BHAGYANAGAR GAS LIMITED
(A Joint Venture of GAIL & HPCL)

BID DOCUMENTS FOR
SUPPLY OF CNG STATIONARY CASCADE ON ARC BASIS FOR A PERIOD OF 24 MONTHS IN GAs OF BHAGYANAGAR GAS LIMITED

UNDER OPEN DOMESTIC COMPETITIVE BIDDING
Bid Document No.:043-LEPL-BGL-10

VOLUME- II of II TECHNICAL

Lyons Engineering Pvt. Ltd.

INDEX
OF
BID DOCUMENT

TECHNICAL VOLUME – II OF II

MATERIAL REQUISITION

FOR

CNG STATIONARY CASCADE

PREPARED AND ISSUED BY

LYONS ENGINEERING PRIVATE LIMITED

INDIA

MATERIAL REQUISITION

Sr. No.	Item Description	Unit	Qty.
A	Design, Engineering, Manufacturing, Assembly, Supply, Inspection and Testing at works, loading, unloading at BGL store/site in Hyderabad, Kakinada GAs including foundation bolts of CNG Storage Cascade with three banking configuration of minimum **4500 WL** capacity of sum of total cylinders proposed at 15°C, for filling and storing of CNG at 255 bar(g) at 20°C to 48°C as specified in Technical Specification inclusive of services as stipulated in the tender document. The inlet/outlet connections & Gauge Panel of the cascade shall be provided at the width side of the cascade frame.		
A.1	Hyderabad	Nos.	7
A.2	Kakinada	No.	1
B	Design, Engineering, Manufacturing, Assembly, Supply, Inspection and Testing at works, loading, unloading at BGL store/site in Hyderabad, Kakinada GAs including foundation bolts of CNG Storage Cascade with three banking configuration of minimum **3000 WL** capacity of sum of total cylinders proposed at 15°C, for filling and storing of CNG at 255 bar(g) at 20°C to 48°C as specified in Technical Specification inclusive of services as stipulated in the tender document. The inlet/outlet connections & Gauge Panel of the cascade shall be provided at the width side of the cascade frame.		
B.1	Hyderabad	No.	1
C	Mandatory Spares: A set of mandatory spares consisting of one each of the following for Cascade specified in Sr. no. A & B above: i) Pressure Gauge Range (0-400) kg/cm2(g) ii) Cylinder Valve with end tube fitting iii) Isolation Valve iv) Check Valve v) Tube Pig Tail vi) Burst Disc with Washer vii) Spindle & Handles for Cylinder Valves viii) Safety Relief Device ix) Bleed Valve		
C.1	Hyderabad	Sets	2
C.2	Kakinada	Set	1

TECHNICAL SPECIFICATION

FOR

CNG STATIONARY CASCADE

PREPARED AND ISSUED BY

LYONS ENGINEERING LIMITED

India

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1.0 GENERAL

1.1 M/s Bhagyanagar Gas Limited, a joint venture of GAIL (India) Limited, and HPCL is engaged in development of CNG (Compressed Natural Gas) as fuel to commercial & private vehicles through filling stations in the automobile sector & PNG (piped Natural Gas) to Industrial, household, commercial sector through City Gas Distribution Networks (CGDN) at different Geographical Areas in the country. PNGRB has awarded to BGL the work of development of City Gas Distribution Network for Hyderabad, Vijayawada & Kakinada Geographical Area. Presently, Bhagyanagar Gas Limited is planning to implement CNG & City Gas Distribution Network (CGDN) to supply Natural Gas to domestic, commercial, industrial and automobile consumers distributed over the Geographical Area (GA) of Hyderabad, Vijayawada & Kakinada Geographical Area.

1.2 SCOPE OF WORK & SERVICES

This specification along with applicable codes as referred, describe the minimum requirements for design, engineering, procurement, manufacturing, assembly & testing at manufacturer's works, packaging, supply including forwarding, transit insurance, handling and unloading at Purchaser's store / site in Hyderabad & Kakinada GA as applicable as per price schedule / special conditions of contract, of the 3000 WL and 4500 WL capacity CNG Stationary Cascades for filling and storing of CNG at 255 bar(g) and as required for dispensing CNG to vehicles at various locations in Hyderabad & Kakinada Geographical Areas.

Any additional work or technical requirement not mentioned in the specification but required to make the offered system complete in accordance with the specification and for safe and proper operation, shall be deemed to be included in the scope of work by the Bidder.

The quantities of CNG Stationary Cascade required shall be as per SOR (Schedule of Rates) cited elsewhere in the tender document.

2.0 FEED GAS SPECIFICATION

- **Gas Composition (INDICATIVE ONLY)**

The expected gas composition of the feed gas to the CNG Storage Cascade is given below:

S. No.	Component	AVG. GAS COMPOSITION (mol%)
1	Nitrogen	0.3505
2	Methane	94.6591
3	CO2	0.5502
4	Ethane	2.3547
5	Propane	1.0458
6	i-Pentane	0.2135
7	n-Butane	0.3223

8	i-Pentane	0.1427
9	n-Pentane	0.1414
10	n-Hexane	0.2199
11	GCV	9721.00
12	NCV	8775.00
13	Specific Gravity	0.59 - 0.625

- **GAS STORAGE PRESSURE**

Fill Pressure: - 255 bar (g)

Gas Delivery Temperature: - 55°C Max. (dependent on ambient temperature)

- **CNG SPECIFICATION**

The CNG specification shall meet the ISO 15403:2000 (E) natural gas quality designation for use as a compressed fuel for vehicles.

The proposed specification of the CNG is as follows:

Gas Temperature : 0 Degree Celsius to +55 Degree Celsius

Pressure dew-point : - 25 Degree Celsius

Particulate matter : Less than 5 microns

Odorant (Mercaptan) : 2 to 7 mg/SCM

- **CLIMATIC CONDITIONS**

A. HYDERABAD

• Minimum ambient temperature: 5 Deg.C

• Maximum ambient temperature: 50 Deg.C

• Relative Humidity: 94% Max.

• Altitude above mean sea level: 100-601 m

• Wind velocity: NA

B. KAKINADA

• Minimum ambient temperature: 5 Deg.C

• Maximum ambient temperature: 45 Deg.C

• Relative Humidity: 95% Max., Non condensing

• Altitude above mean sea level: 2-100 m

• Wind velocity: 120 km/hr

➢ DESIGN PHILOSOPHY

Storage fulfils the following functions:

ONE - It allows more vehicles to fill than the compressor could fill directly one after the other during peak time.

