HPOIL GAS PRIVATE LIMITED

(A Joint Venture of HPCL & OIL)

ANNUAL RATE CONTRACT FOR SUPPLY OF TYPE I – 3000 WL AND 4500 WL CAPACITY CNG CASACADE AT NAGALAND GA

TECHNICAL VOLUME

TENDER NO.: HOGPL/2025-26/C&P/008

DATE: 03.07.2025

SECTION - I MATERIAL REQUISITION

1. DEFINITION

Where used in this document, the following terms shall have the meanings indicated below, unless clearly indicated by the context to this order.

PROJECT: City Gas Distribution Project of Nagaland GA

OWNER/COMPANY/PURCHASER/CLIENT: HPOIL GAS PRIVATE LIMITED (HOGPL)

VENDOR/BIDDER/SUPPLIER/CONTRACTOR: The party, who manufactures and supplies equipmentand Provide services to the OWNER or to CONTRACTOR.

MR: Material Requisition.

2. DOCUMENT PRECEDENCE

It shall be the responsibility of the Manufacturer / Vendor to inform the Purchaser of any errors, ambiguities, inconsistencies, discrepancies or conflict of information that may be found to exist in any document, specification or drawing submitted by the Purchaser.

In case of conflict, the order of precedence shall be as follows:

a. Data Sheets;
b. Technical Specifications;
c. Basic Documents;
d. Codes and Standards.

As a general rule in the event of any discrepancy between technical matter and local laws/ regulations (and documents above listed) the most stringent shall be applied. Manufacturer / Vendor shall notify purchaser of any apparent conflicts between MR, specifications, related datasheets, any code and standards and any other specifications noted herein. (Resolution and / or interpretation precedence shall be obtained from Purchaser in writing before proceeding with the design / manufacturer or completion of services.)

3. SCOPE OF SUPPLY & SERVICES

The Scope includes Design, Procurement of materials and bought out components, manufacture, assembly at shop, inspection, testing at manufacturer's works, packing (if any), delivery of CNG Cascades to site, supply of all Pre-commissioning, Commissioning and Mandatory spares & documentation as per the enclosed engineering standard, specifications and data sheets etc. attached or referred:

SR No	Product	UOM	Qty
1	**CNG Stationary Cascade (3000 WL Capacity)** **Description :** Design, Engineering, Manufacturing, Assembly, Supply, Inspection and Testing at works, Transportation, Loading, Unloading at HOGPL store/site in Nagaland GA including mandatory spares and 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.	Nos	10
2	**Inland Transportation - Nagaland GA** **Description:** Inland transportation upto delivery (Nagaland) location and other costs incidental to delivery of goods (including all taxes & duties except GST)	Nos	10
3	**CNG Mobile Cascade (4500 WL Capacity)** **Description :** Design, Engineering, Manufacturing, Assembly, Supply, Inspection and Testing at works, Transportation, Loading, Unloading at HOGPL store/site in Nagaland GA including mandatory spares and foundation bolts of CNG Storage Cascade with single 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.	Nos	4
4	**Inland Transportation - Nagaland GA** **Description:** Inland transportation upto delivery (Nagaland) location and other costs incidental to delivery of goods (including all taxes & duties except GST)	Nos	4

NOTE:

I. Bidder has to quote the full quantity of quoted item mentioned above; partial quotation for the item shall be liable to rejection.

II. The cost of Third-Party Inspection Agency shall be in bidder/supplier scope.

III. Mandatory spares for each cascade shall be supplied along with the cascade at no extra cost to OWNER. The mandatory spares for each cascade are listed below:

Sr. No	Item Description	Quantity per Cascade
i	Pressure Gauge Range (0-400 kg/cm²)	1 No
ii	Cylinder Valve with end tube fitting	1 No
iii	Isolation Valve	2 Nos
iv	Check Valve	1 No
v	Tube Pig Tail	1 No
vi	Burst Disc with washer	1 No

vii	Seal Kit, spindle & handles for isolation valves	2 Nos
viii	Safety Relief Device	1 No
ix	¼" NPT (M) x ¾" OD – Male Connector	3 Nos
x	Bull Nose Connector – ¼" NPT (M) X ¾" OD	3 Nos

4. SCOPE OF WORK

Work tendered in this bid package consists of design/detail engineering, procurement, fabrication, testing, supply, pre-commissioning, and commissioning of CNG storage cascades. This includes all work that, although not specifically indicated here, are required to complete the work in all respects.

