defect liability period of 12 months including spares, oil and consumables etc. for quantity specified in SOR. Comprehensive engine driven CNG compressor packages including Dispensers, Cascades and their interconnecting piping/accessories and PLC (programmable logic control) system. Each training module of engineers at Gujarat Gas Ltd. shall span for one week 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 its operating areas. 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.

3.1.2. Phase-II:

The scope of work also includes comprehensive Operations & Maintenance (O & M) on man-month basis for 1+9 years from the date of completion of mandatory defect liability period. The work shall be handled through a separate O&M Contract. Bidder to furnish the rates separately for each year of O&M after 1 year warrantee period.

3.1.3. 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.

3.1.4. Various parts of this specification shall be read in conjunction with each other and in case of differences, the more stringent requirement shall govern.

3.1.5. 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.

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

Table 1

Sr. No.	COMPRESSOR CAPACITY	DESCRIPTION OF COMPRESSOR PACKAGE	QUANTITY
1A	1200 SCMH @ 19 kg/cm ² (g)	Gas engine driven 1200 SCMH Packaged Reciprocating Compressor Unit, 2 Car Dispenser, 1 Cascade (3000 WL), 1 LCV Point, 300 meters SS Tubing, Pressure Reducing Skid, Filters, Ball Valves and Fittings (like Union, Reducer, Tee, Elbow, Break-away coupling with LCV Fill Post), CO ₂ flooding system with 2 nos. of cylinders & accessories etc.	As per SOR



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1B	1700 SCMH @ 24 kg/cm ² (g)	Gas engine driven 1700 SCMH Packaged Reciprocating Compressor Unit, 2 Car Dispenser, 1 Cascade (3000 WL), 1 LCV Point, 300 meters SS Tubing, Pressure Reducing Skid, Filters, Ball Valves and Fittings (like Union, Reducer, Tee, Elbow, Break-away coupling with LCV Fill Post), CO ₂ flooding system with 2 nos. of cylinders & accessories etc.	As per SOR
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Note:

1. Rates for high pressure packages may be asked for future requirements for the CNG stations on main transmission pipelines. However, all the above mentioned requirements and schedule of delivery are indicative and the same shall be finalized before awarding the contracts.
2. The suction pressure may vary from 14 to 26 kg/cm² (g) for the rated pressure of 19 kg/cm² (g) for 1200 SCMH and 19-26 kg/cm² (g) for the rated pressure of 24 kg/cm² (g) for 1700 SCMH.
3. 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" (270 meter) and 1/2" (30 meter) and total length of tubing shall be 300 meter. Number of fittings, valves and clamp should be planned accordingly by considering the length of tubes and numbers of equipment connected with the compressor.

3.2. COMPRESSOR PACKAGE

Each CNG Compressor 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.

- 3.2.1 Gas Inlet Pressure Regulator with SSV of 300 # class rating with an outlet discharge range of 14 kg/cm²(g) to 26 kg/cm²(g) adjustable, as applicable.
- 3.2.2 Gas Inlet Pressure Regulator with SSV of 600 # class rating with an outlet discharge range of 45 kg/cm²(g) to 60 kg/cm²(g) adjustable, as applicable.
- 3.2.3 Subsequent suction filter, PRV and SSV shall be designed and tagged as per highest pressure of particular class i.e. 49 KG/cm² for 300 class and 99 KG/cm² for 600 class and tested at 1.5 times of Designed pressure.
- 3.2.4 Suction filtration skid (Pressure Regulating Skid (PRS)) P&ID, QAP and other details enclosed separately. Bidder shall refer the same.



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- 3.2.5 The complete lubricated / non-lubricated compressor unit with suction/ discharge volume bottles (dampers) for each stage (separators) with isolation valves and 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.
- 3.2.6 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
 - (d) Vent point (Excluding SRV and Impulse vent)
 - (e) Fuel line inlet
- 3.2.7 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.
- 3.2.8 Mass flow meter to measure the Natural Gas consumption at packages inlet, package discharge and fuel consumption at Gas Engine inlet with online test arrangement.
- 3.2.9 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.
- 3.2.10 Air-cooled heat exchanger for inter-stage and discharge gas as well as for engine gas
- 3.2.11 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.



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- 3.2.12 Blow-down recovery vessel
- 3.2.13 Dual Discharge filter (Coalescent, Duplex type, 3 micron rating) with differential pressure gauge with differential pressure transmitter as a part of compressor/ 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.
- 3.2.14 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.
- 3.2.15 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.
- 3.2.16 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.
- 3.2.17 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.
- 3.2.18 NRV at final discharge.
- 3.2.19 Nitrogen purging connections up to main header
- 3.2.20 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. However, if any other arrangement supplied by bidder, then bidder shall be complete 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.
- 3.2.21 Coupling/ V-belts/ pulleys.
- 3.2.22 Compressor and Gas engine shall be enclosed in an acoustic enclosure.
- 3.2.23 Gas engine complete with lube oil, closed cooling system, fuel (Natural Gas) supply module, inlet air intake system, exhaust system with silencer, etc.
- 3.2.24 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.



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- 3.2.25 Instrumentation and control system as specified including Local panel, Console/Local gauge boards, PLC/ SCADA etc.
- 3.2.26 The PLC shall have provision of 100% redundancy to avoid downtime and loss of data in case of any problem
- 3.2.27 All instrumentation and control shall be natural gas/ Air actuated type. The Bidder shall, therefore, provide all necessary natural gas regulators and other associated items. All material/ Spare/ Accessories required for gas based/ air based actuator working is in bidder's scope. No additional charges for actuators, materials shall be paid to the bidder. Outlet overpressure protection shall be provided in downstream of pressure regulator.
- 3.2.28 Common structural steel skid for the compressor-engine combination and for all auxiliary equipment/ systems/ items etc. including control panel. However, All auxiliaries like Suction PRS, CO2 flooding system, Air compressor etc. will be supplied loose & to mounted apart from compressor.
- 3.2.29 Stationary storage cascade
- 3.2.30 Dispensers
- 3.2.31 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.
- 3.2.32 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 junction boxes shall not have any high voltage connection. Bidder has meet all statutory requirement for applicability of this clause.
- 3.2.33 Structural supports within the compressor package for all tubing, piping, instruments etc. and all tube welds.
- 3.2.34 GI Powder coated Acoustic enclosure
- 3.2.35 Individual CO2 Flooding System to be installed for each CNG compressor separately. Inlet and outlet manual and automatic isolating valves for maintenance and emergency.
- 3.2.36 Minimum two numbers of emergency stop switch shall be provided outside the hazardous area for easy access in case of emergency. All the systems shall cease the operations and gas supply including that from within the compressor package, priority panel, cascade and dispenser; shall be stopped immediately upon operating the emergency switch in case of emergency. Bidder to consider 50m cable length for the same. In addition to 2 nos. of emergency switch, One emergency stop switch shall be provided on compressor canopy.



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- 3.2.37 Compressor Unloading arrangement
- 3.2.38 Lifting lug Arrangement for installation and maintenance
- 3.2.39 Mandatory spares as required for erection, maintenance and commissioning.
- 3.2.40 Signage's for Warning and Operating instructions to be displayed at equipments as per the statutory/ safety regulations as well as instruction given by GGL EIC.
- 3.2.41 Provision and fixing of foundation bolt and grouting of all equipment, frames, supports etc.
- 3.2.42 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.
- 3.2.43 Bidder shall provide cable for connecting various equipment approximate length of the cables as below:
 - a. Cable for SCADA connectivity between the computer terminal 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
- 3.2.44 All other cables that are not specified above and required for commissioning of compressor package shall be in the scope of Bidder.
- 3.2.45 Documents as specified under Non Material Requirements.
- 3.2.46 Flame arrestor shall be installed in common vent line outside enclosure of the CNG compressor.
- 3.2.47 Bidder shall submit graph and relevant details in table for engine fuel consumption v/s. variable suction pressure (i.e. 14 to 26 bar). Testing at variable flow (i.e. 14 to 26 barg) shall be demonstrated by the bidder during factory acceptance test.
- 3.2.48 All power cable shall be 3 core.
- 3.2.49 Bidder shall Supply, Installation, Erection, Testing and Commissioning of air compressor and it's associated cable, tubing/pipings including comprehensive O&M for operation of Compressor. Proper shed for air compressor shall be provided by the bidder.
- 3.2.50 Compressor Automation



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1. 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.
2. 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.
3. 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.
4. 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.
5. Additional spare holes for cable entries with glands (3/4" x 2 Nos., 1/2" x 2 Nos.) for future provisioning.
6. 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.
7. 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.
8. 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.
9. 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.
10. Bidder shall provide provision to connect 3 CNG car dispensers + 01 LCV filling point mass flow meter for 1200 SCMH, 1700 SCMH compressor in compressor PLC through RS485 or or modbus TCP/IP and the same shall be display in HMI.



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11. 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. Bidder to ensure healthy communication between dispenser & compressor PLC.
 12. 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.
 13. 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.
 14. 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.
- 3.2.51 Bidder shall supply cable with required connector for Connection of dispenser with compressor package. Bidder shall show configuration of dispenser with compressor and data transfer to control room during commissioning and/ or during O&M phase.
- 3.2.52 Requirement for compressor/ compressor package and their associated material (As applicable)
1. All compliance certificate required by statutory authority will be provided by bidder to GGL without any cost during entire contract period.
 2. Bidder will deploy the required manpower for meeting GGL requirements.
 3. 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.
 4. Bidder will provide our service set-up in the locations falling under Gujarat Gas Limited for handling maintenance activities.
 5. Bidder shall maintain Inventory/ Spares for trouble free operations for location falling under Gujarat Gas Limited.
 6. Bidder will follow all required safety and work procedures of GGL as implemented or upgraded time to time.
 7. Requirement of QRC is not applicable for CNG cascade supplied with compressor. This clause supersede requirement of QRC in cascade specification.
- 3.2.53 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;



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- 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.

3.2.54 Bidder shall provide 2 Nos. of hand-held explosive meter with CNG Compressor for operation of CNG Station.

3.2.55 Bidder shall submit the applicable statutory approvals (PESO etc) for the electrical and instrumentation equipments used in Compressor.

3.2.56 Gujarat Gas Ltd logo sticker shall be pasted by bidder on all sides of compressor. However, Logo design will be provided by GGL to bidder.

3.2.57 Bidder shall supply, install heat tracing devices for working of LCV fill post in low temperature.

3.2.58 Bidder shall supply fire retardant blanket for working of compressor in low temperature.

3.3. 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. However, local SCADA shall be in the scope of the Bidder. Bidder's scope shall be as follows but not limited to:

3.3.1. 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: PROFIBUS / Modbus TCP/IP

From PLC to local SCADA (operating station): ETHERNET TCP/IP.



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PLC shall have interface facility with mass flow meter, F&G detection system, 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.

- 3.3.2. Provision shall be available to take Compressor PLC in LAN along with local monitoring system / SCADA
- 3.3.3. All data which are required for monitoring and control the performance of the CNG station including the compressor performance parameter 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 Local SCADA.
- 3.3.4. 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.
- 3.3.5. 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 local SCADA.
- 3.3.6. Bidder shall demonstrate this local SCADA with all clauses above 3.3.1-3.3.5 at their works during FAT for every compressor package & during SAT after commissioning of each compressor.
- 3.3.7. All software shall be of valid license and with life time validity.

3.4. BATTERY LIMITS

- 3.4.1. Natural gas supply at the inlet flange of the suction skid (PRS) of the CNG compressor package.
- 3.4.2. Compressed Natural Gas up to the outlet of the hose arm of the dispenser
- 3.4.3. All vents (i.e. Relief valve, distance piece, packing and starting air) shall be manifold and terminated at skid edge outside the enclosure and vented to safe height, as per norms (3 m from the highest working point at site).
- 3.4.4. All drains from different process equipment, distance piece and packing shall be manifold 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. However, bidder can provide ORV (oil recovery vessel) inside compressor for uninterrupted operation of the compressor. Bidder shall provide single drain with threaded isolation valve.
- 3.4.5. Cooling water is not available as utility.
- 3.4.6. Electric Power:



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- a) The Owner shall supply 240 VAC $\pm 10\%$, 50 Hz $\pm 3\%$ single phase 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 bidder shall supply 230 VAC, 50 Hz $\pm 3\%$ electrical power for instrumentation through UPS at the incomer of the panel supplied by the Bidder.
- c) The bidder shall supply 230 VAC, 50 Hz $\pm 3\%$ UPS supply at the incomer of the each dispenser. All further distribution of electric power within and for the dispenser shall be carried out by the Bidder.
- d) For running the electric motor driven air compressor 415 Volt ($\pm 10\%$) 3-phase 4 wire (TN-S), 50 Hz ($\pm 3\%$) power shall be provided by Owner at a single point outside the enclosure.

3.4.7. Bidder shall supply companion flanges for all battery limit flanges if it differs from ASME B 16.5

3.5. EXCLUSIONS

All civil works and foundation design. However:

- 3.5.1. The Bidder shall furnish all the relevant data for design of any foundation / pedestal if required.
- 3.5.2. The minor civil work such as grouting etc. for the levelling of the equipment/ skid etc. shall be provided by the Bidder.

4. SPECIFICATIONS OF ENGINE DRIVEN CNG COMPRESSOR

4.1. GENERAL REQUIREMENTS

- 4.1.1. Multistage compressor configuration is envisaged. The compressor shall be of reciprocating type, lubricated/non-lubricated, high pressure, multistage, totally air cooled/inbuilt water cooled, gas tight, engine 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.
- 4.1.2. All instrumentation and control shall be natural gas base (Natural gas actuated)/ Air base with all necessary regulators and other items. However the Bidder shall ensure that the total gas losses 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 of suction mass flow meter and install regulator system as required, tap-off from discharge of compressor shall not be allowed.