TWO - It allows the vehicle to fill at a faster rate than if directly from the compressor.

THREE - It prevents the compressor from stopping and starting too often.

FOUR- The Combine storage capacity is compartmentalized into three banks. Each bank is separated with check valves and the direction of flow should be from highest volume to lowest volume and provided with pressure relief valve for each of the bank separately.

It is anticipated that the natural gas feed composition, flow rate and pressure will be fluctuating. Hence, Supplier should design the CNG storage facilities with optimum degree of flexibility, reliability, operability to accommodate the varying composition of feed Gas, other unexpected contaminants, flow rate and pressure fluctuation etc.

The CNG storage facilities should consist of standardized modules, which are assembled into a complete system. Each system should be designed in standardized modular frames bundled together. The modular approach allows the CNG Stationary storage and mobile storage facilities to be easily installed there by reducing installation time. The individual cylinders shall be interconnected using SS-316 tubes and fittings of appropriate pressure and temperature rating and suitable for CNG service.

The design life of the CNG storage facilities should be not less than 20 years.

In the Mother Stations, the compressed natural gas would be directly filled into stationary storage cascades.

➢ DESIGN BASIS

The Supplier should prepare the design basis required to meet the demands mentioned in items 1.0 & 2.0 and submit the designed documents for approval from Consultant/Client before start of manufacturing.

➢ APPLICABLE STANDARDS AND CODES

The design, construction, manufacture, supply, testing and other general requirements of the Storage Cascades should be strictly in accordance with the Applicable Standards and Codes

and should comply fully with relevant Indian or International standards, Gas Cylinder Rule 1981, Indian Explosives Act- 1884, Stationary and Mobile Pressure Vessels (Unfired) Rules (SMPV) 1981, CNG Cylinder Design Code, IS:7285,2004(part-2), CNG Cylinder Valves, IS:3224 1979 (Amendments 1983,84,85,86,89,92,98), Hydrostatic Stretch Test, IS: 5844 - 1970, Safety Devices of Gas Cylinders, IS : 5903 -1970, Regulations of Insurance Association of India and Factories Act while carrying out work as per this specification.

The bidder without any additional cost and delivery implications should carry out any modification suggested by the statutory bodies either during drawing approval or during inspection, if any.

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

i) NFPA 52 Standards for CNG vehicular fuel systems and CNG cylinder code "IS:7285- 2004(PART-2)

ii) OISD 179 Safety requirements for compression, storage, handling and refueling of CNG for use in automotive sector.

iii) GAS CYLINDER RULE 2004 Standards for CNG Storage and Gas Cylinder Rules.

iv) STATIC AND MOBILE PRESSURE VESSELS (UNFIRED) RULES (SMPV) (Latest Edition)

v) CNG CYLINDER DESIGN CODE IS: 7285 2004 (Part-2)

vi) CNG CYLINDER VALVES, IS: 3224 (Latest Edition)

vii) HYDROSTATIC STRETCH TEST IS: 5844 (Latest Edition)

viii) SAFETY DEVICES OF GAS CYLINDERS IS: 5903 (Latest Edition)-Regulations of Insurance Association

ix) INDIAN EXPLOSIVES ACT

x) ANSI, ASTM, NEC, NEMA, ASNZ

3.0 SCOPE OF SUPPLY - STATIONARY CNG STORAGE CASCADES

- **CYLINDERS**

Supply of CNG storage cascades of water liter capacity as specified at clause no. 1.2, permissible tolerance of -0% or +5% at 15°C with the following minimum details:

- All cylinders should be designed, constructed and tested in accordance with the Indian Standard 7285, as amended from time to time, IS:7285 or B 55045: Part 1 or (US) D.O.T 3AA or similar such other standard code approved by the Chief Controller of Explosives.

- Cylinder material shall be seamless alloy steel (Cr-Mo) or as per design approval by Chief Controller of Explosives. The neck threading shall be as per IS: 3224 or as per design approval by Chief Controller of Explosives. The thread size of Dia. 25.04 mm standards, type 4 threads with taper of 1 in 8 on diameter confirming to IS: 3224 or equivalent is recommended. The shut off valve shall be fusible burst disc confirming to requirements of IS: 3224 or as per design approval by Chief Controller of Explosives.

- The required Test certificates and Inspection certificates issued by the manufacturer of the cylinder shall be duly countersigned by an Inspector/TPI that the Cylinder meets the requirements of the standard or code referred above submitted to & approved by the Chief Controller of Explosives shall be provided to the Purchaser.

- All cylinders should be new and unused. Re-certified cylinders are not acceptable. Before dispatching, using or refilling the cylinder which has to be made gas-free, air contained therein shall be purged by N2 gas. Cylinder of 75 liter water capacity at 15°C are only envisaged. All cylinders in a cascade shall be of same capacity.

- Total storage volume with no negative tolerance should be designed to meet storage patterns sizes for storage:
  Stationary Storage- 4500 WLC at 15°C
  Stationary Storage- 3000 WLC at 15°C

- The storage facilities in which cylinders are in a horizontal position, a) the storage unit should be limited to a height of 1.6 M, a length of 4.0 M and a width equal to the length of one cylinder up to 2m for 3000 WLC stationary cascades and b) the storage unit should be limited to a height of 1.6 M, a length of 5.5 M and a width equal to the length of one cylinder up to 2m for 4500 WLC stationary cascades. To ensure ready access, all cylinder fittings should be arranged to face one direction in each unit. Each such storage unit should be separated from other unit by a distance of not less than 2m. Where horizontal units are placed parallel to each other, cylinder fittings should be arranged so that they do not face cylinder fittings of other units.

- The cylinder shut-off valve shall be with fusible burst disc confirming to requirements of IS: 3224 or as per design approved by CCOE, Govt. of India.

- The burst disc shall rupture on excess pressure as well as excess temperature either individually or combined. The burst disc discharge shall be manifold to a common header for safe venting. Vendor shall indicate burst pressure and temperature.