I. Supply of all required materials as per scope of supply as indicated in clause 3.0 of this document and technical specifications.
II. All works related to cleaning, flushing, hydro testing, dewatering, drying, purging, and filling of N2 for CNG storage cascades during dispatch.
III. All associated testing and pre-commissioning checks as applicable at the vendor's work.
IV. Supervision for pre-commissioning and commissioning of cascades at the site.

5. BASIS OF WORK

Fabrication of CNG storage cascades shall be carried out as per the following:

5.1. Approved Documents:

I. General Arrangement Drawing (GAD)/Calculation
II. Piping and Instrumentation Diagram (P&ID)
III. Technical Specifications
IV. Any other drawings/sketches prepared by the Company and/or by the Bidder and approved by the Company

5.2. Applicable Codes and Standards:

I. IS 7285: 2004 - Specification for seamless steel cylinders for permanent and high-pressure liquefiable gases.
II. IS 3224: 2002 - Valve fittings for compressed gas cylinders excluding LPG cylinders.
III. IS 5844-1970 - Hydrostatic Stretch Test.
IV. IS 5903-1970 - Safety Devices of Gas Cylinders.
V. OISD – 179 - Safety requirements on compressors, storage, handling, and refueling of natural gas for automotive use.
VI. All the codes & specifications referred to above shall be of the latest edition at the time of the contract award.

6. DESCRIPTION OF WORK

Bidder shall carry out all works strictly in accordance with the Issued for Construction (IFC)/Approved drawings and reference specifications/standards, drawings, documents, data sheets etc. enclosed with this tender document and instructions of Company/Engineer-in- Charge and other provisions of Contract document. The works related to fabrication, inspection, testing, supply, and pre-commissioning of CNG storage cascades are as follows:

6.1. Procurement and supply of all materials, equipment/instrumentations etc. as required which are included in the scope of supply of Bidder, transportation of all materials from manufacturer's works including loading, unloading, handling, storing and transportation to work site.

6.2. Hydro testing, dewatering, flushing, drying, purging, and N2 filling at the bidder's workshop in the presence of Company/ Company's Representative personnel.

6.3. Installation of all types of valves (if any), all types of inline/online instruments (other than those covered separately), safety valves, tapping for thermo-wells, sample connections, pressure gauges, etc. for all sizes and ratings including installation and fixing of gaskets, bolts, studs & nuts of all sizes, ratings and materials within the CNG storage cascades.

6.4. Painting of cascades, cylinders, piping, and associated items as per the specified requirements.

6.5. Preparation of fabrication drawings for approval before execution.

6.6. Supervision while Pre-commissioning and Commissioning of cascades as per technical specifications, including the supply of materials and manpower.

6.7. Preparation and submission of as-built drawings, documents, and project records.

6.8. Coordination with other agencies, including PESO, until commissioning operations are complete.

6.9. Preparation of detailed procedures for fabrication, testing, and pre-commissioning checks for approval.

6.10. Design, construction, and testing of cylinders in accordance with IS: 7285-2004 Part II or an equivalent standard approved by the Chief Controller of Explosives.

6.11. Material specifications for flanges, header pipes, and female nipples for vent manifolds to be carbon steel (CS).

6.12. Any other works not specifically listed herein but required for completion of the works in all respects.

7. OTHER CONDITIONS OF WORK

7.1. Hydrostatic Testing & NDT

- Complete CNG storage cascades shall undergo hydrostatic testing.
- Non-Destructive Testing (NDT) shall comply with ASME codes.
- Additional radiography, if required due to poor workmanship, shall be at the bidder's cost.