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- 4.1.3. Suction line pressure may vary from 14 kg/cm²(g) to 26 kg/cm²(g) or 35 kg/cm²(g) to 60 kg/cm²(g), as applicable, with discharge pressure remaining constant at 255 kg/cm² (g). A suction pressure regulator may be installed if required by the Bidder. The suction pressure of 19 kg/cm²(g) or 45 kg/cm² (g), as applicable shall be used for compressor sizing/selection and performance test and guaranteed parameters.
- 4.1.4. The pressures specified on the data sheet are at the compressor package battery limits, the Bidder shall consider all pressure losses at suction, inter-stage and discharge at the specified capacity (with no negative tolerance) for compressor/engine and indicate the same on the data sheets. Venting of the gas is not allowed at any point during operation.
- 4.1.5. The compressor driver, engine, 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.
- 4.1.6. The Engine 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 6 kg/cm² (g) or 26 kg/cm² (g) or 60 kg/cm² (g) maximum, as applicable. Venting of gas is not allowed.
- 4.1.7. One number Safety Relief Valve shall be installed before the 1st Stage suction or blow down (if 1st stage suction and blowdown vessel are interconnected), discharge of each stage, vessel. All shall be vented to atmosphere through a common relief valve header.
- 4.1.8. Engine 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/engine/moving parts should not get affected.
- 4.1.9. Allowable speeds, temperature and vibration levels
- a) The rotational speed of both compressor and Engine (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. The linear piston speed shall be limited for non-lubricated compressors / lubricated compressor can be provided as per manufacturer design standard. However, Bidder needs to meet all requirement of PNGRB T4S.



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4.1.10. The maximum final discharge gas temperature after the final stage cooler of the package shall not exceed 55°C (maximum 10°C above the ambient temperature).

4.1.11. 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. The Compressor shall stop if the vibration limit crosses as specified above.

4.1.12. 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.

a) 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. Common vent is not applicable for pressurized crankcase type compressor.
- ERW steel, seamless steel tubing conforming to ASTM A-192 (Standard Specification for Seamless Carbon Steel Boiler Tubes for High-Pressure Service) or series 300 SS tubing conforming to ASTM A-269 (Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service) 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.

4.1.13. Compressor Frame Lubrication

- a) Compressor frame lubrication shall be pressurized system, with main oil pump driven directly by the compressor shaft.



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- 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.

4.1.14. Distance Pieces: Compressor manufacturer's standard Type-1 or Type-2 of API 11P shall be provided as a minimum. Distance pieces can be provided as per manufacturer standard. However, requirement of PNGRB T4S Retail Outlet to be complied by the bidder.

4.1.15. Cylinder and Packing Lubrication

- a) Single plunger per point force feed mechanical lubricator or divider block system shall provide lubrication to compressor cylinders.
- 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 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 hours of normal operation, and shall be equipped with low-level alarm.
- f) The Bidder shall furnish (during technical evaluation of the bidder), 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.

4.1.16. Cooling System

- a) Engine Jacket/Compressor Cylinder shall be air cooled. However, Bidder can provide water cooled compressor but bidder needs to meet.
- b) Inter/After Gas Coolers

Air-cooled Inter-stage and Final stage discharge coolers shall be provided which shall limit the gas temperature after the after cooler to 55 °C (maximum 5°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.



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4.1.17. 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 inter-stages 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.

4.1.18. 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 or Pulsation device can be provided as per manufacturer standard, However, requirement of PNGRB T4S Retail Outlet to be complied
- 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.

4.1.19. Coupling: The first preference is for directly coupled driver-compressor arrangement. However a V-Belt driven compressor is also acceptable.

4.1.20. Common structural steel skid for the compressor, Engine, control panel, all other stationary and rotating equipment and auxiliary systems such as electrical systems etc. However, All auxiliaries like Suction PRS, CO2 flooding system, Air compressor etc. will be supplied loose & to mounted apart from compressor.

4.1.21. Breakaway Coupling shall be part of supply of LCV fill point and it should be installed when the LCV fill Point is installed at Site. Breakaway coupling shall be capable for the flow of 1200 SCMH, 1700 SCMH respectively.



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4.1.22. Gas Engine

- a) The offered gas engine shall be from one of the regular production range of approved make for mechanical drive applications. The gas engine shall be gas fired, 4-stroke, and spark ignited type. The integral gas engine & compressor type design is not acceptable.
- b) The site rating of engine shall be max of the following two conditions;
 - 110% of greatest BkW required by compressor including cooling fan, other auxiliaries and the losses at any of the compressor operating conditions corresponding to suction pressure of 19 or 45 kg/cm²(g) with suction valve fully opened and discharge pressure 255 kg/cm²(g). The normal operating speed of engine shall be 1500 rpm.
 - 105% of greatest BkW required by compressor including cooling fan, other auxiliaries and the losses at any of the compressor operating conditions corresponding to suction pressure of 19 or 45 kg/cm²(g) with suction valve fully opened and discharge pressure at relief valve (RV) set pressure. The normal operating speed of engine shall be 1500 rpm.
- c) The site rating of engine shall be based on 48°C ambient temperature, RH 90% and an altitude of 115 meter taking design case gas composition as specified, the site rating so arrived shall be suitable for the maximum Compressor BkW as arrived at and which can be applied 24 Hrs. a day & seven days a week. Bidder to furnish site-rating calculation including de-rating calculation along with bid. Note that the Design Gas specified for the compressor shall be used as engine fuel.
- d) All the auxiliary equipment including the cooling fans shall be engine driven.
- e) Engine shall be provided with Compressed air starting complete with air compressor & receiver of approved make. The air receiver vessel shall be suitable for 6 consecutive starts in one hour. Air compressor, drier, filter and air receiver for gas engine starting/instrument air, shall be kept off the package in safe area with rigid piping, electrical & instrumentation cabling in bidders' scope. One air bottle of 300WL (or six starts per hour) whichever is of higher capacity must be installed outside the enclosure for engine starting. One more additional air-bottle of 500WL capacity shall be provided for dispenser feeding. Air compressor shall be complete with air drier at -40°C dew point, complete with coalescent filter and particulate filter.
- f) The engine shall be provided with the shielded ignition system of breaker less type, low-tension solid state having vapor proof enclosure with a high-tension coil at each power cylinder. The spark plug shall be shielded and all low-tension wiring shall be enclosed in grounded steel conduits. But the spark plug connecting cables shall be enclosed in grounded, metal-shielded flexible conduits.



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- g) Constant speed hydraulic/electronic governor preferably of WOODWARD make adjustable for speed setting over the operating range.
- h) The engine silencer shall be residential type mounted on the roof of the engine enclosure. Suitable enclosure to be provided above the silencer to avoid direct contact with the body of the silencer. Thermal insulation to be provided upto the Silencer.
- i) Bidder shall provide the fuel gas supply line consisting of valves, pressure regulator, differential pressure regulator, shut off valve and necessary instrumentation etc. as required for the engine to ensure continuous supply of conditioned gas to engine.
- j) Bidder shall provide suitable provision in the exhaust so that the exhaust gas meets the emission norms of CPCB.

4.2. DATA SHEET FOR COMPRESSOR

4.2.1. 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.

4.2.2. Indicates data to be furnished by the bidder/ supplier/ Bidder

Sr. No.	Description	Specification/ detail
1	Capacity	1200 SCMH
2	Qty.	Refer Scope of Work
3	Suction pressure kg/cm ² (g)	Refer Scope of Work
4	Discharge pressure kg/cm ² (g) Compressor Make	Refer Scope of Work
5	Driver	GAS ENGINE
6	Engine Make	*
7	Installation	Outdoor
8	Service	Continuous
9	Gas Handled	Compressed N.G (CNG)
10	Gas Characteristic	Sweet, Odorized, Non-
11	Gas composition (% by volume)	Sweet Gas
12	- Methane	91.9132 (May vary up to 97)
13	- Propane	1.18705
14	- I-butane	0.1993
15	- n-butane	0.28415
16	- I-pentane	0.0143
17	- n-pentane	0.00685
18	- Ethane	5.8181
19	- c6+	0.00745



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20	- N ₂	0.54685
21	- CO ₂	0.02085
22	- Neo pentane	0.0019
23	Molecular weight of gas at suction	17.38 at NTP condition
24	Cp/Cv at suction	1.18 at NTP condition
25	Pressure	Maximum _*
26	Std. condition referred to	1.1013 bar(a) & 15.56 °C
27	<i>Suction temp.:</i>	
28	Normal	35 °C
29	Maximum	48 °C
30	Flow meter type	Coriolis
31	Discharge Pressure of Compressors: Normal/Min./Max. kg/cm ² (g)	255/ * / *
32	No. of Compressor /per Refueling Station	1
33	No. total of units	*
34	No. of stages of compressor	*
35	Stroke / Compressor Crank RPM	* (Pressurized crank case
36	Actual Suction Pressure kg/cm ² (g)	Variable
37	Final Discharge Temperature	* (Maximum 52°C)
38	Guaranteed Shaft Power (1KB/BKW)	* / *
39	Driver rating selected	*
40	Driver RPM	*
41	Direction of rotation from driving end	Clockwise/ Anti Clockwise
42	Driver make & Frame size	*
43	Drive Arrangement - Direct coupled or V-Belt, guard (Anti-Static)	*
44	Nozzles at Supply & Discharge Limit	*
45	Suction	*
46	Discharge	*
47	Cylinder Bore (mm)	*
48	Single Acting/Double Acting	*
49	Type of Cooling	*
50	Jacketed or Dip finned	*
51	Inside Liner Yes/No	*
52	Piston Displacement	*
53	Mean Piston Speed	*
54	Inlet/Discharge Temp.	*
55	Inlet/Discharge Press.	*



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56	Max. Allowable Cylinder Temperature	*
57	Max. Allowable Cylinder Pressure	*
58	Hydrostatic test Pressure	*
59	Helium Test Pressure	*
60	Type of Cylinder Valves	*
61	No. of Suction / Discharge valve	*
62	Valve Un-loaders	*
63	Piston Rod Diameter	*
64	Piston Rod Load (Nom./Max.)	*
65	Packing Lubricant	*
66	Packing Vent to	*
67	Distance piece type	*
68	Distance piece purging	*
69	Discharge relief Valve setting	*
70	Lubrication system	*
71	Type of system Mfgr.	*
72	Oil filter type & make	*
73	Oil pump type	*
74	Engine	*
75	Oil pump make	*
76	Oil cooler Type & make	Air/Water cooled
77	Detail of piping & valves	*
78	System oil capacity	*
79	Grade of oil to be used	*
80	Heat Exchanger (I/C & A/C)	Air cooled
81	Frame	Cast iron / Structural Steel
82	Cylinder & head	Cast iron / Spheroidal grey
83	Liner	Cast iron
84	Piston	Cast iron
85	Piston Ring	Malleable Cast iron
86	Valve Seat	Stainless steel
87	Valve Plate / Ring	Stainless steel
88	Valve Spring	Stainless Spring Steel
89	Crank Shaft	Spheroidal grey iron / steel
90	Connecting Rod	Steel
91	Piston Rod / Piston Rod	Steel / Stainless Steel



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92	Location	M/c Mounted/ Off Mounted
93	Cooler type	Air cooled Fin Fan type
94	Overall size of cooler	*
95	Code of design & construction	*
96	Heat Transfer area provided	*
97	Tube / Fin size	*
98	Tube / Fin Material	*
99	Header Material	*
100	Inlet Nozzle	*
101	Outlet Nozzle	*
102	Drain	*
103	Vent	*
104	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
105	Qty.	1 each
106	Capacity	
107	Design & Construction Code	ASME Section VIII Div.1
108	Design Pressure	*
109	Qty./refueling station	1
110	Type	Dry
111	Make / Model	
112	Design & Construction code	ASME Section VIII Div.1
113	Operating Pressure	*
114	Pressure drop across the filter	*
115	Micron rating (Filtration level)	3 Microns
116	Filtration Efficiency	99.50%
117	Cartridge Material	*
118	Bonnet / Casing Material	*
119	Inlet Nozzle	*
120	Outlet Nozzle	*
121	Drain	*
122	Vent	*
123	Qty./refueling station	1
124	Type	Dry
125	Make / Model	



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126	Design & Construction code	ASME Section VIII Div.1
127	Operating Pressure	
128	Pressure drop across the filter	
129	Micron rating (Filtration level)	3 Microns
130	Filtration Efficiency	99.50%
131	Cartridge Material	*
132	Bonnet / Casing Material	*
133	Inlet Nozzle	*
134	Outlet Nozzle	*
135	Drain	*
136	Vent	*
137	Qty.	1 each
138	Capacity	
139	Design & Construction code	ASME Section VIII Div.1
140	Design Pressure	*
141	Design Temperature	*
142	Hydrostatic Test Pressure	*
143	Material of Construction for:	*
144	Shell	*
145	Heads	*
146	Inlet Nozzle	*
147	Outlet Nozzle	*
148	Drain	*
149	Vent	*

4.3. SPECIFICATION OF ENCLOSURE / CANOPY OF COMPRESSOR PACKAGE

- 4.3.1. 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 in day time and 70 dBA at 1 meter from the enclosure in night time in line with statutory requirement.
- 4.3.2. The maximum temperature within the enclosure shall be limited to 55°C (maximum 5°C above the ambient temperature). 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.
- 4.3.3. 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.



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- 4.3.4. Enclosures shall provide a degree of protection equivalent to IP 54 as defined in AS 1939 and provided with adequate ventilation system.
- 4.3.5. 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. However, opening can be provided for air circulation inside compressor.
- 4.3.6. The enclosures shall have doors for normal access and removable wall panels/ hinged for ease of maintenance. The acoustic material should be fire resistant with fire retardant rating of 30 minutes. Necessary certification and documents to be submitted for the material selected.
- 4.3.7. 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.
- 4.3.8. 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. However, bidder can provide gas low and oil level meter inside the compressor.
- 4.3.9. Enclosure shall have internal flame proof lighting arrangement.
- 4.3.10. 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.
- 4.3.11. All Coolers, Knock out Drums (KOD), Scrubbers, Separators, 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.
- 4.3.12. Components such as pressure gauges, temperature and pressure switch etc., which require in-situ adjustment and reading shall be easily accessible.
- 4.3.13. 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.
- 4.3.14. 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.



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- 4.3.15. 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.
- 4.3.16. Items which must be operated & monitored during operation shall be readily accessible without opening the door.
- 4.3.17. Suitable gradients shall be provided on the enclosure roof for rain drainage and to avoid water pockets.
- 4.3.18. 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. Bidder shall use high temperature paint on exhaust and its surrounding.
- 4.3.19. The enclosure shall be provided with door limit switches, two numbers Gas detectors and two numbers UV detector 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.
- 4.3.20. The compressor canopy shall be pre-fabricated tray/ 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.