- The cylinder shut-off valve orifice shall be designed for high flow to permit the combined flow of 100 kg/min for each bank at a pressure of 255 bar (g). Vendor to furnish necessary

calculation indicating overall pressure drop of each bank, coefficient of flow (Cv) values, valve orifice size etc.

- Number of cylinders in the cascade shall be divided into three independent banks for low, medium & high pressure of different storage pressure. Vendor shall optimize the number of cylinder in each bank for maximizing the recovery from the storage cascade and submit the calculations along with the bid, indicative ratio of Low : Medium : High is 5:3:2 by volume.
- The interconnecting tube work of cylinder manifold in configuration suitable for priority filling and sequential dispensing system by the electronic CNG dispensers.
- Full bore 3/4" ball valves for isolation shall be provided at inlet/outlet of each line/ banks.
- Pressure gauge of appropriate range suitable for CNG service shall be provided in each bank at the common manifold point with enclosure having transparent panel for visibility of the gages. One common temperature gauge of the range 0-100°C should also be provided.
- Inter-Connecting tube work shall be maximum of ¾"OD SS-316 tubing. The sizing of connecting tubing between each outlet and its associated cylinder shall be such that where they join the total incoming flow areas shall not be less than the total outgoing area. The loops in the tube work shall be provided for absorbing contraction, expansion and vibration. Piping/ tubing shall be suitably clamped to the frame structure.
- There shall not be any back flow between any two banks with all valves open.
- Cylinders installed horizontally should be separated from one another in each storage unit by a distance of not less than 30mm. The material used to separate the cylinders should be sufficiently strong enough and should not absorb moisture and anti-static material. Special precautions should be taken to avoid corrosion at the point of contact.
- All cylinder valves and fittings must be rated for the full range of temperature and pressures and the manufacturer should stamp or otherwise permanently mark the valve body to indicate the service rating.
- All cylinders is to be hydrostatically tested and approved by third party certification body. Test certificates shall be duly endorsed by approving body and issued before delivery.
- The location of inlet/outlet tube manifold and pressure/temperature gauges shall be at the first width side of the cascades taking anti-clockwise from the side of the common cylinders valves.
- The cascade cylinder shall be purged with N_2 and maintain 1 bar (g) pressure before despatch.
- Cascade canopy design to be maintained to protect the CNG cylinders from direct sunlight.
- Doors for cascade manifold gauge panel shall be provided with sufficient and proper hinges to avoid breaking of doors during operation.
- Vent lines shall be provided at a height of 3.0M from operating platform.

- 3 nos. PG, 3 nos. PSV, & 1 No. TG shall be incorporated in each unit.
- All cylinder valves shall be of ¼ turn type for ease of operation.

➢ **MARKING ON THE CYLINDERS**

a. Every Gas cylinder shall be clearly and permanently marked in accordance with the following conditions by stamping, engraving or similar process;
   i) On the shoulder of the cylinder which shall be enforced by forging or other means, or
   ii) On such a part which is inseparably bound with the cylinder and which is not or only negligibly affected by the stresses due to the gas pressure within it.

b. The name plate shall not be affixed to the cylinder by soldering, if there is risk of corrosion.

c. In conjunction with the original marking, space shall be provided for stamping the test date obtained at the periodic inspection.

d. Markings shall be as carried out and the letters and numerals used shall be of such shape and size that the marking is clear and easily readable and does not give place for misreading.

e. All cylinders must be permanently stamped with the word CNG together with the following information:
   i) Manufacturers, owners and inspectors marking and rotation number;
   ii) Specifying that the cylinder has been manufactured for “CNG only”
   iii) A symbol to indicate the nature of heat treatment (such as normalizing, quenching, or tempering) given to the cylinder during manufacture.
   iv) The date of the hydrostatic stretch test, as the case may be, with the code mark of recognized testing station where the test was carried out. The code mark shall be registered with the Chief Controller of Explosives.
   v) Working pressure and test pressure;
   vi) Tare weight
   vii) Water capacity.

f. All the markings, except the manufacturers marking, which may be on the base, shall be stamped on the neck end of the cylinder.

➢ **MARKING ON THE VALVES**

Valves fitted to the cylinder shall be clearly and durably marked in accordance with the following provisions by stamping, engraving or similar process:

i) The specification of the valves;

ii) Year and quarter of manufacture;

iii) Manufacturers symbol;

iv) Working pressure;

v) The name or chemical symbol of the gas for which the valve is to be used;

vi) The type of screw threads on the outlet namely left handed (L.H) or right handed (R.H);

vii) Inspectors stamp;

- Identification Colours

Every cylinder is painted with the appropriate identification colours specified in IS: 4379 for Industrial cylinders.

Colour of the Cylinder shell --- White (Total DFT: 75 micron min. / As per process data sheet / approved drawing / as per code)

Colour of band at neck end of cylinder--- Red (IS Standard Colour No. 537)

Colour of the Frame --- Yellow (Total DFT: 75 micron min. / As per process data sheet / approved drawing / as per code)

- Labeling of cylinders

i) Every cylinder shall be labeled with the name “CNG ONLY” with letter of at least 25mm high in contrasting colour and the name and address of the Purchaser by whom the cylinder was filled with gas.

ii) A warning in the following terms shall be attached to every cascade containing Compressed Natural Gas namely:

a. Do not change the colour of the cylinder

b. This cylinder should not be filled with any gas other than CNG.

c. No flammable material should be stored in the immediate vicinity of this cylinder or in the same place in which it is kept.

d. No oil or similar lubricant should be used on the valves or other fittings of this cylinder.

e. Please look for the next date of test, which is marked on a metal ring inserted between the valve and the neck of the cylinder, and if this date is over, do not accept the cylinder.

- All storage system should be supplied in three banks arrangement:-

Low Bank-50% by volume of the total capacity

Medium Bank- 30% by volume of the total capacity

High Bank- 20% by volume of the total capacity

➢ **PRESSURE RELIEF DEVICES**

- Each bank (All the three banks) used for the storage of CNG should be equipped with a suitable pressure relieving device and a suitable isolating valve which should be readily accessible when installed in the storage bank. The isolating valve should not be capable of closing off the pressure relieving device.

- Relief devices should be positioned in such a way as to avoid discharge of high pressure gas to the operator or persons in close vicinity and suitably extended.

➢ **SAFETY RELIEF DEVICES FOR CYLINDER STORAGE**

- Cylinders manufactured in India, if fitted with safety relief devices in their bodies, shall have such safety devices manufactured and maintained in accordance with IS:5903.