7.2. Pre-Commissioning & Commissioning

- Commissioning shall be owner's responsibility. However, bidder to send his authorised representative for supervision during Pre-commissioning & commissioning.

8. AS-BUILT DOCUMENTS

After successful hydrostatic testing, the bidder shall prepare and submit as-built drawings and reports. The submission shall include:

- Four hard copies of as-built drawings (GAD, Fabrication Drawings, P&ID, 4G calculation, etc.)
- Test reports/results/records
- Digital copies in MS Word/Excel (for reports) and AutoCAD (for drawings)
- Updated "Issued for Construction" (IFC) drawings based on approved modifications

9. DOCUMENTS TO BE SUBMITTED AT THE TIME OF BIDDING

- Sizing calculations for cascades with the number of cylinders.
- Preliminary GAD of cascades with overall dimensions and weight.
- Bill of Quantities (BOQ).
- Compliance with all requirements of the bid document without deviations.

10. BIDDER'S RESPONSIBILITIES

- Interpretation and verification of data provided by the Company.
- Engineering, procurement, fabrication, and QA/QC procedures must be reviewed and approved by the Company.
- Ensuring a safe and efficient design, supply, and operation of the system.
- Deployment of an independent third-party inspector (TPIA) for all necessary inspections.
- Supervision during Pre-commissioning and commissioning of the entire CNG storage cascades system.
- Conducting all necessary testing and inspections through independent laboratories if required.

11. CHECKLIST FOR SCOPE OF SUPPLY

- Vendor shall furnish all equipment, instruments, and safety devices as per the enquiry document.
- Any additional requirements for safe and satisfactory operation must be included by the vendor.
- Vendor must confirm the inclusion of each item in the supply scope by marking "YES/NO." A "NO" response requires justification.

12. SPECIAL INSTRUCTIONS TO BIDDERS

12.1. If the offer contains any technical deviations or clarifications or stipulates any technical specifications (even if in line with MR requirements) and does not include complete scope & technical / performance data required to be submitted with the offer, the offer shall be liable for rejection.

12.2. The bidder must submit all documents listed in the checklist along with his offer.

12.3. The Supplier shall deliver a Certificate confirming to EN 10204 3.2 stating the quality, the mechanical properties, the chemical analysis, the process of manufacture and the making of the Cascades.

12.4. All materials shall be delivered to the designated store of HPOIL Gas Private Limited at Nagaland GA. Detail address will be furnished later.

13. DOCUMENTS & DATA REQUIREMENTS

13.1. The table hereunder specifies the quantities & nature of the documents to be submitted by the Supplier to Company.

13.2. The documents required at the inquiry stage to be included in the bid are listed under column A.

13.3. The documents required after award of the agreement and subject to the written approval of the Company are listed under column B.

13.4. The final & certified documents are listed under column C.

13.5. Any document even when preliminary shall be binding and therefore duly identified & signed by the Supplier. It shall bear the Company's project reference, the PO number and identification number.

13.6. The documents are fully part of the supply which shall be complete only if and when the documents comply fully with the purchase requisition requirements received by the Engineer.

Sr No	Number of copies	A	B		C	
		Number of copies	Number of copies	Required date	Number of copies	Required date
1	Technical specification for CNG storage CASCADE and Accessories giving details of various components.	1	1	1 week	1	1 week
2	Detail GA Drawing with part names and MOC of each part. 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	1	1	1 week	1	1 week
3	Code Compliance Certificate as per applicable governing standard	1	1	1 week	1	1 week
4	Process and instrument diagram	1	1	1 week	1	1 week
5	Test / Calibration / Inspection Certificates / Reports		1	1 week after test	1	1 week
6	Installation, Operation and Maintenance manuals, Catalogues with part list for meters along with software CD and calibration reports.		1	2 weeks before shipping	1	1 week
7	Sizing calculation		1	1 Week	1	1 Week
8	Packing / Shipping list with weights and dimensions. (Note-6)		1	2 weeks before shipping	1	
9	Final technical file (containing all final drawings and documents listed in column 'c')		1	2 weeks before shipping	1	
10	Drawing of cylinder of specified parameters proposed to be used in offered cascade approved from chief controller of explosives, Government of India.	1	1	1 week	1	1 week