4.4. SPECIFICATION FOR PRIORITY PANEL

4.4.1. 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:

- a. Free standing welded and powder coated (0.03 mm to 0.05mm thick epoxy) steel frame structure.
- b. Interconnected SS tubing and manifold.
- c. Isolation valves, Bleed valves, Non return valves and vent system.
- d. Connections of all isolation valves with the emergency switch for closure of isolation valves in case of emergency.
- e. Pressure gauges
- f. Actuators for control of flow to dispensers / cascade / LCV point
- g. Solenoid Valves
- h. Clamps to fit the pipes & valve to the main frame
- i. Any accessories which Bidder feels necessary for better performance.



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4.4.2. Specific requirements

- 4.4.2.1. 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.
- 4.4.2.2. 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.
- 4.4.2.3. Priority Panel shall be the package to avoid gas leakages due to high operating frequency of actuator and for ease of operations and supervision.
- 4.4.2.4. 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.
- 4.4.2.5. 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/cm²(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/cm²(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/cm²(g). Now, when the medium bank of cascade reaches to predetermined pressure of 220 kg/cm²(g), the low bank of the cascade starts receiving the gas till the discharge pressure reaches 250 kg/cm²(g). Once the pressure in the low bank reaches to 250 kg/cm² (g), the gas is diverted to mobile cascade filling (LCV point). As soon as the pressure in the mobile cascade reaches 250 kg/cm² (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/cm² (g) or auto shut down, before the compressor goes to standby state.
- 4.4.2.6. In short, priority sequence would be 1st to direct/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/cm² (g).
- 4.4.2.7. Actuator ball valves (Gas/ Air actuated) shall be provided between priority panel and dispenser as well as stationary and mobile cascade to control flow.
- 4.4.2.8. 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



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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.

4.4.2.9. 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%.

4.4.3. Basic datasheet

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

Sr. No.	Description	Specification/ detail
1	Priority sequence for transfer / allocation of the gas shall be as under. (a) Fore-court high bank dispenser (b) Fore-court medium bank dispenser (c) Fore-court low bank dispenser (d) Stationary cascade high bank line (e) Stationary cascade medium bank line (f) Stationary cascade low bank line (g) Mobile cascade (Vehicle mounted)	
2	Control System	PLC/ SCADA Based
3	Location of priority panel	Outside and on the enclosure of compressor package
4	Set Pressure for Bank filling	250 kg/cm ² (g) (must be settable)



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5	Flow Rating Cv	*
6	Maximum Flow Rate	*
7	Priority Valve Type	Solenoid operated actuator ball valve
8	Inlet / Outlet Connection	$\frac{3}{4}$ " (0.095" thickness) OD SS 316 Tube
9	Size of inter connecting tubes	$\frac{3}{4}$ " 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)

4.5. COMPRESSOR INSTRUMENTATION

- 4.5.1. All instrumentation and control shall be natural gas/ Air base (Natural gas/ Air actuated) with all necessary regulators and other items.
- 4.5.2. 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.
- 4.5.3. 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.
- 4.5.4. All the instrumentation shall be capable of operating for full range of operation.
- 4.5.5. All field instruments power shall be limited to 24 VDC. Power conversion unit if required shall be in the scope of the bidder. All instruments and enclosures shall be dust proof and weather proof to IP 65.



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- 4.5.6. Instrumentation electronics shall be certified by a recognized authority such as BASEEFA, PTB, LCIE, etc.
- 4.5.7. Each compressor package shall be provided with following indicators:
- a) Pressure indicator at suction of each stage and final stage discharge. However, requirement of indicator will be discussed during HAZOP and recommendation of HAZOP shall be incorporated by the bidder.
 - b) Temperature indicator at suction and each stage discharge.
 - c) Oil pressure indicator on each pressure lubrication system. Oil cooler outlet temperature.
- DPG for oil pressure considered
 - d) Oil levels.
 - e) Hour meter.
 - f) Compressor jacket water temperature.
- 4.5.8. 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 pressure at inlet, High inlet inter stage and discharge pressure at each stage shall be provided. Low suction gas pressure.
 - f) Low cooling water flow.
 - g) On high vibration-on activation of vibration switch
 - h) Door Limit switch for all door entries
- 4.5.9. 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 pressing of manual stop button at compressor package.
 - d) On pushing of emergency stop device.
 - e) Each package shall be furnished with an audible and visual alarm system for annunciation on compressor trip.



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4.6. COMPRESSOR PACKAGE OPERATION PHILOSOPHY

- 4.6.1. 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 200 kg/cm² and shall stop once the pressure in all three banks of stationary cascade reaches 255 kg/cm². 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.
- 4.6.2. 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.
- 4.6.3. 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.
- 4.6.4. 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.
- 4.6.5. Once the fault is acknowledged or the engine, 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.
- 4.6.6. The Bidder shall provide Emergency Shutdown System and switch in control room as well as locally mounted on the compressor panel. Upon energizing the same, all the operations of the compressor must stop including running of engine and supply / discharge of gas.
- 4.6.7. Fail-safe system shall be designed and incorporated to isolate cascade storage from Compressor, stop compressor, isolate the compressor suction line and on activation of Emergency Shutdown (ESD) switch. ESD switch shall have to be manually reset to restart the compressor package again.
- 4.6.8. All control logic, interlock, monitoring and annunciation shall be achieved using programmable logic controller (PLC). The controller and associated equipment shall be designed to work satisfactorily in the environment expected to be prevailing at site.



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- 4.6.9. Compressor Package shall be provided with a Programmable Logic Controller (PLC) of approved make which shall be housed in weatherproof Panel confirming 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 Hazardous Area Certificate (HAC) compliance. All displays shall be made available in local panel through numerical display.
- 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 tropicalized, MIL standard adopted with complete wiring and necessary terminals. Wiring to be color coded with cross ferruling in position.
 - b) The PLC shall have provision of 100% redundancy to avoid downtime and loss of data in case of any problem
 - 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 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 Grid SCADA system. Local gauges shall be connected neither to local monitoring system nor SCADA system.
 - g) Provision shall be available to take Compressor PLC in LAN along with local monitoring system / SCADA. Licensed SCADA software along with personal computer for the local control room shall be provided by the Bidder.



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- 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 through a personal computer. 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 per compressor for PLC, HMI (Human Machine Interface) on LCP (one set) along with all interfacing adaptors and cables. The Bidder shall also provide 2 sets per compressor of source and object codes for PLC, HMI on LCP (in both forms, hard & soft).

4.7. CO₂ FLOODING SYSTEM

The package shall be protected against fire with automatically operated CO₂ 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.

- 4.7.1. Gas detection by 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.
- 4.7.2. 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.
- 4.7.3. CO₂ flooding system will consist of 2 nos. of adequately sized CO₂ cylinders. 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.
- 4.7.4. The System shall be designed to operate on 24 V DC supply.
- 4.7.5. FRLS (Fire resistant low smoke) cables shall be used for the wiring of the system.
- 4.7.6. Interlock of CO₂ 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 CO₂ gas shall take place from the main cylinder simultaneously.



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(c) Compressor shall not start if the CO₂ Flooding System is faulty, not working, Switched OFF etc. The compressor shall be able to start only when the CO₂ 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.

4.7.7. Alarm panel for CO₂ Flooding System shall be integral with the main compressor panel. 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.

4.7.8. 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.

4.7.9. 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.

4.7.10. All installation shall be compatible for hazardous area, Temperature T6 1, Division 1, Group-D for Methane Gas.

4.7.11. The system designed by the Bidder shall be duly approved by GUJARAT GAS LTD.

4.7.12. 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.

4.7.13. 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.

4.7.14. CO₂ flooding system piping of the compressor shall be Hydro tested after installation at site. Color code of piping shall be as per relevant standard.



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- 4.7.15. Bidder shall provide flame proof manual call point with hammer at fencing for manual operation of CO₂ flooding system. Also supply of cable and connectivity of manual call point with compressor, CO₂ flooding system is in the scope of bidder.
- 4.7.16. Bidder to provide adequate size of SS tubing and fitting for connecting CO₂ flooding system and compressor package canopy.

5. GENERAL SPECIFICATIONS FOR PRESSURE VESSELS

5.1. 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.

5.2. DESIGN AND CONSTRUCTION CODE

- 5.2.1. 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.
- 5.2.2. Wind loads and earthquake forces shall be calculated in accordance with relevant Indian Standards, unless otherwise specified.

5.3. STATUTORY REQUIREMENTS

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 Bidders shall have to get the itemized 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.

5.4. DESIGN BASIS

- 5.4.1. Vessel shell and heads shall have minimum wall thickness calculated with design pressure, temperature, in accordance with codes.
- 5.4.2. Design pressure shall be equal to maximum operating pressure at the top of vessel plus 10% (or minimum of 1.0 kg/cm²) more than operating pressure.
- 5.4.3. Design Temperature shall be equal to operating temperature plus 15°C.
- 5.4.4. Minimum corrosion allowance for all vessels shall be 3.0 mm minimum unless otherwise specified elsewhere.

5.5. MATERIALS

Material to be used shall conform to



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

Following guidelines are given for selection of carbon steel materials

5.5.1. 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.

5.5.2. 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.

5.5.3. Specifications of Carbon Steel plates:

- a) Plates used shall conform to latest addition of SA-20 with additional requirements mentioned herein:
- b) Only normalized 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%.
- 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.

5.6. 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



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thickness shall be normalized if cold pressed or formed. However, in case, hot forming is carried out with in normalizing temperature range, no stress relieving is necessary

5.7. HAND HOLES AND NOZZLES

- 5.7.1. 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.
- 5.7.2. 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.

5.8. FLANGES

- 5.8.1. All flanges shall conform to as per ANSI B-16.5.
- 5.8.2. All flanges above 150 lbs. rating should be of weld-neck type only.
- 5.8.3. Studs and Nuts :

All studs and nuts shall be hot deep galvanized and as per ASTM A193 Gr. B7 and ASTM A194 Gr. 2H

5.9. 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

5.10. 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

5.11. 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.

5.12. POST WELD HEAT TREATMENT (PWHT)

Vessels shall be heat-treated whenever it is required due to service requirement or due to code requirements. Vessels shall be post weld-heat treated as a complete unit and no welding is permitted once PWHT is done.

5.13. RADIOGRAPHY



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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.

5.14. 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

5.15. GENERAL REQUIREMENT

5.15.1. 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.

5.15.2. 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.

5.15.3. Vessels of diameter 300 NB & below shall be made from seamless pipe.

5.15.4. Rolling of plates for making of shell shall be lengthwise.

5.15.5. Guarantee of the vessel.

5.16. DATA SHEET FOR PRESSURE VESSEL

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

S. No.	Item	Offered:
1	Item	
2	Package	
3	Code for design and Construction	
4	Operating Conditions - Pressure (kg/cm ² (g)) - Temperature(°C)	
5	Design conditions - Pressure (kg/cm ² (g)) - Temperature(°C)	



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6	Corrosion allowance - Type of vessel - Diameter(MM)	Hor.() Vert.()
7	Height TL-TL(MM)	
8	Skirt / Leg height	
9	Post Weld Heat Treatment	
10	Material of Construction of all parts	

5.17. SPECIFICATIONS FOR TUBING AND PIPING

- 5.17.1. All gas tubing shall be Stainless Steel series –316 conforming to ASTM-A269 with maximum hardness of RB80.
- 5.17.2. All high-pressure double ferrule fitting and 2/3 way valves shall be from makes provided in provided in approved vendor list and shall be SS 316 material only.
- 5.17.3. The instrument gas/ air tubing material shall be Stainless Steel series –316 conforming to ASTM-A269. Other tubing shall be SS 316 material confirming to ASTM-A269.
- 5.17.4. All lube oil piping down stream of filter shall be Stainless Steel 304.
- 5.17.5. All carbon steel piping shall be seamless in accordance with ASTM A-53 Grade 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 of ball valve/ needle valve & globe valve as per STD.
- 5.17.6. 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.
- 5.17.7. 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.
- 5.17.8. All bank tubing shall be installed with 3 Nos. of isolation valve on each line as per OISD-179
- 5.17.9. Open ends on fittings and vents shall be provided with caps.
- 5.17.10. One number lockable isolation valve on each bank shall be provided at outside the fencing area of compressor package.



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5.17.11. While carrying out the work at site, the Bidder shall take all necessary precautions to prevent any damage to the tubing work.

5.17.12. 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 air. The pneumatic test shall also be carried out at the maximum available pressure but not less than 100 kg/cm² (g).

5.18. GENERAL SPECIFICATION STAINLESS STEEL FABRICATION

5.18.1. Cutting, fit-up and laying out

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

- a) 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.
- b) Spacers shall be used to maintain a uniform weld gap to ensure adequate weld penetration.
- c) Stub end faces shall be in a plane perpendicular, true and square to the Centre line of pipe to which the same is attached.
- d) Only small tack welds which penetrate to the root of the weld gap shall be allowed to form part of the finished weld.
- e) 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.

5.18.3. Bending

- a) Completed bends shall have a smooth surface and free of flat spots and corrugations.

5.18.4. Hot bending is not permitted.

5.18.5. Cold bends to radius of three (3) times the pipe diameter or more may be made without subsequent stress relieving.

5.18.6. The bends shall be free of buckles, cracks, wrinkles, bulges and other visible defects.

5.18.7. The following tolerances on bending shall be maintained -

5.18.8. 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.

5.18.9. 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



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thickness as measured by the difference between nominal thickness and minimum thickness shall not exceed 10% of nominal pipe thickness.

5.18.10. 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 beveled 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 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.

5.18.11. 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.



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- 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

5.18.12. 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.

5.19. PAINTING

- 5.19.1. The Bidder shall properly paint CNG Compressor, piping and other accessories.
- 5.19.2. 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.
- 5.19.3. 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 faded free life without oxidation of paint surface for ten years in an environment of bright sunlight with an intense UV content.
- 5.19.4. Name plate, moving parts of machinery, finned tube surfaces; v-belts sheave grooves and temporary shall not be painted.
- 5.19.5. 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

6. FIRE AND SAFETY

- 6.1. This Specification gives requirements for fire extinguishers as per OISD 179.