- Piping and gas storage systems should be protected against overpressure by safety relief devices fitted in each bank. Relief devices installed to protect the storage systems should have sufficient capacity to vent the maximum flow produced by the compressor and should be set to open at a pressure not exceeding 20% above the maximum allowable working pressure of the system or the pressure which produces a hoop stress of 75% of the specified minimum yield strength, whichever is lower.

- A combination burst disc/fusible alloy assembly should be incorporated in the cylinder valves. Burst disc should yield at a pressure not less than 1.5 times manufacturer's recommended operating pressure of the cylinder, and not more than test pressure. The disc should relieve pressures in excess of 30 MPA.

- In addition to 3.3.2 a mechanical pressure relief valve which opens at a predetermined pressure should be used. This should not be part of the cylinder valve.

- Safety relief valves should be provided with means to seal to prevent tampering by unauthorized persons.

- Minimum required rate of discharge from the safety valve should be at least equal to any input from the system whether stored or being compressed.

- Each safety relief valve should be clearly marked by the manufacturer.

- The maximum pressure in the storage system should not exceed 255 bar (g)

- The cascade cylinders should be supplied with impact test certification.

➢ **CORROSION PROTECTION**

- Pressure vessels which are made of materials that are subject to corrosion by atmospheric conditions should be protected by painting or other equivalent means necessary to prevent corrosion.

➢ **VALVES**

- All Valves fitted to gas cylinders shall comply in all respects with the following Specifications namely:

  i) In respect of VALVE FITTINGS FOR COMPRESSED GAS CYLINDERS, IS: 3224

  ii) Valves for cylinders shall be hand wheel operated.

- Each gas storage unit should have a quick action gas storage isolation valve installed in the steel supply pipe immediately adjacent to its gas storage unit to enable individual shut off and isolation of each unit. These valves will be within fence enclosure.

- Separate common valve system to be supplied for each storage bank complete with non return valve.

➢ **RIGID PIPING**

- All rigid piping, tubing and other components on the storage system should be designed for the full range of pressures, temperatures and loadings to which they maybe subjected with the factor of safety of at least 4 based on the tensile strength at 20°C. Any materials used including gaskets and packing should be compatible with natural gas and its service conditions.

- All piping should be designed in accordance with engineering calculations based on the requirements of ASME B31.3 in conjunction with EEMUA supplement to ASME B31.3 or equivalent design standards. Standards used should be used in total.

- All welding piping should be fabricated and tested in accordance with ANSI/ASME B31.3, API 1104, ASME SEC.IX. Whichever standard is chosen for use, it should be used in total.

- All piping to be tested after assembly to a pressure equal to that of the pressure relief device setting and proved leak free.

- Cylinders to be connected in stainless steel tubing 316 (Stainless Steel Tubing Specifications ASTM A269, ultimate tensile 517 MPA, or equivalent) incorporating stress reducing hoops. Only approved manufacturers of high pressure fittings are to be used. All fitting should be of fractional dimension in Inch unit.

➢ **PRESSURE & TEMPERATURE GAUGES**

- Every CNG storage unit including each manifold group or bulk storage tank should be provided with a suitable pressure gauge for each bank. The pressure gauge should be directly connected to the bank or storage system. The gauge should be dial graduated to read approximately double the operating pressure. Pressure gauge should be equipped with 3-way relief/isolation valve. Similarly one surface contact type Temperature gage should be provided at a suitable location representing the equivalent temperature of the whole cascade.

- A good quality industrial pressure gauge should be used with a dial face of at least 63mm or larger. Gauges should be built to requirements of BS 1780 or ANSI/ASME B40.1 or equivalent.

➢ PIPE WORK, VALVES AND FITTINGS

Pipe work should be designed, tested and installed to ensure its safe operation at the worst conceivable conditions of flow, pressure and temperature.

All pipe work should be ASTM 316 stainless steel tube. Fittings shall be of SS 316 of approved make. The system should be “go-no-go” gaugable to demonstrate that fittings are properly tightened. Wherever, possible valves and control devices should incorporate the same end connector system. The number of fittings used should be minimized. The Supplier should ensure that personnel assembling the pipe work should be competent in the system employed. Valves & Fittings shall be of PARKER / SWAGELOK make and SS tubing shall be of SANDVIK / RATNAMANI / MITSUBISHI / FAE / SUMITOMO / PARKER make. Vendor to ensure that only one make, out of the specified makes of SS Tubes, Valves & fittings shall be used in a cascade and no mixing of makes shall be permitted.

The preferred valve types for isolation are ¼” turn full ball valves. Such valves have similar material to the tube they are attached to. Ball valves must be of good quality and be appropriately selected frequency of use. Ball seats must be suitable for natural gas operation of the gas composition indicated.

Valves and fittings subject to corrosion must be either inherently resistant, or be coated with a corrosion inhibiting paint or surface treatment.

The gas inlet connection of each bank shall be terminated with ¾“union after the isolation valve.

➢ CYLINDER FRAME

- Cascade storage system to be skid mounted and complete with removable metal frames and non-metal / non-sparking spacer material.
- Cascade and spacer frame to be painted with anti-rust and etching primer under coat. Importance should be drawn to avoiding corrosion which can limit the working life of a cylinder and affect the fatigue characteristics in serious cases. The implementation of good periodic maintenance anti-corrosion procedures is strongly recommended.
- Each storage system should be supplied with suitable lifting lugs. Bottom and top of frame shall be reinforced to prevent any twisting or strain to inter connections among cascade cylinders during lifting by crane, forklift and during transport
- All cylinder tubing, manual isolation valves and pressure relief valves should be protected from knocking by any moving object and should not protrude outside the metal frame or brackets.

- The frame shall not allow lateral and rotational movement of cylinders during regular road transport under circumstances.
- The frame structure of each cascade shall be capable of withstanding 4g (four times gravity) impact from any direction without any distortion.
- All fixing/supporting items used in the frame shall be of weather proof type.
- Supplier shall submit structural drawing of the frame (not Mandatory) giving details of the steel design calculation, welding procedure, corrosion protection etc. for approval before commencement of fabrication work.
- Cascade Assembly to be protected from elements by a roof canopy supported on cylinder frame. Roof sheeting to be precoated galvanized iron or approved equivalent.