11	Drawing of cascade frame along with 4G static calculations for one complete assemble cascade with all the cylinders mounted & filled.		1	1 week	1	1 week
12	SOR of quoted items along with signed and stamped	1	1	2 Weeks before shipping	1	1 Week
13	Deviation form, Technical specification if any with proper justification.	1			1	
14	Inspection and test procedures	1	1	2 Weeks before shipping	~	1 Week
15	Compliance certificate to quality assurance plan	1		1 week		1 Week
16	Test Certificates of each and every components including cylinders & cascade assembly as per approved Quality Assurance Plan		1	1 week before shipping	3	1 week

NOTES:

VII. Duration in column B (required date) are weeks after purchase order date (=T0).
VIII. Duration in column C (required date) are weeks after document approval.
IX. The due date of each document may be proposed.
X. Final technical file shall be supplied in hard copy as indicated, and in electronic format (PDF).

14. DESIGN BASIS & PHILOSOPHY

14.1. Design Basis:

The supplier should prepare the design basis required to meet the requirement with respect to technical specification and liaise with PMC/Client to obtain necessary confirmation and approval.

14.2. Design Philosophy

Storage fulfills three functions:

A. It allows more vehicles to fill than the compressor could fill directly one after the other during peak times.
B. It allows the vehicle to fill at a faster rate than if directly from the compressor.
C. It prevents the compressor from stopping and starting too often.

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, other unexpected contaminants, flow rate and pressure.

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. The modular approach allows the CNG stationary storage and mobile storage facilities to be easily installed there by reducing installation time.

The design life of the CNG storage facilities should be 25 years.

14.3. GAS COMPOSITION

Component	**Range (mole %)**	**Design Case (mole %)**
Methane	84.50 - 98.77	89
Ethane	0.69 - 9.00	5
Propane	0.30 - 4.00	1.5
Butane	0.00 - 2.00	0.5
Pentane	0.00 - 0.35	0.35
Hexane	0.00 - 0.15	0.15
Heptane	0	0
Carbon dioxide	0.00 - 4.50	3
Nitrogen	0.05 - 1.25	0.5
Sum	**100**	**100**

- **O2 not more than 0.5% mole.**
- **Co2 less than 4%.**
- **Total S including H2S Not more than 17 PPM by weight.**
- **H2S not more than 23 mg/m3 by volume.**
- **Temp of gas shall be 10 to 55˚C**

14.4. Cascades (including all components) shall be designed and suitable for Natural Gas and shall comply with the technical specification of Cascades.

14.5. All physical and mechanical testing shall be in accordance with the requirements of connected line pipe.

14.6. The submission of prices by the bidder shall be construed to mean that he has confirmed compliance with all technical specifications of the corresponding item(s)

14.7. If the offer contains any technical deviations or clarifications or stipulates any technical specifications (even if in line with MR requirements) and does not include complete scope & Technical/ Performance Data required to be submitted with the offer, the offer shall be liable for rejection.

14.8. Purchaser's inspector reserves the right to perform stage wise inspection and witness tests, as indicated in specification of Cascades / ITP at manufacture's works prior to shipment. Manufacturers should give reasonable notice of time and shall provide without charge reasonable access and facilities required for inspection to the purchaser's inspector. Inspection and tests performed/witnessed by purchaser's inspector shall in no way relieve the manufacturer's obligation to perform the required inspection and test.

14.9. All drawings, instructions, catalogues, etc. shall be in English language and all dimensions shall be metric units.