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6.2. All portable extinguishers shall be as per the specified Indian standard or equivalent NFPA, BS EN standards.

6.3. Bidder shall check/Calibrate flame detector with UV torch or appropriate instruments.

6.4. Bidder shall calibrate the Gas detector with calibration GAS bottle or cylinder.

6.5. Bidder shall carry out inspection & maintenance of fire extinguisher as per relevant standards and GGL AOMP (Annual Operation & Maintenance Plan)

Sr.	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 CNG Compressor	1 No.
3	10 kg, ABC DCP type as per IS 13849	Near Dispenser	1 with each dispenser
4	10 kg, ABC DCP type as per IS 13849	Storage Cascade	1 No.
5	4.5 kg, CO2 type as per IS 2878	1 each in control room, transformer room and near compressor panel	3 Nos.
6	6 Nos. 16 gauge GI, Red colored 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 color	Near the approach and exit of CNG station	2 sets
7	Automated CO2 flooding system with 2 nos. of storage cylinder & accessories	Outside the package at a safe place	1 Set

7. GENERAL SPECIFICATIONS FOR ELECTRICAL WORK

7.1.SCOPE/INTRODUCTION

7.1.1. 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



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of complete electrical work in accordance with the specifications and in compliance with applicable codes and standards.

- 7.1.2. All the materials shall comply with the local statutory regulation.
- 7.1.3. 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.
- 7.1.4. "DGMS" is not required in this work & for the construction and execution work.

7.2. APPLICABLE CODES, STANDARDS AND STATUTORY REQUIREMENTS

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:

IS309	Plugs, socket-outlets and couplers for industrial purposes
IS694	PVC insulated cables for working voltages up to and including 1100V
IS732	Code of practice for electrical wiring installations
IS1271	Thermal evaluation and classification of electrical insulation.
IS1293	Plugs and socket outlets of 250 watts and rated current up to 16 amps
IS1554	PVC insulated (Heavy duty) electric cables
IS/IEC 60079-1	Explosive Atmospheres. Part-1 Equipment protection by flameproof enclosures "d"
IS2253	Designation for types of construction and mounting arrangement of rotating electrical machines
IS2968	Dimensions of slide rails for electric motors
IS3043	Code of practice for Earthing
IS3961	Recommended current ratings for cables
IS/IEC 60034- 5	Degree of protection provided by enclosures for rotating electrical machinery
IS4722	Rotating electrical machines
IS4728	Terminal marking and direction of rotation for rotating electrical machinery



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IS4889	Method of determination of efficiency of rotating electrical machines
IS5422	Turbine type generators
IS 16724	Explosive atmospheres - Electrical installations design, selection and erection
IS5572	Classification of Hazardous areas (other than mines) having inflammable gases and vapors for electrical installation
IS/IEC 60079-11	Explosive atmospheres, Part 7: Equipment protection by increased safety'e'
IS6362	Methods of cooling for rotating electrical machines
IS6381	Construction and testing of electrical apparatus with type of protection 'e'
IS6665	Code of practice for industrial lighting
IS7098	Crosslinked polyethylene insulated PVC sheathed cables
IS7132	Guide for testing synchronous machines
IS7389	Specification for pressurized enclosures of electrical equipment for use in Hazardous areas
IS7689	Guide for the control of undesirable static electricity
IS7816	Guide for testing insulation resistance of rotating machines
IS8144	Multiple purpose dry batteries
IS8223	Dimensions and output series for rotating electrical machines
IS8270	Guide for preparation of diagrams, charts and tables for electrotechnology
IS8623	Specification for low voltage switchgear and control gear assemblies
IS9537	Conduits for electrical installations
IS9676	Reference ambient temperature for electrical equipment
IS9814	Lead acid storage batteries for marine use
IS9968	Elastomer insulated cables
IS10118	Code of practice for selection, installation and maintenance of switchgear and control gear



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IS10810	Methods of test for cables
IS10918	Vented type Nickel Cadmium batteries
IS11955	Preferred current ratings
IS12032	Graphical symbols for diagrams in the field of electro technology
IS12065	Permissible limits of noise level for rotating electrical machines
IS12075	Mechanical limits of vibration of rotating electrical machines
IS12309	Code of practice for installation and maintenance of aerodrome lighting fittings
IS12762	Photovoltaic devices
IS12943	Brass glands for PVC cables
IS13234	Guide for short circuit current calculation in three phase AC systems
IS/IEC 60079 : PART 0	Explosive Atmospheres Part 0 Equipment — General Requirements
IS13408	Code of practice for selection, installation and maintenance of electrical apparatus in potentially explosive atmosphere.
IS/IEC 60947	LV switchgear and control gear
IS14218	Sealed cylindrical type rechargeable Nickel Cadmium cells

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

*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.



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7.3.2. Hazardous areas

- 7.3.2.1. 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.
- 7.3.2.2. 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.
- 7.3.2.3. Isolating devices for equipment located in hazardous areas shall switch all poles of the supply including the neutral.

7.4. GENERAL DESIGN REQUIREMENTS

- 7.4.1. All equipment shall be designed to facilitate inspection, cleaning and maintenance with due care to safety in operation and personnel protection.
- 7.4.2. The rating and size of all electrical equipments and Engine shall be designed based on minimum 10 % margin after considering all its 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.
- 7.4.3. All equipment shall run without undue vibration and within the noise level specification.
- 7.4.4. All equipment shall be designed to prevent the risk of accidental short-circuit or open circuit.
- 7.4.5. All materials shall be new and of good quality.
- 7.4.6. 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.
- 7.4.7. 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. SPECIFICATION FOR CONTROL EQUIPMENT (PANEL BOARD)

- 7.5.1. 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.
- 7.5.2. 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.
- 7.5.3. The panel shall have external fixing lugs and shall be suitable for mounting on vertical face such as wall / column or steel pedestal.



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- 7.5.4. All outgoing feeders shall be provided with adequately rated MCCB / ACB. In no case the SFU shall be used.
- 7.5.5. 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.
- 7.5.6. 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.
 - 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).
- 7.5.7. All control wiring terminals and components shall be clearly labelled with the item number or designation and must be easily identifiable with those shown on the drawings.
- 7.5.8. All terminal blocks, connectors and wires shall be numbered and identified with core markers.
- 7.5.9. 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.
- 7.5.10. 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



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provided suitable for the incoming cable size. Crimping type lugs shall be provided for incoming cable.

- 7.5.11. 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.
- 7.5.12. All outgoing circuit shall also have ON / OFF indicators.
- 7.5.13. Terminals shall be provided in an independent compartment for connection of outgoing cables. Terminals should be anti-loosening type and suitable for 6/10/16/25 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.
- 7.5.14. 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.
- 7.5.15. 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.
- 7.5.16. The panel shall be painted with epoxy type, acid / alkali resistant paint, while hardware shall be zinc passivated / electro galvanized.
- 7.5.17. 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.
- 7.5.18. Approval Certificate from CMRS or equivalent independent testing agency and general arrangement drawings shall be furnished during detail engineering.
- 7.5.19. Copies of certificates from the certifying agencies shall be furnished for all the equipment used in hazardous areas. Necessary approvals from CCOE/ PESO, DGMS/CMFR as applicable shall be obtained by the Bidder for all equipment installed in hazardous areas.
- 7.5.20. 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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7.5.21. 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.

7.6.EQUIPMENT ENCLOSURES

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

- enclosed indoor locations - IP 42

7.6.2. With enclosures open, all live parts shall be shrouded as a minimum to IP21.

7.6.3. 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.

7.6.4. 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.

7.7.CABLING AND WIRING

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

7.7.2. 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.

7.7.3. Interface cables connecting the packaged equipment to other plant equipment supplied by owner shall be supplied and installed by others.

7.7.4. The Bidder shall supply all cable size details for the approval of the Owner.

7.7.5. Top entry of cables or conduits into enclosures or equipment will not be accepted without prior approval.

7.7.6. Low voltage electrical wiring shall have multi-stranded copper conductors, 1.1 kV grade PVC insulation with round wire armoring and extruded PVC inner and FRLS outer sheaths with the marking of batch number.

7.7.7. 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.



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- 7.7.8. Control, instrumentation and power circuits shall be terminated in separate junction boxes for connection to the external cables.
- 7.7.9. Minimum cable bending radius as recommended by the cable manufacturer shall be strictly adhered to.
- 7.7.10. All cables shall be identified by means of a unique cable number. The Bidder may use his standard numbering system within the package. Cable tagging shall be fixed to all cables ends, immediately adjacent to glands, using a corrosion and ultra violet resistant proprietary system (Grafoplast or Owner approved equivalent).
- 7.7.11. All internal junction box, enclosure or panel wiring shall be clearly identified by means of permanent core identification markers Grafoplast or Owner approved equivalent
- 7.7.12. Circuits and terminals, which operate at different voltages and those that perform different functions, shall be physically segregated.
- 7.7.13. 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.
- 7.7.14. Cables will be terminated into enclosures using mechanical type compression glands.
- 7.7.15. The Bidder shall provide cable glands of a type specified by the Owner and terminate all cables within the scope of the Package Equipment
- 7.7.16. 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.
- 7.7.17. Gland entries into enclosures made through clearance holes must be retained with two back 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.
- 7.7.18. 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.
- 7.7.19. 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 centers. Gland plates for single core power cables shall be non-magnetic.

7.8. EARTHING

- 7.8.1. Earthing shall be carried out as per IS Code of Practice: 3043 and as shown in the relevant drawings



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- 7.8.2. Minimum two M10 sizes earthing bosses, one at each end of the package unit, shall be provided.
- 7.8.3. 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.
- 7.8.4. 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.
- 7.8.5. 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 instruments earthing and 16/25 sq.mm for internal/external connections. Insulated Earthing cables shall be colored green with yellow stripe.
- 7.8.6. 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 earthing shall be provided for electronics / instrumentation
- 7.8.7. Bidder shall make the dual earthing point at single location and integral body earthing shall be done at their works.

7.9. LIGHTING

- 7.9.1. All exterior lighting and general area lighting shall be supplied and installed by the Owner.
- 7.9.2. 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

7.10. NAME PLATES

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.

7.11. INSPECTION AND TESTING

- 7.11.1. 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.



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7.11.2. 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.

7.11.3. The specific test procedures of key items shall be as follows:

a) 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.

(c) Hydraulic test and 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 (thru 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. Test the operation of tie breakers / bus couplers.

8. The following tests shall be performed on all circuit breakers before they are operated:-

8.1. Contact alignment shall be checked and adjusted where necessary in accordance with Manufacturer's instructions.

8.2. Each circuit breaker shall be drawn out of its cubicle and shall be closed manually, and then its insulation resistance shall be measured from phase to phase and from phase to earth.



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- 8.3. All adjustable direct acting trip devices shall be set using values given in the approved relay settings for the job.
9. Before switchgear is energized, the following tests shall be performed on each circuit breaker in its 'test' position:-
 - 9.1. Close and trip circuit breaker from its control switch, push button or operating handle.
 - 9.2. Test operation of circuit breaker latch and check switch, where provided.
 - 9.3. Test proper operation of lockout device in the closing circuit, where provided, by simulating conditions, which would cause a lockout to occur.
 - 9.4. Trip breaker by manual operation or by applying current or voltage to each of its associated protective relays.
 - 9.5. All automatic control operations and interlocks shall be tested for correct operation.
10. 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.
11. All test reports shall indicate the details of the instruments used for test with date and time of test.
12. 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.
13. Seven copies of routine and type test certificates including of CMRS Dhanbad, Chief Inspector of Explosives / IS certificate shall be furnished before dispatch.

b) L.T. cable

- 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.
- Record test data between phase to phase and phase to earth.
- The test voltage, duration of test and test procedure shall be in accordance with IS : 4288.

c) Earthing

- Check that earthing system is installed as per drawings.
- Check that all connections are tight and connections are protected from mechanical injury.
- The resistance to ground shall be measured at the following locations:



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- (a) The resistance of the system/neutral earthing should be maintained preferably at less than 1 Ohm.
- (b) At each earthing point provided for lightning protection, the earth resistance shall preferably not exceed 1 Ohm.
- (c) At any one point of each system used to provide earthing to electrical equipment enclosures, resistance shall not preferably exceed 1 Ohm.
- (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

- 8.1.1. 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.
- 8.1.2. 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.
- 8.1.3. No instrument requiring special maintenance or operating facilities shall be offered or supplied as far as possible.
- 8.1.4. 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 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	American Gas Association. Gas Measurement Committee	
	Report No. 3	National Gas Measurement – Orifice Meterin
	Report No. 7	Measurement of gas by turbine meters
	Report No. 11	National Gas Measurement



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3	American National Standards Institute/American Society of Mechanical Engineers - ANSI/ASME:	
	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	American National Standards Institute/Fluid Control Institute - ANSI/FCI	
	70.2	Control Valve seat leakage classification.
5	American Petroleum Institute - API	
	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	European Standards	
	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



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	DIN 50049	Document on Material Testing
	DIN	PN sizes indicates Steel Pipe Flange Standards.
7	International Electro-technical Commission.	
	IEC 79	Electrical Apparatus for Explosive Gas atmosphere
	IEC 85	Thermal Evaluation and Classification of Electrical Insulation
	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	Indian Standard	
	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	Instrument Society of America - ISA	
	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	National Association of Corrosion Engineers
11	NEC	National Electric Code
12	NEMA	National Electrical Manufacturers' Association
13	ICS 6	Enclosures for Industrial Controls and Systems.