➢ **PROTECTION OF VALVES AND ACCESSORIES**

- All valves and accessories shall be safeguarded against accidental damage or interference.
- Valves and accessories shall be mounted and protected in such a way that risk of accidental rupture of the branch to which the valve or accessory is connected is minimized.
- Valves and accessories situated at the rear of a vehicle shall be protected by the rear cross member of the frame of the vehicle against damage.

➢ **EQUIPMENT**

- Piping, Fittings and meters:

  i) All piping, fittings and meters mounted on the Cascade shall be designed to with stand the most sever combined stresses imposed by the following, namely:

     a. The maximum design pressure of the vessel

     b. The super imposed pumping pressure of the shock loading caused by road movements;

  ii) The materials used for vessel equipment shall be sufficient ductile to withstand rough usage and accidental damage. Brittle materials such as cast iron shall not be used.

- Protection of piping and equipment:

  i) All piping and equipment shall be adequately protected to minimize accidental damage which may be caused by rough usage, collision or over-turning;

  ii) Any equipment or section of piping in which liquid may be trapped shall be protected against excessive pressure caused by thermal expansion of the contents.

- Marketing of connections-

  All connections on the vehicle which require manipulation by the operator of the

vehicle should be clearly marked to prevent incorrect operation. The form of this marking should correspond with the operating procedure laid down for the vehicle.

4.0 CALIBRATIONS, TEST CERTIFICATES AND THIRD-PARTY CERTIFICATION

- Every Cylinder should be carried with Hydrostatic or Hydrostatic stretch test and a certificate should be provided.
- Leak test should be carried for each cylinder or cascades with all tubing, valves and a certificate should be furnished to the Owner.
- All Instrument gauges, Valves, Pressure gauges, safety relief devices, shut off valves tubing and piping etc. should be Pressure tested, calibrated and such test, calibration certificates.
- If any of the test certificates is not in order, the Suppliers should replace the affected equipment with valid certificate at Supplier cost.
- Calculation shall be carried out for 4G Static of one complete cascade with all cylinders mounted and filled and the same should be submitted for review of the Owner.
- Burst test of one cylinder from the entire supplies shall be produced and in case offered once are new design the schedule for the test should be informed prior to enable the Owner or their authorized representative to depute their personnel for witnessing the test.
- All standards shop tests / QA / QC as per the recommendation of the manufacturer / Chief Controller of Explosives to be carried out and a copy of such certificates shall be furnished to the Owner.
- Record of storage capacity check of each cylinder in a cascade shall be furnished and same shall be demonstrated.
- Third Party Inspection

  All the above quality system implementation, witness and verification of requisite documents shall be independently check, verified and certified by any one of the approved Third Party Inspection Agencies like M/s Bureau Veritas, M/s SGS, M/s LRIS or any other PNGRB Approved firms after the cascades have been assembled to complete finish condition before dispatch. Vendors shall inform the Name of the appointed Agency along with contact details.

  Vendors shall notify BGL well in advance (minimum 10 days) of such inspections so as to enable BGL provides clearance for conducting the inspections and also to depute BGL's official to witness the same.

Note: The manufacturer of the Cylinders and the Cascades shall have adequate facilities for shop testing & quality assurances.

5.0 PROTECTION DURING SHIPPING

The cascade shall be packaged to withstand rough handling during ocean shipment and inland journey. It shall be supplier's responsibility to make good any deterioration and that occurs during shipment. Sling points shall be clearly indicated on crates.

6.0 EXPERIENCE RECORD PROFORMA FOR CASCADE (TABLE-1)

Supplier must fill the following format, which is essential to access the bidder's capability.

TABLE-1

Sl. No.	Parameter	Information On offered model	Information on existing Cascade (Location)		
1	No. of units		1	2	3
2	Service				
3	Working pressure of cascade in bar g				
4	Site min/ max temp.				
5	Normal flow from each bank kg/hr				
6	Cascade water capacity-liters				
7	Water capacity of single cylinder used in cascade-liter				
8	Material of cylinder				
9	Thickness of cylinder wall and disc end in mm				
10	Material of vent tubing				
11	Piping material and make				
12	Valve make				
13	Valve type and dia.				
14	Nos. of banks in cascade				
15	Nos. of cylinder in low bank				
16	Nos. of cylinder in medium bank				
17	Nos. of cylinder in high bank				

18	Water capacity of cylinders in individual banks				
19	Contact person				
20	4 G static calculation for one complete assembled package				
21	Cylinder burst test for one cylinder				
20	Design standard (Code) used				
23	Total weight of cascades in tones				
24	Burst pressure and temperature for burst disc in bar g and deg C.				
25	Hydrostatic or Hydrostatic Stretch Test				
26	Pressure test for leakage				
27	Design case gas composition				
28	Approved Manufacturer License certificate from PESO				
29	Dimensions of the Total package				
30	Warranty certificates				
31	Dimension of package max.				
32	Calibration certificates for all instrument gauges etc of package				
33	Test certificates of all instruments with cylinder, tubing's, fittings of total package				
34	Date of commissioning of cascade				
35	Approval from PESO Nagpur				
36	Dimensions of package Max.				
37	Date of commissioning of cascade				
38	Where cascades are located: Address and fax/ telephone no. of				
39	Major problems encountered, if any				

7.0 CHECK LIST FOR SCOPE OF SUPPLY (TABLE-2)

- Vendor shall furnish all the equipment of Storage Cascade System instruments and gauges and safety devices as per the enquiry document. Anything required over and above what is specified, for safe and satisfactory operation of the equipment package shall be included by the Vendor in his scope.