15. CHECK LIST FOR SCOPE OF SUPPLY

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

15.2. 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 vendors reply is "NO", Vendor should give reason for the same

15.3. Vendor's scope of supply shall include but not limited to be following:

S. No.	DESCRIPTION	Specified by Purchaser YES / NO	Included by Vendor YES / NO	Remarks
ss1	**Each storage cascade package completes with:**	YES		
1.1	Specification - IS: 7285-2004 & 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 A 269 TP 316 stainless steel tube.	YES		
1.5	All cylinders are Hydro static Tested	YES		

1.6	Water capacity of single cylinder used in cascade 75 Litres.	YES		
1.7	Nos. of banks in cascade-three bank system or Single bank system	YES		
1.8	One cylinder should be burst test	YES		
1.9	4G Stationary calculation for one complete assembled package is done	YES		
1.10	Working pressure of cascade min. 250 bar (g)	YES		
1.11	Pressure test for Leakage on cylinders with assembled condition	YES		
1.12	Isolation Valve complete with vending 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 and proposed to be used in offered cascades approved by PESO	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 Foundation 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	YES		

	manufacturing, cascade frame fabrication, shop testing, dispatch of material from works at delivery site			
2.0	**Spares**			
2.1	Mandatory spares as specified in " List for Mandatory Spares"	YES		
3.0	**Inspection and Testing**			
3.1	As specified on the inspection and testing clauses	YES		
4.0	Vendor Data and drawings			
4.1	All data & drawings as required per VDDR 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 vendor**			
6.1	Pressure ranges from 19 bar (g) -250 bar at 15° C	YES		
6.2	Fill pressure Kg/cm2g or [bar(g)] -200	YES		
6.3	Operating Temperature range - [-55 C to 70 C]	YES		
6.4	Design code: IS 7285-2004, IS 3244 or as per applicable standard codes or approved by PESO	YES		
6.5	Calibration traceability - To NIST as per ISO 5168	YES		
6.6	Enclosure weatherproof to - IP65, NENA4x	YES		
6.7	Process Temperature effect - ± 0.01 % of normal flow rate/degree C on zero offset	YES		
6.8	All valves as per IS 3224 or as applicable standard code or approved by PESO	YES		
6.9	Safety relief devices as per IS: 5903 or applicable standard code or approved by PESO	YES		

SECTION - II MATERIAL SPECIFICATION

1. SCOPE

This specification provides vendor the technical and operating conditions the CNG cascades must fulfill. Additional features other than those indicated herein which call for a better design, increase in efficiency, enhance reliability, optimization may be accepted subjected to Client's approval. The vendor may submit their bid for any alternative design as an optional item which may be indicated separately describing all advantages. The cascades shall be shipped in completely assembled conditions. Gas supply line and delivery connection shall be made at site.

The vendor shall bid their main offer, items according to the technical specifications mentioned below

2. CASCADE

Cascade shall be a group of identical cylinders of capacity interconnected with SS tubing, fitting, and valves required to meet the specified total water capacity, dimensional, and weight limitations. The cascades shall also be provided with a structural frame having facility of lifting and placement.

- The water storage capacity of cascade shall be 3000 or 4500 {(-)0%, (+)5%} water litres at 15 degree C (cylinders conforming to IS: 7285-2004).
- Cascade storage dimension:
    - For ready access and to ensure that all cylinder fittings are easily accessible, multiple cylinder units which comprise a CNG storage facility and are stored in a horizontal position, each storage unit should be limited to a height of 1.6M, a length of 5.5M, and a width equal to the length of one cylinder up to 2M 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 another 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. (L x W x H - 5500mm x 2000mm x 1600mm)
- A Stationary cascade system is comprised of three banks (low, medium, high), which are high-pressure storage vessels.
- Stationary storage cascades consist of 40 cylinders of 75 Water Liter capacity each for 3000 WL cascades respectively.
- Mobile storage cascades are single bank and consist of 60 cylinders of 75 Water Liter capacity each for 4500 WL storage cascades.
- The design, material, construction & testing of the cylinder shall be as per IS 7285-2004 and approved by PESO.
- Storage cylinders manufactured older than 2016 shall not be accepted.
- Working pressure of cascade cylinders shall be a minimum of 250 bar g at 15-degree C.
- Cylinder material shall be seamless alloy steel (Cr-Mo) as per design/drawings approved by PESO.
- Cylinder neck threading shall be as per IS 3224-2002 or as per design approved by PESO.
- Offered cascades shall be of 75 litres water capacity cylinders and the vendor shall observe a minimum neck thread size of 25.4mm standard. Type 4 threads with a taper of 1 in 8 on diameter conforming to IS-3224: 2002 or equivalent.
- The cylinder shut-off valve shall be with a combination fusible bursting disc conforming to requirements of IS 3224: 2002 or as per design approved by PESO.