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14	NFPA	National Fire Protection Association
15	496	Purged & pressurised Enclosures for Electrical Equipment
16	ISA 75.01	Control valve Sizing
17	SAMA	Scientific Apparatus Manufacturers' Association

8.3. DOCUMENTS AND DRAWINGS TO BE SUBMITTED DURING DETAIL 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.

Bidder shall furnish the following information along with their offer:

- 8.3.1. Complete Scope of work.
- 8.3.2. Specification of Control Panel and Control System.
- 8.3.3. Configuration diagram for all programmable / configurable control system like Programmable Logic Controller (PLC).
- 8.3.4. Utility requirement like Power consumption
- 8.3.5. Estimated heat load for the equipment located in control room.
- 8.3.6. Sub Vendor List.
- 8.3.7. List of deviations, if any, from purchaser's specifications clause number wise with reasons thereof, wherever applicable.
- 8.3.8. Information like Instrument list and typical specification if supplied by Bidder in their bid, shall be retained for information only. All such details shall be submitted only after the finalisation of P & I D (Piping and Instrument Diagram). No implication shall be admissible on the basis of these documents.
- 8.3.9. 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

- 8.4.1. Instrument index
- 8.4.2. 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.
- 8.4.3. Instrument sizing calculation:
 - a) Instrument sizing calculation shall furnish information regarding sizing (as per standard elsewhere in this document), type, selection and other related information. Following sizing calculation shall be applicable, in general.



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- b) Control valve sizing including noise calculations.
- c) Safety valves/ pilot operated pressure relief valve sizing.
- d) Flow element sizing including orifice plates, flow nozzle sizing and selection.
- e) Utility consumption calculation including power supply (UPS/Non UPS) etc.
- f) Cable calculations for Power cables.

8.4.4. 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.

8.4.5. 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.

8.4.6. 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.

8.4.7. Purchase order specification: Purchase order specification contains all information which form part of material requisition but updated in line with the finally accepted offer of the Successful bidder.

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



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- 8.4.9. 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).
- 8.4.10. 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.
- 8.4.11. Configuration Diagram: This drawing is a graphical representation of all major hardwares required in a configurable control system which are necessary to meet all the expected functional requirements.
- 8.4.12. 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.
- 8.4.13. 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.
- 8.4.14. 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.
- 8.4.15. Bidder shall provide below listed documents within 2 week of LOA for GGL review and HAZOP of CNG compressor.
1. P&ID of compressor, Air system, Priority panel, Lubricating system, CO2 flooding system, Water Cooling system etc.
 2. GAD,
 3. Cause and Effect diagram,
 4. Operation and Control Philosophy,
 5. Interlock Table,
 6. Maintenance schedule and Maintenance procedure.

Any recommendation/ document penetrating to the HAZOP recommendation will be comply by bidder without any additional cost.

8.5. COMPRESSOR INSTRUMENTATION



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- 8.5.1. 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.
- 8.5.2. Bidder shall supply all hardware and software related to the operation and safety of the compressor.
- 8.5.3. Vibration and Axial Displacement Monitoring
- 8.5.4. Vibration and axial displacement monitoring system shall be based on non-contacting type sensing probe, unless otherwise specified.
- 8.5.5. 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 for vibration monitoring.
- 8.5.6. 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.
- 8.5.7. 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.
- 8.5.8. Emergency switch shall be provided in the Isolated room / office. All such switches shall have a protective cover to avoid inadvertent shutdown.
- 8.5.9. 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 +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.

- 8.6.1. All instruments, control systems (PLC) and analyser system shall be able to operate at the Following UPS specification:

Voltage level : 220 V AC + 10%



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Frequency : 50 Hz + 3 Hz

Switch over time : 5 milli seconds

8.6.2. 24V DC - the necessary arrangement will be in Bidder's scope

8.6.3. Solenoid Valves, Relays, Lamps : 230V AC + 10%

8.6.4. If 110 V AC required for Solenoid, the necessary arrangement will be in Bidder's scope

Panel/Cabinets lighting : 240V AC + 10%

8.6.5. In case 24 V DC is required for Input interrogations, relays and lamps etc., the same shall be arranged by the Bidder using dual redundant power packs (230V AC to 24V DC converter).

8.6.6. 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

8.7.ALARM PHILOSOPHY

8.7.1. Adequate alarms shall be provided to give audible and visual warning of any process and machine malfunction in the package.

8.7.2. All trips shall have a pre-trip warning alarm in addition to alarm at the trip condition.

8.7.3. All package alarms including pre-trip warning alarms and trip alarms (shutdown alarms) shall be annunciated on the local panel.

8.7.4. All rotating equipments shall have the status indication provided on the local panel.

8.7.5. 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.

8.7.6. "Fail-safe" type with normally closed alarm contacts shall be used.

8.7.7. 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.

8.7.8. 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.



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8.7.9. In case where suitable material of construction is not feasible/ possible, diaphragm seal shall be considered.

8.7.10. 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

8.8.1. Instrument connections for signal and gas supply shall be 1/4" NPT(F).

8.8.2. Electrical cable entry connection shall be 1/2" NPT(F). Suitable cable gland shall be used.

8.8.3. End connections shall meet the following, unless otherwise specified:

8.8.4. Threaded end connection shall be NPT as per ANSI/ASME B1.20.2

8.8.5. Flanged end connection shall be as per ANSI/ASME B16.5

8.8.6. 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

8.8.7. Grooves or ring type joint flanges shall be octagonal as per ANSI/ASME B 16.20

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:

8.9.1.1. 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.

8.9.1.2. 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.

8.9.1.3. 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/ S/IEC 60079-1 and secure against the ingress of



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- fumes, dampness, insects and vermin. All external surfaces shall be suitably treated to provide protection against corrosive Sea shore atmosphere.
- 8.9.1.4. 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.
- 8.9.1.5. Instrumentation electronics shall be certified by a recognized authority such as BASEEFA, CENELEC, FM, PTB, CMRI, LCIE, CESI, INIEX, ATEX and SMRS.
- 8.9.1.6. 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".
- 8.9.1.7. 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.
- 8.9.1.8. 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.
- 8.9.1.9. 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 integral action, while temperature controller with proportional plus integral plus derivative action.
- 8.9.1.10. 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.
- 8.9.1.11. 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.
- 8.9.1.12. All instruments shall be provided with proper tagging w.r.t. tag of instrument cables
- 8.9.1.13. Junction boxes and accessories required for flameproof instruments shall also be certified flameproof.



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- 8.9.1.14. Separate FLP 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.
- 8.9.1.15. 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.
- 8.9.1.16. 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).
- 8.9.1.17. 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.
- 8.9.1.18. All field instruments power shall be limited to 24 VDC. Power conversion unit if required shall be in the scope of the Bidder.
- 8.9.1.19. Units of measurement shall be:
- a) Gas flow SM3/hr or kg/hr for compressor and other application
 - b) Gas flow kg/hr for dispenser
 - c) Pressure Kg/cm²(g)
 - d) Temperature °C
 - e) Level %
 - f) Liquid flow M3/hr

8.9.2. Electronic instruments

- 8.9.2.1. All electronic instruments requiring separate power supply shall generally operate on 230V 50 Hz. Instruments operating at 24 V DC shall also be acceptable.
- 8.9.2.2. Electronic transmitters shall generally be two wire type. These shall have transmission/output signal of 4-20 mA DC and shall be capable of delivering rated current into external load of at least 600ohms when powered with 24 V DC nominal voltage.
- 8.9.2.3. Smart transmitter when selected, shall be used in analogue output mode. Digital integration shall be avoided unless specified otherwise.



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8.9.2.4. 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.

8.9.2.5. The design of electronic instruments shall be in compliance with the electromagnetic compatibility requirements as per IEC-801.

8.9.2.6. Pneumatic Instruments shall operate on gas supply of suitable pressure and shall have transmission and output signal of 0.2 to 1.0 kg/cm²g.

8.9.3. Panel board instruments

8.9.3.1. 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.

8.9.3.2. 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

8.9.3.3. Multiplying factors for flow scales shall be specified on manufacturers name plate.

8.9.3.4. Recorder charts shall be dual graduated, in general, in 0 to 10 square root and in 0 to 100 linear.

8.9.3.5. 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.

8.9.3.6. 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

8.9.4.1. 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.



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8.9.4.2. 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.

8.9.4.3. Smart transmitters if specified shall have accuracy + 0.1% of span, as a minimum.

8.9.5. Temperature Instruments

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

8.9.5.2. 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 63 mm/ 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.

8.9.5.3. 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



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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 0oC calibrated as per IEC 751/DIN 43760. RTD shall be used within a temperature range of -200 to 650oC. 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.

8.9.5.4. Temperature Transmitter

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

8.9.6.1. Pressure Gauges

- a) Liquid filled pressure gauge of diameter 4", (0-400 kg/cm²) 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/ 63 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.



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- f) All pressure gauges with maximum operating pressure exceeding 60 kg/cm²(g) shall be solid front type.
- g) Connection shall normally be 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/ 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.

8.9.6.2. 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 + 0.25% of URV, as a minimum. Whenever smart transmitters are specified/supplied, accuracy shall be governed by clause 2.19 (c).

8.9.6.3. Pressure Switches

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

8.9.7.1. 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



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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.

8.9.7.2. 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.

8.9.7.3. 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

8.9.8.1. CNG Compressor shall be equipped with Five Mass Flow Meters Viz:



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- Suction Mass Flow meter – For measurement of Gas at the inlet point of the CNG Compressor. Mass flow meters shall be of 'Coriolis' type.
- Discharge Mass Flow meter – For measurement of Gas at the outlet point of the CNG Compressor. Mass flow meters shall be of 'Coriolis' type.
- Mass flow meter at Mobile filling point - For measurement of Gas filled in MCV at Mobile fill point. Mass flow meters shall be of 'Coriolis' type.
- Mass flow meter at Inlet of Engine - For measurement of Gas consumed by Engine. Mass flow meters shall be of 'Coriolis' type.
- Vent Mass Flow Meter – For measurement of Gas through the Common Vent line of the CNG Compressor (Excluding SRV and Impulse vent). Mass flow meters shall be of 'Coriolis' type or 'Thermal' type.

8.9.8.2. Accuracy of the vent meter is +/- 2% and the gas measured in the vent meter is displayed on the PLC of the compressor package.

8.9.8.3. Shall have Provision of local display and output must be communicated with PLC display.

8.9.8.4. 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 /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.

8.9.8.5. Allowable pressure drop for the flowmeter at the inlet, outlet, mobile fill point and inlet of engine of the compressor shall be 1.0 kg/ cm². Offered mass flowmeter shall be necessary for Custody Transfer application but not exceeding 0.5% of span.

8.9.8.6. Calibration for the offered mass flow meter from a recognized institute shall be in Kg/hr and SM³/hr. Pressure, Temperature compensation shall be provided by the meter.

8.9.8.7. 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 /IEC 60947-1 and IS/IEC 60079. Additional gland shall be provided for AO/DO.



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8.9.8.8. 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.

8.9.8.9. 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 pre-amplifiers converters lineariser signal isolators etc.

8.9.8.10. 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.

8.9.8.11. 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) Calibration report including calibration factors for each Mass flow meter certificate from statutory body for offered sensor and transmitter for required area classification
- c) W&M Certificate.

8.9.9. Control Valves

8.9.9.1. 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.

8.9.9.2. 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

8.9.9.3. Flanged control valves shall be used. Body material, body rating and flange rating, shall be as per piping specifications as a minimum.

8.9.9.4. Material used for trim shall be SS-316, as a minimum. For higher pressure drops (greater than 10 kg/cm²g), trim shall be stellated. (Wetted parts like set ring, valve plug, plug guide, plug stem, guide bushing and cage are being termed as trim).

8.9.9.5. 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.



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- 8.9.9.6. 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).
- 8.9.9.7. Valve seat leakage shall be as per ANSI FCI 70.2 and shall be selected with due consideration to meet the requirement.
- 8.9.9.8. 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.
- 8.9.9.9. 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.
- 8.9.9.10. Solenoid valves, shall be universal type and shall be continuous rated type with class F coil insulation as per IEC 85/IS-1271. These shall be of brass body with SS-316 trim, as a minimum.
- 8.9.9.11. 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
- 8.9.10.1. Gas Inlet (approved make) Pressure Regulator with SSV of 150/300/600 # class rating should be suitable for 1200 & 1700 SCMH CNG compressor.
- 8.9.10.2. All pressure relieving devices shall be designed in accordance with ASME code for 'Boilers and Pressure Vessels', API-521 and Indian Boiler Regulations.
- 8.9.10.3. Pressure relief valves shall be full nozzle full lift type except for thermal relief valves.
- 8.9.10.4. 3/4" x 1" threaded (NPT) modified nozzle type valves with typically 0.38 cm² orifice size shall be specified for thermal relief.
- 8.9.10.5. 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



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- 8.10.1. 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.
- 8.10.2. 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.
- 8.10.3. The system shall be designed using electromagnetic relays unless specified otherwise and shall be located locally or remotely as per the operational requirements.
- 8.10.4. Each shutdown circuit and solenoid valve shall be provided with a switch-fuse unit separately.

8.11. CONTROL PANEL

- 8.11.1. The local control Panel shall be flame proof with enclosure made from cast aluminium (LM6).
- 8.11.2. 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.
- 8.11.3. 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.
- 8.11.4. 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.
- 8.11.5. 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:



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- 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.
- 8.11.6. 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.
- 8.11.7. 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.
- 8.11.8. All control panels shall be supplied in pre-tubed/pre-wired conditioned and shall be completely tested at manufacturer's works prior to dispatch
- 8.11.9. A shed shall be provided above the control panel mounted on compressor canopy.

8.12. PROGRAMMABLE LOGIC CONTROLLER (PLC)

8.12.1. General

- 8.12.1.1. The programmable logic controller (PLC) shall be microprocessor 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.
- 8.12.1.2. The PLC shall have provision of 100% redundancy to avoid downtime and loss of data in case of any problem.
- 8.12.1.3. 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.
- 8.12.1.4. 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.
- 8.12.1.5. 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.
- 8.12.1.6. 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.



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8.12.1.7. Operation of PLC shall be completely unaffected by a momentary power loss of the order of 20 milli seconds.

8.12.1.8. The system shall be programmed in general as per the logic diagram or ladder diagram.

8.12.1.9. 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

8.12.2.1. 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.

8.12.2.2. Input/output Sub-system.

8.12.2.3. 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.

8.12.2.4. Each I/O shall be protected against the reversal of polarity of the power supply voltage to I/O.

8.12.2.5. Each module shall have a LED for each I/O per channel to indicate the status of each Input/ Output.

8.12.2.6. Each output shall be short circuit proof and protected by using fuse. Visual indication of fuse blown must be provided for each output.