- Vendor to write YES/NO against each item. Vendor is required to include complete scope, as such 'NO' is not warranted. However, in case for any of the items if supplier's reply is 'NO', supplier should give reason for the same:

- Vendor's scope of supply shall include but not limited to the following :

TABLE-2

Sr. No.	Description	Specified by Purchaser	Included by Vendor YES / NO	Remarks
1.0	**Each Storage cascade Package complete with:**			
1.1	Specification - Indian Standard 2825, as amended time to time, IS : 7285 similar such other standard code approved by PESO	YES		
1.2	Cylinder material - Seamless alloy steel (Cr-Mo) or standard code approved by the Chief Controller of Explosives.	YES		
1.3	All the fittings, Valves, Safety devices, gauges are as per IS 3224 or standard code approved by the Chief Controller of Explosives.	YES		
1.4	Tubing's are of rigid type ASTM 316 stainless steel tube.	YES		
1.5	All cylinders are Hydrostatic Tested	YES		
1.6	Water capacity of single cylinder used in cascade not less than 75 Ltrs.	YES		
1.7	Nos. of banks in cascade- three bank system for Stationary Cascade	YES		
1.8	One Cylinder should be for burst test	YES		
1.9	4-G Stationary calculation for one complete assembled package is done	YES		
1.10	Working Pressure of Cascade min. 250-255 bar(g)	YES		
1.11	Pressure test for Leakage on cylinders with assembled condition	YES		
1.12	Isolation Valve complete with venting line valve and end plug installed on the inlet of the cylinder	YES		
1.13	Copy of Calibration certificates for all instrument gauges etc. of Cascade package, Test certificates of all instruments with cylinder, tubing's, fittings of total package	YES		
1.14	BOQ with weight of each component	YES		

1.15	Drawing of cylinder of specified parameters approved by CCOE	YES		
1.16	Drawing of cascade frame	YES		
1.17	Storage cascade with frame assembly is shipped in fully and assembled condition only to be mounted on anchored bolts laid at site.	YES		
1.18	GA drawing of the cascade	YES		
1.19	Warranty for a period of 12 months is provided from the date of final site acceptance of CNG facilities by the Company's.	YES		
1.20	Make of bought out items	YES		
1.21	Detailed time schedule for supply indicating time periods required for cylinder manufacturing, cascade frame fabrication, shop testing, dispatch of material from works at delivery site	YES		
2.0	**Spares**			
2.1	Mandatory spares as specified in the "Material Requisition / SOR" (Indicate separate price for each item)	YES		
3.0	**Inspection and Testing**			
3.1	As specified on the Inspection and testing clauses	YES		
4.0	**Supplier Data and drawings**			
4.1	All data & drawings as required per VDR format as per Material Requisition.	YES		
5.0	**Supervision during the Trial Run if required at site of the CNG storage cascade system**			
5.1	Additional Items not specified by purchaser but recommended by bidder for safe smooth and normal operation. (Bidder shall indicate separate list of such items in his proposal)	YES		
6.0	**Technical Parameters to be confirmed by supplier**			
6.1	Pressure range: 19 bar(g) to 255 bar(g) at 15°C	YES		
6.2	Fill Pressure: 200 bar(g)	YES		
6.3	Operating Temperature range: 20°C to 65°C	YES		
6.4	Design Code: IS-2825, IS-7285, IS-3224 or as per Applicable standard Codes or approved by CCOE	YES		
6.5	Calibration traceability: NABL as per ISO 17025	YES		
6.6	Enclosure weather proof: IP65, NENA4x	YES		
6.7	Process Temperature effect: ± 0.01% of nominal Flow rate/degree C on zero offset	YES		

6.8	All valves as per IS-3224 or as Applicable standard code or approved by CCOE	YES		
6.9	Safety relief devices as per IS-5903 or Applicable standard code or approved by PESO	YES		

8.0 WARRANTY SERVICING AND SPARE PARTS

- All necessary spare parts to sustain the operations and maintenance of the CNG Stationary storage facilities should be supplied and stock at the Supplier workshop / warehouse located in India for immediate replacement of parts. The costs to stock these spare parts should be at supplier cost. However, once the parts are replaced in the CNG mother and daughter Cascades, the Company's should compensate the Suppliers accordingly provided that the warranty period has expired.
- The suppliers should provide a warranty period of 12 months from the date of final site acceptance of CNG facilities by the Company.
- All the material and equipment to be free from defects in design, manufacture, material and workmanship.
- Replacement shall be made if any defective items found damaged or not performing to the specified requirements of any part of cylinder for at least 24 months from the date of delivery or 12 months from the date of successful commissioning whichever is later.

9.0 SERVICES

- Preparation of submission of document drawing.
- Obtaining approvals from statutory authorities.
- Bidder to submit foundation and other drawings indicating requirement of work to be Carried out by Owner within one month of placement of order.
- Supervision during trial runs if required.

10.0 DATA AND DRAWING DETAIL

After the placement of FOI, a conference (kick off meeting) will be held at such date and at such place, as may be mutually agreed upon between the Bidder and the purchaser. The intent of this conference should be to discuss / clarify various requirements and finalize the modus operandi for execution of the contract within the scheduled delivery period.

Along with the technical bid the following information is to be provided.

i) Process and instrument diagram along with Bill of Material. The Bill of Material should indicate all items, quantity of all items installed per storage system, their part nos. and make.

ii) Process and instrument diagram along with Bill of Materials for all major components within the tender.

iii) General arrangement drawing of the storage system giving overall dimensions and erection shipping weight.

iv) Technical data sheet of storage system.

v) Typical cross-sectional drawing and literature to fully describe the details of all major components such as Cylinders, valve, gauges piping etc. Data sheet indicating material of tube, tube size etc., piping and instrument diagram.

vi) The supplier shall have to provide a comprehensive list of mandatory spares required per each type of the storage system and other auxiliary equipment, if any. Itemized rate shall have to be given in price bid.

vii) The supplier shall have to provide, in addition to those mentioned above, for 2 years normal operation & maintenance per each type of storage system.

viii) The supplier shall have to provide, a list of commissioning spares, if any, per each type of storage system.

ix) The supplier shall have to provide, a list of special tools & tackles required for installation & maintenance per each type of storage system.

x) Leaflets, catalogues for all major items & bought out items.

xi) Shop test procedure.

xii) Maintenance schedule of the storage system along with list of Spares for O&M during warranty period.

xiii) A complete zonal drawing of the Storage Cascade (complete package), all certification for all components used within the hazardous areas should be provided.

xiv) Reference list of similar / identical storage system supplied in last 7 years of CNG application.

xv) Deviation sheet (if any).

Within one month from date of P.O.

xvi) General arrangement drawing, schematic of cascade piping, drawing of cascade frame the storage system giving overall dimension and erection / shipping weight.

xvii) Detailed foundation drawing of the storage system for casting foundation giving load pattern etc.

xviii) Details of inlet gas termination to the storage system including X, Y, Z co-ordinates with respect to center of storage system skid or any reference.

xix) Detailed time schedule for supply indicating time periods required for cylinder manufacturing, cascade frame fabrication, shop testing, dispatch of material from works and delivery at site.

xx) Operation and maintenance manuals - 3 sets all in original for each Storage Cascade. The instruction manual should describe in details the construction and recommended procedure for maintaining, operating and troubleshooting of the storage. System should also include cross-sectional drawings, exploded views of all spare parts along with part nos., quantity installed per storage unit. The manual should provide detailed catalogues of all bought out items.

xxi) Test certificates of all major components like cylinders, shutoff valves, pressure relief valves tubing / pipe work etc.

xxii) Calibration certificates for all measuring and protection devices.

xxiii) In case of foreign supply, the bidder should get all certificates endorsed by office of Chief Controller of Explosives (CCOE), Govt of India within one month of delivery of cascades at site.

xxiv) The bidder can submit (not Mandatory) draft QAP / Data Sheet / GA Drawing along with the Bid.

LIST OF RECOMMENDED THIRD PARTY INSPECTION AGENCY (TPIA)

SL. NO	NAME OF TPI	ADDRESS	PHONE NO	FAX NO
1	Tata Projects Ltd.	22, Sarvodaya Society, Nizampura, Baroda-390002	0265-2392863	0265-2785952
2	Bax counsel Insepection Bureau Pvt. Ltd.	303, Madhava,Bandra Kurla Complex, Bandra(E),Mumbai-400051	022-26591526,022-26590236	022-26591526
3	Germanischer Lloyd	4th Floor, Dakshna Building, Sec-11, Plot NO.2, CBD Belapur, Navi Mumbai 400 614	022-4078 1000	022-4024 2935
4	ABS Industrial Verification Ltd., Mumbai	404, Mayuresh Chambers, Sector-11, CBD Belapur(E), Navi Mumbai-400614	022-27578780 /1 /2	022-27578784 / 5
5	Certification Engineers International Ltd.	EIL Bhavan,5th floor,1,Bhikaji Camma Place,New Delhi-110066	011-26167539,26102121	011-26101419
6	Dalal Mott MacDonald	501, Sakar -II, Ellisbridge,Ahemedabad-380006	079-26575550	079-6575558
7	International Certification Systems	E-7,Chand Society, Juhu Road, Juhu, Mumbai-4000049	022-26245747	022-226248167
8	SGS	SGS India Pvt. Ltd.,SGS House,4B,A.S.Marg,Vikhroli(W), Mumbai-400083	022-25798421 to 28	022-25798431 to 33
9	Intertek Moody	9th Floor, Kanchenjunga Building, 18-Barakhamba Road, New Delhi-110001	011-4713 3900	011-4713 3999
10	TUV SUD South Asia	C-153/1, Okhla Industrial Ara, Phase-1, New Delhi-110020	011-3088 9611/9797	011-3088 9598
11	TUV Rheinland (India) Pvt. Ltd.	F-51, Kailash Complex GF, Veer Savarkar Marg, Vikhroli Park Site, Vikhroli(W), Mumbai-400079	022-4215 5435	022-4215 5434
12	Vincott International India Assessment Service Pvt. Ltd.	C-301, Mangalya Premises Cooperative Soc. Ltd, Off. Marol Maroshi Road, Andheri(E), Mumbai-400959	022-4247 4100	022-4247 4101
13	Meenar Global Consultants	Mr. Nitin Taneja (Project Manager)	M: +91-9711212783 T: +91-129-4072836	Web : www.meenaar.in Email : nitin.taneja@meenaar.in
14	VCS Quality Services Pvt. Ltd.	505, 5th floor, 360 Degree Business Park, Next to R-Mall, L.B.S. Marg, Mulund West, Mumbai 400080	Tel: 91 22 21649720	091 22 21646392

QUALITY ASSURANCE PLAN – HIGH PRESSURE GAS CYLINDER, CASCADE FRAME & FITTINGS								
Sr. No.	**OPERARATION / PARAMETER**	**CHARACTERISICS / PARAMETERS**	**ACCEPTANCE CRITERIA & CERTIFICATION**	**INSPECTION FREQUENCY**	**VENDOR**	**TPAI**	**CLIENT / PMC**	**REMARKS**
1	Raw Material	Chemical Composition	Chrome Moly Steel, Grade-DS-202/IS: 7285-2004 ci. 5.2 Table-1	One sample per heat No.	P	R	R	Verification of RMT certificate Received from RM supplier.
IN PROCESS								
2	Raw Material Cutting (seamless Tube)	Length	As per process heat	4-5 jobs during setting approval & every two hour.	P	W/R	R	
		Thickness						
		Outside Diameter						
		Surface Flaws						
		Ultrasonic Examination						
3	Bottom Forming	Bottom Thickness	1.5 T min (where T is wall thickness)	4-5 jobs during setting approval & every four hour.	P	W/R	R	
		Centre of Bottom	IS: 7285 : 2004					
		Side of Bottom Forting	Free from crack, excess metal, pin	4-5 jobs during setting approval & every two hour.				
		Visual Inspection						
		Ultrasonic examination	IS: 7285 : 2004	Each cylinder				
4	Neck Forming	Solid Neck Length	As per Approved Drawing	4-5 Jobs during setting approval & every two hour.	P	W/R	R	
		Neck Diameter	As per Approved Drawing	4-5 jobs during setting approval & every two hour.				
		Surface finish, defects	Free from crack, excess metal, pin hole, ball formation, roller mark and other surface defects.	4-5 jobs during setting approval & every two hour.				