8.12.2.7. PLC input card shall have the provision to incorporate minimum three (3) analogue inputs from Suction train package.

8.12.3. Processor Sub-System

8.12.3.1. The processor shall have capability to implement all the control functions required to programme instructions required by the logic schemes.

8.12.3.2. 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.

8.12.3.3. It shall be possible to generate the first out alarm output by the PLC.

8.12.3.4. PLC Console

8.12.3.5. 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.



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8.12.3.6. The keyboard shall be easy to operate with each key clearly identified. It shall be provided with a lock and key to prevent any unintentional programme modification.

8.12.3.7. It shall be possible to modify, add or delete the application programme on-line without affecting the output.

8.12.3.8. PC based console when offered must be of current release and state-of-the art.

8.12.3.9. System Power Supplies

8.12.3.10. Programmable Logic controller shall operate on uninterrupted power supply with following specifications:

- Voltage 230V + 10%
- Frequency 50 Hz + 3 Hz
- Switchover time 5 milli second

8.12.3.11. Each I/O rack shall be provided with a separate power supply

8.12.4. Self-Diagnostics

8.12.4.1. 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.

8.12.4.2. 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

8.13.1.1. 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 stellite etc. shall be selected based on process conditions.

8.13.1.2. 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.

8.13.1.3. 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.



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8.13.1.4. MATERIAL SELECTION CHART:

Sr. No.	PIPING CLASS	CONTROL VALVE		PRESSURE RELIEF VALVE		
		Body	Trim	Body/ Bonnet	Nozzle / Disc	Bellow
1	A1a, B1a	A216 Gr WCB	SS 316 Stellited	A216 Gr WCB	SS 316	SS 316
2	F2b	A217 GrWC1	SS 316 Stellited	A217 GrWC1	SS 316 Stellited	SS 316

Sr. No.	PIPING CLASS	ORIFICE/SENIOR ORIFICE		FIELD TRANSMITTER	
		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. No.	PIPING CLASS	THERMOWELL		LEVEL INSTRUMENT		
		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. No.	PIPING CLASS	LEVEL SWITCH		LEVEL GAUGE		
		Cage	Float	Chamber	Cock Body	Cock Trim
1	A1a, B1a	A106 Gr.B	SS 316	A105	A105	SS 316
2	F2b	A335 GrP1	SS 316	A182 GrF1	A182 GrF1	SS 316

8.14. SPECIFICATION FOR INSTALLATION MATERIAL

8.14.1. Cables

8.14.1.1. 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.



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- 8.14.1.2. The insulation grade shall be 600 V/1100 V as a minimum and shall meet insulation resistance, voltage and spark test requirement as per BS-5308 Part-II.
- 8.14.1.3. All cables shall be twisted and armoured. Armour over inner jacket shall be of galvanised steel wire/flat as per IS-1554 Part I.
- 8.14.1.4. 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 mm² conductor.
 - 39.7 ohms/km at 20°C for cables with 0.5 mm² conductor.
- 8.14.1.5. The mutual capacitance of the pair or adjacent cores shall not exceed 250 pF/m at a frequency of 1 kHz.
- 8.14.1.6. L/R ratio of adjacent cores shall not exceed 40 microhenry/ohms for cables with 1.5 mm² conductor and 25 µH/ohms for cables with 0.5 mm² conductor.
- 8.14.1.7. The drain wire resistance including shield shall not exceed 30 ohms/km.
- 8.14.1.8. Signal Cables:
- a) Single pair shielded signal/alarm cables shall be used between field instruments/switches and junction boxes/local control panels.
 - b) Multipair individually and overall shielded signal/alarm cables shall be used between junction boxes/local control panels and control room, in general.
 - c) The single pair/triad cables shall be 1.5 mm² conductor size, made of electrolytic copper conductor of 7 strand each of 0.53 mm diameter, multipair cables with 0.5 mm² 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 mm² conductor shall have 7 strand each strand of 0.53 mm diameter.
 - d) 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.
 - e) Drain wire shall be provided for individual pair and overall shield, which shall be 0.5 mm² multi stranded bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminium side of the shield.
 - f) All multi-pair cables shall have 6 pair/12 pairs only. White multi-triad cable shall have 6 triads/8 triads only.
 - g) Power, signal and control Cables, FLP glands including FLP gland for incoming cables to compressor package incoming electric panel, electric accessories for the package.



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8.14.1.9. Control cables

- a) 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.
- b) 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.
- c) These control cables shall have 1.5 mm² conductor size with 7 stranded conductors of annealed electrolyte grade copper, with each strand of 0.53 mm diameter

8.14.1.10. Thermocouple extension cables

- a) Single pair shielded thermocouple extension cables shall be used between thermocouple head and junction boxes transmitter/local control panel mounted instruments.
- b) Multi-pair individually and overall shielded thermocouple extension cables shall be used between junction boxes and control room mounted devices.
- c) The cable shall have 16 AWG and 20 AWG solid conductors for single and multi-pairs respectively.
- d) All thermocouple extension cable shall be matched and calibrated in accordance with IEC-584-2
- e) 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 mm² multi stranded bare tinned annealed copper conductor. The drain wire shall be in continuous contact with aluminium side of the shield.
- f) Inductance shall not exceed 4mH/km. However for J-type thermocouple inductance could be 8 mH/km.
- g) All multi-pair cables shall have 6 pairs/12 pairs only

8.14.1.11. Power supply and other cables

- a) 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 mm² of copper conductor. For higher size, aluminium conductor can be considered. All these cables shall be PVC/FRLS, XLPE/PVC insulated and armoured.
- b) Any other special cable required for instruments shall also be supplied as per requirement.



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8.14.2. Cable glands

- 8.14.2.1. 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.
- 8.14.2.2. All cable glands shall be nickel-plated brass and they shall be double compression type suitable for armoured cables.
- 8.14.2.3. Flame proof glands shall be supplied with Ex(d) certification.

8.14.3. Junction boxes

- 8.14.3.1. 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.
- 8.14.3.2. These boxes shall have terminals suitable for minimum or 4 mm² or less cable termination mounted on rails. 10 % spare terminals shall be supplied in each junction box.
- 8.14.3.3. 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

- 8.14.4.1. Bidder shall supply instrument valves (miniature type) and valve manifolds wherever required.
- 8.14.4.2. Body rating shall be as per piping class or better. However trim material shall be SS 304, as a minimum. All valves and manifolds shall be forged type only.
- 8.14.4.3. Valve body and trim material shall be SS 316, unless otherwise specified. Superior trim material shall be selected as required by process conditions. Packing material in general shall be PTFE.

8.14.5. Impulse piping/tubing

- 8.14.5.1. 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 except SS 304 tubing for instrument Air/ Gas.
- 8.14.5.2. Where pressure (operating) exceeds 70 kg/cm²(g). or if piping is specified as impulse line, seamless pipes of size 3/4" NB x 0.083" thick. Required. Seamless tubes shall have a hardness of max. 80 RB as typical.

8.14.6. Pipe and tube fitting



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8.14.6.1. 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.

8.14.6.2. 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.

8.14.6.3. Instrument gas fittings shall be suitable for use on SS tube confirming to ASTM 269 Hardness not exceeding RB 80.

8.14.6.4. All threaded fittings shall have NPT threads as per ANSI/ASME B 16.11 only.

8.14.7. Instrument signal tubes

8.14.7.1. Bidder The instrument gas tubing material shall be Stainless Steel series –316 conforming to ASTM-A269.

8.14.7.2. Bidder shall avoid use of intermediate connections and shall estimate single length for each instrument location

8.14.8. Gas filter regulators

8.14.8.1. 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.

8.14.8.2. The body of the filter shall be anodised aluminium.

8.14.8.3. 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

8.14.9.1. All cables in the cable trench shall be laid in cable trays.

8.14.9.2. 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.

8.14.9.3. The width shall be so selected that 50% of tray space is available for future use.

8.14.9.4. 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



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8.15. INSTALLATION WORK

- 8.15.1. 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.
- 8.15.2. 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.
- 8.15.3. 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.
- 8.15.4. 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.
- 8.15.5. All primary piping/tubing (impulse lines) shall have a slope of 1 In 12 on the horizontal run.
- 8.15.6. 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.
- 8.15.7. All threaded joints shall be joined with PTFE tapes only.
- 8.15.8. All impulse lines shall be supported at regular intervals.
- 8.15.9. Instrument drain/vent connection shall be piped to safe area or connected to vent header to avoid accumulation of gas in the station.
- 8.15.10. All tubes/cables shall be properly laid on cable trays, which shall be supported at regular intervals.
- 8.15.11. Separate routing or physical separation shall be maintained between signal cable, shut down & power cables.
- 8.15.12. The cases of instrumentations shall be earthed by earthing wire to the nearest earth bus bar for safety runs.
- 8.15.13. Where cables are to be buried or laid in concrete trench, requirement of trenches shall be provided with prior intimation to client.

8.16. INSTALLATION OF PLC SYSTEM



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- 8.16.1. 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.
- 8.16.2. 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.
- 8.16.3. 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

- 8.17.1. 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'.
- 8.17.2. 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.
- 8.17.3. The total resistance of system ground shall be less than 5 ohms unless otherwise recommended by system manufacturer.

8.18. TESTING AND CALIBRATION

- 8.18.1. 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.
- 8.18.2. 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.
- 8.18.3. All external cage type level instruments shall be drained and dried with dry air to remove any traces of moisture, oil and dust.
- 8.18.4. After pressure testing, all these impulse shall be drained and dried with dry air to remove any traces of moisture, oil & dust.
- 8.18.5. Instrument gas lines shall be duly tested with soap solution for any leak after pressurising 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.
- 8.18.6. Signal tubes shall be flushed and tested with instrument gas for any leak at a pressure of 1.5 kg/cm²(g). After pressurizing 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.



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- 8.18.7. 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.
- 8.18.8. All instruments supplied by the Bidder shall be calibrated using proper test equipment.
- 8.18.9. All instruments shall be calibrated for 0%, 25%, 50%, 75%, 100% and vice versa.
- 8.18.10. All temperature gauges shall be calibrated using temperature bath.
- 8.18.11. All thermocouple activated instruments shall be calibrated by generating millivolts by a potentiometer.
- 8.18.12. All transmitters shall be calibrated as per instrument ranges.
- 8.18.13. All displacer type level transmitters shall be calibrated with water or suitable fluids and corrected for specific gravity.
- 8.18.14. 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.
- 8.18.15. Bidder shall check/Calibrate flame detector with UV torch or appropriate instruments. Bidder shall calibrate the Gas detector with calibration GAS bottle or cylinder
- 8.18.16. 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.
- 8.18.17. Bubble tight shut off control valves & shut down valves shall be checked for leak test and gland leak test.
- 8.18.18. Solenoid valve shall be checked functionally for its operation.
- 8.18.19. 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.
- 8.18.20. All electronic/pneumatic receiver instruments shall be calibrated as per the manufacturer's instructions. Controllers shall be aligned properly.
- 8.18.21. 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.
- 8.18.22. The accuracy of overall loop shall be within $\pm 1\%$ for electronic and $\pm 1.5\%$ for pneumatic loops.



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- 8.18.23. After performing the calibration of all instruments, the entire loop shall be checked for proper operation.
- 8.18.24. 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.
- 8.18.25. If no instrument gas is available, Bidder shall provide necessary dry N2 cylinders to carry out the above activity.

8.19. TESTING OF SYSTEM (PLC)

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

- 8.20.1. Loop checking shall be carried out by Bidder, which shall include proper functioning and interconnection of all items in the loop.
- 8.20.2. All inputs signals shall be generated in the field and corresponding reading shall be checked at all corresponding displays.
- 8.20.3. 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.



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8.20.4. After loop checking completed, Bidder shall connect back any terminals and connections removed during loop checking

8.21. COMMISSIONING

8.21.1. Bidder shall submit commissioning procedure, which include list of commissioning spares, pre-commissioning checklist.

8.21.2. This activity shall be carried out in a systematic manner so as to avoid any accident to operating personnel.

8.21.3. During the start up all the instruments calibration, controller alignment, trip point setting shall be trimmed so as to meet the operation requirements.

8.21.4. Prior to guarantee run of CNG Station, the vital instrument as required by Bidder have to be recalibrated and the results recorded.

8.22. CONSTRUCTION PHILOSOPHY

8.22.1. LCP Arrangement

- a) 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, analysers, programmable logic controllers, personal computers, etc.
- b) 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 requirement of Programmable Logic Controller.
- c) A minimum of 20% spare windows with alarm modules shall be provided in alarm annunciator.
- d) A minimum of 20% spare status lamps/switches/push buttons/terminals or one of each type, whichever is higher, shall be provided.

8.22.2. Commissioning Spares

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

8.22.3. 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



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- 9.1.1. Inspection and Test Requirements shall be as specified in respective equipment / item / work specification, unless specified hereunder.
- 9.1.2. Bidder facility will be equipped with test facility for carryout following test for compressors as per international standards API 618, API 11P etc.
 1. Mechanical Run Test
 2. Gas loss check as per Tender Requirement.
 3. SCADA facility for remote monitoring and automatic operation of compressor including alarm to alert the operator, stop/ restart the compressor, Remote alarm reset facility.
 4. Electric supply for PLC and other electrical equipments.
 5. Test Certificates.
- 9.1.3. Bidder shall confirm compliance to all inspection and testing requirements stipulated therein and include the inspection charges in the lump sum cost.
- 9.1.4. 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.
- 9.1.5. The Bidder shall submit detailed Test Procedure for Approval of the Owner two months in advance of the actual date of conducting each test.
- 9.1.6. 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.
- 9.1.7. The test procedure shall include a schedule listing the proposed tests.
- 9.1.8. Each item of the contract shall be tested and certified in the works where it is manufactured.
- 9.1.9. 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.
- 9.1.10. 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.



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- 9.1.11. Bidder shall have facility for movement & fitting of cascade above compressor in their premises.
- 9.1.12. Bidder will appoint Third Party Inspection Agency for inspection of Cascade, UPS, Dispenser and Pressure Regulating Skid.
- 9.1.13. 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.

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

9.2.6. **Mechanical running test (MRT)**

9.2.6.1. 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. During this test following shall be recorded at agreed intervals in inline with manufacturer standard.