		Ultrasonic Examination	IS: 7285 : 2004	Each cylinder				
5	Heat Treatment	Hardness	As per approved drawing	Every cylinder	P	W	R	
		(As Tempered)	IS: 7285 : 2004					
		Mechanical Properties Tensile Strength	As per IS: 7285 : 2004	One random cylinder will be selected from Heat Treatment Batch conforming the mechanical properties like tensile test, impact test, bend test etc, in presence of inspecting officer.				
			IS: 7285 : 2004					
		Yield Strength						
		% Elongation						
		Impact test (at-20˚C)	IS: 7285 : 2004					
		Bend Test	IS: 7285 : 2004					
		Burst Test	IS: 7285 : 2004					
6	Ultrasonic testing	Crank deduction	As per IS: 7285 : 2004	Every cylinder	P	W	R	
		Wall Thickness measurement	As per approved drg. IS: 7285-2004					
7	Neck cutting & threading	Neck Length	As per approved drawing	Audit check by Q.A staff	P	W	R	
		Machined neck step diameter	As per approved drawing	Audit check by Q.A staff				
		Neck thread configuration	As per approved drawing	Every cylinder				
		Visual inspection thread finish	Free from crack blow hole excess metal at inside neck, thread damage ,flat threads etc.	Every cylinder				
8	Water capacity checking & hydrostatic strength testing.	Measurement of water capacity. Total Expansion and permanent expansion at test pressure.	Tolerance on water capacity +5 % IS-7285: 2004	Every cylinder	P	W	R	

		Holding Time = 30 sec min.	Permanent expansion shall not exceed 10% of total expansion. IS : 7285:2004	Audit check by Q.A staff				
9	Air leakage Test	Access leakage from cylinder body, neck and bottom side at working pressure. Holding Time=60 sec.	Free from Leakage. IS: 7285:2004	Every cylinder Audit check by Q.A staff	P	W	R	
10	Bursting Test	The value of hoop stress shall be not less than 0.95 of the minimum specified tensile strength of the cylinder material.	IS-7285-2004	One Cylinder of the first batch.	P	W	R	
11	Steam cleaning & Air Drying	Examination of Oil residue, Moisture etc.	Free from Oil , Moisture etc when Cylinder is exposed to steam jet at steam temp. 160-180˚C for period minimum 5-6 minutes.	Audit check by Q.A staff	P	R	R	
12	Internal shot blasting	Scale free surface	Inner surface should be free from scales, metallic particles etc	Audit Check by Q.A staff	P	R	R	
13	External shot blasting	Scale free surface	Cylinders should be free from scales & other surface imperfection	Audit Check by Q.A staff	P	R	R	
14	Fixed data stamping	Stamp data	As per IS: 7285 : 2004	Audit Check by Q.A staff	P	R	R	
15	Variable Data stamping	Stamp data	Verification of data as per drawing & test Result	Every cylinder check by Q.A staff	P	R	R	

16	Vacuum Cleaning	Any scales, dust etc inside cylinder	Free from scales, dust etc from inside cylinder	Every cylinder check by Q.A staff	P	R	R	
17	Weighing	Tare weight / calibration	As per approved drawing	Every cylinder check	P	W	R	
18	Painting (primer & finish painting)	Paint coating thickness	As per process data sheet / approved drawing / as per code	Audit check by Q.A staff	P	R	R	
19	Marking		IS: 7285 : 2004	Each cylinder	P	R	R	
20	Colour identification		IS: 7285 : 2004	Each cylinder	P	R	R	
21	Cascade frame fabrication painting cascade frame complete	Visual (Welding etc) Dimensional Physical Test Chemical Test	Approved Drawing/ Manufacturers standard. Owner's specification approved drawing	100%	P	R	R	
22	polyurethane/ Epoxy paint	Chemical properties	Approved Make / Owner's Specification		P	W	R	
23	SS Tubes	Physical Test Chemical Test Visual (Welding etc) Dimensional Fitment & Alignment	Approved Drawing, Manufacture Test certificate for bought out items.	As per tender / Owner's instruction.	P	R	R	
24	Fittings	Visual Dimensional pressure Test Fitment & Alignment	Approved Drawing / Manufactures standard	As per tender / Owner's instructions	P	R	P	
25	Valves 2 way	Visual dimensional fitment & Alignment	Approved Drawing/ Manufacturer Test Certificate for bought out items.	As per tender/owner's instruction	P	R	P	
26	CNG Cascade Assembly	Visual (Welding etc) Dimensional Fitment & Alignment	Approved drawing/Manufacturer std.	Owner's specification/instruction	P	W	R	
27	CU Tubes for vending of Burst Disc separator	Visual (welding etc) Dimensional pressure test leakage Fitment & Alignment	Approved Drawing /Manufacturer std.	Owner's specification/instruction	P	W	R	

28	Cylinder valves		As per approved CCOE Drawing, Bill of Material.	Owner's specification/instruction	P	100 % W	R	
29	Gauge	Visual Dimensional Fitment & Alignment	Approved Drawing. Bill of Material.	Owner's specification/instruction	P	100 % W	R	
30	**Final Inspection of Finished Cylinders**: Visual Inspection for Internal cleaning and painting of Cylinder and Cascade frame. Final dimensional checking of cylinders & cascade frame. Check every cylinder for neck threads & cleaning from inside/outside surface. Verification of stamped data like cylinder serial No. tare Weight, Water Capacity etc.		IS: 7285-2004	Each cylinder	P	100 % W		
LEGENDS: W=witness; H=Hold; M=Monitoring; P=Perform; R=Review of documents; R/M=Random Check; A=Approved; TPAI=Third Party Inspection Agency								

Notes:

1. The above testing and acceptance criteria are minimum requirements; however, manufacturer shall ensure that the product shall also comply to the additional requirements as per particular Technical Specification (PTS) and Data Sheet.
2. The supplier shall submit their own detailed QAP prepared on the basis of above / Technical specification for approval of Owner/Owner's representative.
3. Supplier shall submit calibration certificates of all instruments/Equipment to be used for inspection and Testing to TPIA with relevant procedures and updated standards for TPIA review/Approval. All reference codes / documents shall be arranged by vendor for reference of TPIA at the time of inspection.
4. Owner / Owner's representative include TPIA will have the right to inspect activity of manufacturing at any time.
5. TPIA along with Owner / Owner's representative shall review/approval all the documents related to QAP/Quality manuals/Drawings etc. submitted by supplier.
6. Contractor shall in coordination with supplier/sub vendor shall issue detailed production and inspection schedule indicating the dates and the location of facilities Owner/Owner's representative and TPIA to organise inspection.
7. Special manufacturing procedure have to be specially approved or only previously approved procedures have to be used ,in case of conflict between specification more stringent condition shall be applicable.
8. All reference codes/standards, Documents; P.O. Copies shall be arranged by vendor/Supplier for reference of TPIA/VCS at the time of inspection.
9. Certification requirement shall comply with European standard EN 10204-3.2 (Latest edition)