- a) Vibration levels measured on cylinders and frame
- b) Temperature of bearing, cylinders and other parts
- c) Temperature and pressure of lube-oil system and air cooling system, etc.
- d) Nozzle test
- e) Testing of the Control Panel & instrumentation

9.2.6.2. Subsequent to satisfactory run the compressor shall be examined as per standard procedure & following shall be examined as minimum:



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- a) Bore and other parts by opening a valve
- b) Piston & cylinder clearance
- c) Visual examination of position rod, controlled guide bore without dismantling

9.2.6.3. 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.

9.2.6.4. However, Compressor manufacturer can perform MRT by their Manufactures standard Procedures above three steps are not compulsory for manufacturer standard procedure.

9.2.7. **Mechanical string test**

Mechanical String Test for 4 hrs is a mandatory requirement to be performed at packager's shop in presence of the Owner or Owner's authorised representatives or a third party. This test can be clubbed up with the Mechanical Run Test of compressor as specified above, provided the job driver & lube Oil system is used for the test.

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

- 9.3.1. 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.
- 9.3.2. Complete package shall be performance tested as a module whereby along with Engine compressor performance the Bidder shall demonstrate all controls, shutdown, trips/alarms etc.
- 9.3.3. Inspection, testing and performance testing of package as a whole & individually (if required) itemized testing shall be carried out.
- 9.3.4. Factory acceptance test of compressor shall be performed with natural gas. Bidder shall have relevant permits and certificates for cascade filling and storage from PESO which used during FAT of compressor.
- 9.3.5. The parameters of performance test shall as follows with Min. Pressure, Max Pressure for suction and guaranteed discharge pressure :
 - a) Capacity
 - b) Gas Discharge Pressure and Temperature.



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- c) Power Consumption
 - d) Vibration (10/5 mm/sec for unfiltered/filtered peak velocity condition respectively)
 - e) Noise level 75 dBA @ 1m from the enclosure
 - f) Lube oil Pressures and Temperatures
 - g) Unloading of the compressors and it's auto-controls
 - h) All Instruments, Valves & PLC All interlocks
- 9.3.6. 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.
- 9.3.7. The following points to be adhere by bidder and shall be part of QAP for witness by TPI during factory acceptable test:
- Leak test @ 250 during the FAT
 - 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
 - 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 and mobile cascade line need to be tested at operating pressure in all valves open condition
- 9.3.8. 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.
- 9.3.9. 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



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9.6. INSPECTION AND TESTING OF HEAT EXCHANGERS AND PRESSURE VESSELS

- 9.6.1. As specified in the general specification for the equipment and as follows.
- 9.6.2. Material Identification (Material composition & physical properties certificate to be furnished).
- 9.6.3. All pressure parts and weld joints shall be DP tested / MP tested /UT tested/ Radiography tested as mentioned in approved QAP.
- 9.6.4. Heat treatment, if any.
- 9.6.5. Hydrostatic test and leakage test.
- 9.6.6. Visual inspection and dimensional checks.
- 9.6.7. 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

- 9.9.1. 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.
- 9.9.2. All nozzle openings shall be covered by metal closures to prevent entry of dust and dirt.
- 9.9.3. All delicate components/instruments shall be packed separately with proper tag marking.
- 9.9.4. All other equipment except compressor package shall be packed in a wooden case.
- 9.9.5. The Tag. No. of the item shall be prominently painted on the packing case.

9.10. MINIMUM REQUIREMENTS FOR QUALITY ASSURANCE PLAN

The Bidder shall develop Quality Assurance Plan (QAP) and get it approved from the Owner. 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



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Sr. No.	Particulars	Bidder's Scope	Scope of third party	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.	Nondestructive 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	R	R
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

- a. 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.
- b. The Bidder shall have to furnish the conceptual Equipment layout to be given along with his offer to enable the Owner to finalize plot size for the refueling stations.
- c. 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.
- d. The foundation of the equipment shall be designed the Owner, based on the loading data and foundation plan furnished by the Bidder
- e. 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.
- f. 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.



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- g. 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.
- h. The Bidder shall clearly mention in detail about the transportation of whole CNG package unit.
- i. The Bidder shall give the list of tools, tackles and components required for erection and alignment for CNG package. The same shall be used during O&M contracting period. Afterward the same shall be handed over to the Owner at no extra cost.
- j. Valid PESO License for the CNG Dispenser Model and
- k. Valid Model Approval from Legal Metrology Department for the CNG Dispenser Model
- l. Valid License from Legal Metrology Department for Manufacturing of the CNG Dispenser
- m. 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 1+9 year of O&M period.

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.

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 has to arrange for manpower, tools and tackles required for installation, erection and commissioning and performance guarantee test 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



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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.

Openings for level gauges, thermo wells and other instruments shall be protected during and after erection.

3. All accessories like pressure gauge, temperature indicators, safety valves, etc. shall be tagged and separately kept till erection.
4. All flange connections and openings shall be kept blanked with wooden covers to prevent entry of foreign matter.

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



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



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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 engines, 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 Engine 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



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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.
 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. 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.
 8. Running test of engine etc. shall be performed with no load and it shall be confirmed that vibrations, sound and temperature of engine are not abnormal.
 9. After running test of engine, the surface of engine and the driven unit shall be coupled with confirmation of rotating direction of unit and engine.
 10. 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.



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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 @ 250 during the SAT
 - 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



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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.
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

- 10.3.1. 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-



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commissioning checks, functional tests of instrumentation and control before trial runs of 72 hours and commissioning.

10.3.2. On completion of erection and commissioning. The Bidder shall arrange for the performance and guarantee tests run of the CNG package.

10.3.3. 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.

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 authorized representatives of the Owner before it is handed over to the owner.

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:

- a) Hazardous characteristics of CNG.
- b) Familiarization with operational procedures and practices.
- c) Hands on experience on Operation of Equipment.
- d) Routine maintenance activities of the facilities.
- e) Knowledge of emergency and manual shut down systems.
- f) Immediate and effective isolation of any CNG leak.
- g) Accounting of product.
- h) Safety regulations and accident prevention.
- i) Evacuation and safe escape of vehicles.
- j) 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

- a. 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.



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b. All the equipment/items shall be capable of performing the duties specified in this specification without damage, distortion or failure of any component.

c. 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

- a. Performance guarantee for capacity, pressure and power consumption.
- b. Performance tests shall confirm to relative standard for the compressor without negative tolerance on capacity
- c. 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.
- d. The Bidder shall guarantee the fuel consumption at rated point and submit the performance curves. Bidder shall provide fuel consumption details in tabular format at different suction pressure range according to specification
- e. 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.
- f. 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)

- 11.1. 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.
- 11.2. 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.
- 11.3. The bidder would need to specify the timeline when the documents requiring approval would be submitted in the PERT chart.



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- 11.4. 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			
		During Detailed Eng.	For Approval	For Information	Final/As-Built
	General				
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, engine, Cascades, Dispensers, Controller, Ancillaries and Auxiliaries.	Yes	Yes		Yes
3	Utility and their consumption requirement at battery limit	Yes		Yes	Yes
4	Itemized electrical load data	Yes	Yes		Yes
5	Itemized 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		
	Design Documents				
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



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9	Sizing calculation of all coolers, cable sizing, piping, electrical system, instrumentation and control.				
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	Itemized 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
General Arrangement Drawings					
26	Compressor Package	Yes	Yes		Yes
27	Engine	Yes	Yes		Yes
28	Cooler	Yes	Yes		Yes
29	Storage Cascade, Dispenser	Yes	Yes		Yes
30	Priority Panel	Yes	Yes		Yes

 GUJARAT GAS	TECHNICAL SPECIFICATION FOR GAS ENGINE DRIVEN CNG COMPRESSOR PACKAGES
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32	Electrical panels	Yes	Yes		Yes
32	Skid with mounting details		Yes		Yes
33	Foundation plan for all the items			Yes	Yes
34	Overall equipment layout showing compressor skid, cascades, panels location, dispensers and requirement for access platforms, drains, movement, clearances.	Yes	Yes		Yes
35	Piping GA from tie-in point to compressor skid to storage cascade and to dispensers		Yes		Yes
List of Spares					
36	Itemized price list of mandatory spares	-	-	Yes	-
37	Itemized list with price of spares for erection / commissioning	-	-	Yes	-
38	Item list of spares with price for 2 years running	-	-	Yes	-
Testing and Certificates					
39	Overall as well individual assembly quality assurance plan	Yes	Yes		Yes
40	Drawing for testing arrangement and test procedure to be adopted			Yes	
41	Certificate for following				
	a) Hydraulic testing				Yes
	b) Nondestructive testing				Yes
	c) Material composition and physical properties				Yes
	d) Leak proofs list of frame				Yes
	e) Lube oil pump, frame oil pump, hyd. Oil pump				Yes
42	Design / Actual assembly clearance chart			Yes	Yes
43	Test records of following:				
	a) Mechanical running				Yes
	b) Performance test				Yes
	c) Noise level test				Yes
44	Dispenser communication protocol			Yes	Yes
45	Statutory documents			Yes	Yes



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46	O & M manual	Yes		Yes	Yes
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APPENDIX A: GUARANTEED PARAMETERS

NOTE: Bidder to furnish the guaranteed parameters during detailed engineering phase.

1200 SCM^H Compressor package

Sr. No.	Parameter	Bidder's Data
		Inlet Pressure 19 kg/cm ² (g)
1	Compressor Capacity in SCM ^H . (required 1200 SCM ^H)	
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	
6	Site rated BkW of gas engine (No -ve tolerance)	
7	Fuel consumption of package in SM ³ /Hr. (basis of loading & penalty)	
8	Vent/packing losses in package in percentage of throughput(Basis of loading and penalty)	

1700 SCM^H Compressor package

Sr. No.	Parameter	Bidder's Data
		Inlet Pressure 24 kg/cm ² (g)
1	Compressor Capacity in SCM ^H . (required 1700 SCM ^H)	
2	Compressor BkW at Rated Conditions (No +ve tolerance), KW	
3	Compressor BkW at RV Set Conditions (No +ve tolerance), KW	



TECHNICAL SPECIFICATION FOR GAS ENGINE DRIVEN CNG COMPRESSOR PACKAGES

4	Net of all auxiliaries/package ventilation loads, KW	
5	Noise level 75 dBA @ 1 meter from enclosure	
6	Site rated BKW of gas engine (No –ve tolerance)	
7	Fuel consumption of package in SM3/Hr. (basis of loading & penalty)	
8	Vent/packing losses in package in percentage of throughput (Basis of loading and penalty)	

Note: if it is observed that bidder is failed to comply with guaranteed parameter, penalty of Rs. 1000/- per day shall be levied in addition to Penalty for Fuel Consumption on the bidder

APPENDIX B DATASHEET FOR UV FIRE DETECTORS

Sr. No.	TECHNICAL GENERAL	
1	PROJECT:	
2	OWNER:	SITE:
3	EQUIPMENT: UV FIRE DETECTION FOR CNG STATIONS	
4	NO.	FIRE DETECTION TYPE:
5	NOTE: ■ SCOPE OPTION / INFORMATION SPECIFIED BY GUJARAT GAS LTD □ INFORMATION REQUIRED FROM VENDOR.	
6	□ MANUFACTURER:	□ MODEL NO.:
7	□ WAVE LENGTHS:	■ TYPICAL RESPONSE TIME: < 3 SEC @ 50FT
8	□ FIELD OF VIEW:	□ MINIMUM SENSOR RESPONSE TIME:
9	□ SENSITIVITY	□ MAINTENACE SIGNAL:
10	■ CLASSIFICATION: CLASS I, DIV 1, GROUPS B, C & D: Eexd IIC, T5, IP66	■ CLASS II, GROUP E,F & GCLASS III, TYPE 4X
11	■ APPROVALS: CSA, FM, ATEX, CENELEC, CE MARKING	
12	■ ENVIRONMENTAL SPECIFICATIONS	
13	■ OPERATING TEMPERATURE RANGE: -40 (0C) to 85 (0C)	
14	■ STORAGE TEMPERATURE RANGE: -50 (0C) to 85 (0C)	
15	■ OPERATING HUMIDITY RANGE: 0% TO 100% RH NON-CON-DENSING	



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16	■ ALTITUDE (M):	55 M FROM MSL	AMBIENT TEMP: 110 OF (MAX.), 51 OF (MIN.)
17	■ EARTH QUAKE ZONE V		
18	■ INSTALLATION: ■ INDOOR		
■ ELECTRICAL SPECIFICATION:			
19	■ INPUT POWER: 20 – 36 VDC, 24 VDC @ 150Ma max.		<input type="checkbox"/> COPM FAULT
20	■ ANALOG SIGNAL: 4-20mA (600 Ohms Max.)		<input type="checkbox"/> READY SIGNAL
21	<input type="checkbox"/> FAULT SIGNAL: 0Ma		<input type="checkbox"/> UV SIGNAL:
22	<input type="checkbox"/> IR SIGNAL:		<input type="checkbox"/> WARN SIGNAL:
23	<input type="checkbox"/> ALARM SIGNAL:		<input type="checkbox"/> BAUD RATE:
24	■ RELAY CONTACT RATING: 8A, 250VAC, 8A @ 24VDC		<input type="checkbox"/> RS-485 OUTPUT:
25	■ RFI/EMI PROTECTION: COMPLIES WITH EN50081-2		<input type="checkbox"/> STATUS INDICATOR:
26	<input type="checkbox"/> FAULT MONITORING:		
■ MECHANICAL SPECIFICATION:			
28	■ HOUSING:		■ LENGTH:
29	■ DIAMETER:		■ MOUNTING:
30	■ CABLE ENTRY:		■ WEIGHT:
SCOPE OF SUPPLY			
31	■ UV FIRE DETCTION SENSORS COMPLETE:		
	REMARKS:		



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APPENDIX C DATASHEET FOR GAS DETECTION SYSTEM

1	TECHNICAL GENERAL				
2	PROJECT:				
3	OWNER: M/S		SITE:		
4	EQUIPMENT: GAS DETECTION FOR CNG STATIONS				
5	NO.		GAS DETECTION TYPE:		
6	NOTE: ■ SCOPE OPTION / INFORMATION SPECIFIED BY GUJARAT GAS LTD □ INFORMATION REQUIRED FROM VENDOR.				
7	□ MANUFACTURER:		□ MODEL NO.:		
	SIGNAL TRANSMISSION				
8	□ ANALOG: TRANSMISSION BY 3CORE SHEILDED CABLE				
9	□ MEASUREMENT CONTROL: 4mA to 20Ma				
10	□ SENSOR DRIFTS BELOW ZERO:				
11	□ MEASURING RANGE EXCEEDED:				
12	□ TRANSMITTER FAULT:				
13	□ MAINTENACE SIGNAL:				
14	□ HART COMPATIBLE:				
	■ SITE / ENVIRONMENTAL DATA				
15	SITE DATA:				
16	AMBIENT TEMP. (°F):	MAX:	110		



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APPENDIX D: SPECIFICATION – NATURAL GAS (COMPRESSOR SUCTION) AND NITROGEN SERVICE PIPING (PMS)



TECHNICAL SPECIFICATION FOR GAS ENGINE DRIVEN CNG COMPRESSOR PACKAGES

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 ² (g) 25.0										RATING & FACING : 300#, RF										
		MAX.TEMPERATURE : °C 55.0																				
		SYSTEM TEST PRESSURE : kg/cm ² (g) 37.5										CORROSION ALLOWANCE : 1.5 MM										
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 GAS ENGINE DRIVEN CNG COMPRESSOR PACKAGES

PIPING MATERIAL SPECIFICATION					SPEC.NO. : MSD-1011 SHEET NO. : 3 OF 3	
BASE MATERIAL: CS			INSULATION : NIL TRACING : NIL		JDB NO : 249040 CLASS : B1a	
SERVICE : NATURAL GAS (COMPRESSOR SUCTION), NITROGEN (OUT SIDE PACKAGE)						
VALVE						
TYPE :		BALL	GLOBE		CHECK	
TAG NO. :						
SIZE RANGE : NB		15NB & ABOVE	15T040	50&ABV	15T040	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
NOTE:- 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.						



TECHNICAL SPECIFICATION FOR GAS ENGINE DRIVEN CNG COMPRESSOR PACKAGES

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 ² (g)	310.0			RATING & FACING : 2500#, RTJ		
	MAX.TEMPERATURE :		°C	55.00					
	SYSTEM TEST PRESSURE :		kg/cm ² (g)	420.75			CORROSION ALLOWANCE : NIL		
TUBE/PIPE	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	
	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				
FLANGES	PIPE TO PIPE JOINT :	UNION			BUTT WELDING				
	DIMENSION STANDARD :	ASTM A 269			ASME B-36.19				
BENDS	TYPE :	-			WELDING NECK, RTJ				
	RATING :	-			2500 #				
	MATERIAL :	-			ASTM A-182 F 316				
	DIMENSION STANDARD :	-			ASME B-16.5				
FITTINGS	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				
GASKETS	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) ASME B-16.9 / MSS SP-97 (ONLY FOR WELDOLETS)				
	DIMENSION STANDARD :	EQUIVALENT TO SWAGE LOCK FITTINGS							
BOLTING	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 GAS ENGINE DRIVEN CNG COMPRESSOR PACKAGES

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	
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TECHNICAL SPECIFICATION FOR GAS ENGINE DRIVEN CNG COMPRESSOR PACKAGES

PIPING ELEMENT SPECIFICATION				SPEC.NO. : MSD-1013 SHEET NO. : 3 OF 3	
BASE MATERIAL : SS-316 INSULATION : - TRACING : -				JOB NO. : 249040 CLASS : F2b	
SERVICE : NATURAL GAS (COMPRESSOR DISCHARGE), NITROGEN (TUBING)					
VALVE					
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	
TRIM	SHAFT	AISI-316		AISI-316	
	SEAT	PTFE			
	DISC/WEDGE/BALL/	BALL		DISC	
	DIAPHRAGM/PLUG	AISI-316		AISI-316	
CONSTRUCTION	-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	
SPECIFICATION :					
MFG. STD.		API 6D	MFG. STD.	NOTE-2	MFG. STD.
<p><u>NOTE</u></p> <p>1.VALVES TO BE FIRE TEST APPROVED TO BS 6755 PART 2.</p> <p>2.VALVE DESIGN CONFIRM TO ANSI B 16.34 & VALVE END TO END DIMENSIONS TO ANSI B16.10.</p> <p>3.END CONNECTION TO SUIT DOUBLE FERRULE TYPE COMPRESSION FITTING.</p> <p>4.MAX. WORKING PRESSURE RATING OF VALVE.</p> <p>5.THREADS TO ANSI/ASME B 1.20.1</p> <p>6.HYDRO TESTING OF PIPING SYSTEM SHALL BE DONE AT THE HYDROTEST PRESSURE MENTIONED IN THE LINE LIST.</p>					

APPENDIX F SPECIFICATION – DRAIN AND VENT SERVICE TUBING/ PIPING



TECHNICAL SPECIFICATION FOR GAS ENGINE DRIVEN CNG COMPRESSOR PACKAGES

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 :	kg/cm ² (g)	10.50
	MAX.TEMPERATURE :	°C	260.00
	MAX. SYSTEM TEST PRESSURE :	kg/cm ² (g)	15.75
		RATING & FACING : 150# RF	
		CORROSION ALLOWANCE : 1.5 mm	
NOMINAL SIZE		IN	REF. NOTE NO.
		mm	
		1/2	3/4
		1	1.5
		2	3
		4	6
		8	10
		12	14
		16	18
		20	24
		30	36
		42	48
		60	72
		90	108
		120	144
		150	180
		200	240
		250	300
		300	360
		360	420
		420	480
		480	540
		540	600
		600	660
		660	720
		720	780
		780	840
		840	900
		900	960
		960	1020
		1020	1080
		1080	1140
		1140	1200
		1200	1260
		1260	1320
		1320	1380
		1380	1440
		1440	1500
		1500	1560
		1560	1620
		1620	1680
		1680	1740
		1740	1800
		1800	1860
		1860	1920
		1920	1980
		1980	2040
		2040	2100
		2100	2160
		2160	2220
		2220	2280
		2280	2340
		2340	2400
		2400	2460
		2460	2520
		2520	2580
		2580	2640
		2640	2700
		2700	2760
		2760	2820
		2820	2880
		2880	2940
		2940	3000
		3000	3060
		3060	3120
		3120	3180
		3180	3240
		3240	3300
		3300	3360
		3360	3420
		3420	3480
		3480	3540
		3540	3600
		3600	3660
		3660	3720
		3720	3780
		3780	3840
		3840	3900
		3900	3960
		3960	4020
		4020	4080
		4080	4140
		4140	4200
		4200	4260
		4260	4320
		4320	4380
		4380	4440
		4440	4500
		4500	4560
		4560	4620
		4620	4680
		4680	4740
		4740	4800
		4800	4860
		4860	4920
		4920	4980
		4980	5040
		5040	5100
		5100	5160
		5160	5220
		5220	5280
		5280	5340
		5340	5400
		5400	5460
		5460	5520
		5520	5580
		5580	5640
		5640	5700
		5700	5760
		5760	5820
		5820	5880
		5880	5940
		5940	6000
		6000	6060
		6060	6120
		6120	6180
		6180	6240
		6240	6300
		6300	6360
		6360	6420
		6420	6480
		6480	6540
		6540	6600
		6600	6660
		6660	6720
		6720	6780
		6780	6840
		6840	6900
		6900	6960
		6960	7020
		7020	7080
		7080	7140
		7140	7200
		7200	7260
		7260	7320
		7320	7380
		7380	7440
		7440	7500
		7500	7560
		7560	7620
		7620	7680
		7680	7740
		7740	7800
		7800	7860
		7860	7920
		7920	7980
		7980	8040
		8040	8100
		8100	8160
		8160	8220
		8220	8280
		8280	8340
		8340	8400
		8400	8460
		8460	8520
		8520	8580
		8580	8640
		8640	8700
		8700	8760
		8760	8820
		8820	8880
		8880	8940
		8940	9000
		9000	9060
		9060	9120
		9120	9180
		9180	9240
		9240	9300
		9300	9360
		9360	9420
		9420	9480
		9480	9540
		9540	9600
		9600	9660
		9660	9720
		9720	9780
		9780	9840
		9840	9900
		9900	9960
		9960	10020
		10020	10080
		10080	10140
		10140	10200
		10200	10260
		10260	10320
		10320	10380
		10380	10440
		10440	10500
		10500	10560
		10560	10620
		10620	10680
		10680	10740
		10740	10800
		10800	10860
		10860	10920
		10920	10980
		10980	11040
		11040	11100
		11100	11160
		11160	11220
		11220	11280
		11280	11340
		11340	11400
		11400	11460
		11460	11520
		11520	11580
		11580	11640
		11640	11700
		11700	11760
		11760	11820
		11820	11880
		11880	11940
		11940	12000
		12000	12060
		12060	12120
		12120	12180
		12180	12240
		12240	12300
		12300	12360
		12360	12420
		12420	12480
		12480	12540
		12540	12600
		12600	12660
		12660	12720
		12720	12780
		12780	12840
		12840	12900
		12900	12960
		12960	13020
		13020	13080
		13080	13140
		13140	13200
		13200	13260
		13260	13320
		13320	13380
		13380	13440
		13440	13500
		13500	13560
		13560	13620
		13620	13680
		13680	13740
		13740	13800
		13800	13860
		13860	13920
		13920	13980
		13980	14040
		14040	14100
		14100	14160
		14160	14220
		14220	14280
		14280	14340
		14340	14400
		14400	14460
		14460	14520
		14520	14580
		14580	14640
		14640	14700
		14700	14760
		14760	14820
		14820	14880
		14880	14940
		14940	15000
		15000	15060
		15060	15120
		15120	15180
		15180	15240
		15240	15300
		15300	15360
		15360	15420
		15420	15480
		15480	15540
		15540	15600
		15600	15660
		15660	15720
		15720	15780
		15780	15840
		15840	15900
		15900	15960
		15960	16020
		16020	16080
		16080	16140
		16140	16200
		16200	16260
		16260	16320
		16320	16380
		16380	16440
		16440	16500
		16500	16560
		16560	16620
		16620	16680
		16680	16740
		16740	16800
		16800	16860
		16860	16920
		16920	16980
		16980	17040
		17040	17100
		17100	17160
		17160	17220
		17220	17280
		17280	17340
		17340	17400
		17400	17460
		17460	17520
		17520	17580
		17580	17640
		17640	17700
		17700	17760
		17760	17820
		17820	17880
		17880	17940
		17940	18000
		18000	18060
		18060	18120
		18120	18180
		18180	18240
		18240	18300
		18300	18360
		18360	18420
		18420	18480
		18480	18540
		18540	18600
		18600	18660
		18660	18720
		18720	18780
		18780	18840
		18840	18900
		18900	18960
		18960	19020
		19020	19080
		19080	19140
		19	



TECHNICAL SPECIFICATION FOR GAS ENGINE DRIVEN CNG COMPRESSOR PACKAGES

PIPING ELEMENT SPECIFICATION		SPEC.NO. : MSD-1001 SHEET NO. : 2 OF 3
BASE MATERIAL : M.S.	INSULATION : NIL TRACING :	JOB NO : 249040 CLASS : A1a
SERVICE : DRAIN, VENT.		
ITEM	SIZE	DESCRIPTION
PIPE JOINT	40NB & BELOW	3000# COUPLING S.W.
	50NB & ABOVE	BUTT WELDED
DRAINS	ON LINES \leq 20NB	SAME AS LINE SIZE
	ON LINES $>$ 20NB	20NB OR AS PER P & I DIAGRAMS
VENTS	ON LINES \leq 20NB	SAME AS LINE SIZE
	ON LINES $>$ 20NB	20NB OR AS PER P & I DIAGRAMS
TEMP. CONN	40NB	FLANGED.
PRESS. CONN.	20NB	S.W. HEAVY NIPPLE WITH ISOLATION VALVE.
BRANCH CONNECTION	900 36	<div style="display: flex; align-items: center;"> <div style="writing-mode: vertical-rl; transform: rotate(180deg);">BRANCH SIZES</div> <div style="margin-left: 20px;"> <p><u>LEGEND</u></p> <p>R-REINFORCED FABRICATED TEE</p> <p>S-SOCKOLET</p> <p>T-THREADED</p> <p>U-UNREINFORCED</p> <p>W-WELDOLET</p> <p>BW-BUTT WELDED TEE</p> <p>HC-HALF COUPLING SW</p> <p>SW-SOCKET WELDED TEE</p> <p>SC-SCREWED TEE</p> </div> <div style="flex-grow: 1;"> </div> </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	
	mm	
		1/2 3/4 1 1.5 2 3 4 6 8 10 12 14 16 18 20 24 26 28 30 32 36
		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 GAS ENGINE DRIVEN CNG COMPRESSOR PACKAGES

PIPING ELEMENT SPECIFICATION						SPEC.NO. : MSD-1001 SHEET NO. : 3 OF 3						
BASE MATERIAL : M.S. INSULATION : NIL TRACING : -						JOB NO : 249040 CLASS : A1a						
SERVICE : DRAIN, VENT.												
VALVE												
TYPE :	GATE		GLOBE		CHECK		BALL		BUTTER FLY	DIAPHRAGM	PLUG	NEEDLE
TAG NO. :												
SIZE RANGE : NB	15 TO 40	50 & ABOVE	15 TO 40	50 & ABOVE	15 TO 40	50 & ABOVE	15 TO 40	50 & ABOVE	80 NB & ABOVE	15 & ABOVE	15 & ABOVE	15 TO 25
RATING :	800#	150#	800#	150#	800#	150#	150#	150#	150#	150#	150#	800#
END CONNECTIONS :	SW	RF.FLGD.	SW	RF.FLGD.	SW	RF.FLGD.	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	ISI 304	
TRIM	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. GGG-40	NEOPRENE RUBBER	A-216 WCB
CONSTRUCTION	-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-1888	BS-5351	API-609	BS-5156	API 599	-	-
<p><u>NOTE</u></p> <p>1.BALL VALVE UP TO 40NB SHOULD BE FULL PORT,50NB & 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>												