- The burst disc shall rupture on excess pressure as well as excess temperature either individually or combined. The burst disc discharge shall be a common header for safe venting. The 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 from each bank at a pressure of 250 bar g. The vendor shall furnish necessary calculations indicating overall pressure drop for each bank, coefficient of flow (Cv) values, valve orifice size, etc.
- The number of cylinders in the stationary cascades shall be divided into three independent banks of low, medium, and high pressure for CNG dispensing. The vendor shall optimize the number of cylinders in each bank for maximizing the recovery from the cascade storage and submit the calculations along with the bid. The vendor may assume the residual cylinder pressure of the vehicle coming for refill at 35 bar g.
- The interconnecting tube work of cylinders manifold in configuration shall be suitable for priority filling and sequential dispensing system by the electronic CNG dispensers at the retail outlets.
- Full bore ball valves for isolation shall be provided at the inlet of each fill line and at each bank outlet line. The final end connection at the battery limit shall be ¾" OD tube.
- Ball valves must be of good quality and be appropriately selected for frequency of use. Ball valve sets 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 interconnecting tube work shall be a minimum of ¾" OD tubing. The sizing of connecting tubing between each outlet and its associated cylinders shall be such that where they join the total incoming flow areas shall not be less than the outgoing area. The loops in tube work shall be provided for absorbing contraction, expansion, and vibration. Piping/tubing shall be suitably clamped to the frame structure.
- Pipe work should be designed, tested, and installed to ensure its safe operation at the worst conceivable conditions of flow, pressure, and temperature.
- A test and inspection certificate issued by the manufacturer of the cylinder duly countersigned by an inspector that the cylinder meets the requirements of the standard or code referred above submitted to PESO shall be provided.
- All cylinders should be new and unused. Used or re-certified cylinders are not acceptable. Before using the cylinder or before refilling the cylinder, which has to be made gas-free, the contained gas shall be purged by an inert gas or by the CNG gas. Cylinders of 75-liter water capacity at 15°C are only envisaged and all cylinders in a cascade shall be of the same capacity.
- The vendor should ensure that personnel assembling the piping work are competent in the system employed.
- The preferred valve types for isolation are ¼ turn ball valves. Such valves have similar material to the attached tube/fittings.
- Cylinders in the cascade shall be horizontally placed. In case of horizontal configuration, a minimum 30mm cylinder-to-cylinder gap shall be provided (conforming to requirements of OISD-179). The material used to separate the cylinders should be sufficiently strong and should not absorb moisture. 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.
- Double compression ferrule fittings shall be used for tube connection.
- All cylinders to be hydrostatically tested and approved by a third-party certification body. Test certificates shall be duly endorsed by the approval body and issued before delivery.
- The location of inlet/outlet tubes and pressure gauges shall be as per the approved drawing.
- The cascade shall be purged with N2 after testing and shipped with a positive pressure of N2 at 1 bar g in the cascade before dispatch.
- A suitable vent as attached in the drawing shall be provided for the station
- ary cascade. The height of the vent should be 3m from the base of the cascade.

3. Marking of Cylinders

- Every gas cylinder shall be clearly and permanently marked in accordance with the following conditions by stamping, engraving, or similar process:
    1. On the shoulder of the cylinder, which shall be enforced by forging or other means, or
    2. 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.
- The nameplate shall not be affixed to the cylinder by soldering, if there is a risk of corrosion or embrittlement.
- In conjunction with the original marking, space shall be provided for stamping the test date obtained at the periodic inspection.
- Markings shall be as carried out and the letters and numerals used shall be such shape and size that the marking is clear and easily readable and does not give place for misreading.
- All cylinders must be permanently stamped with the word CNG together with the following information:
    a) Manufacturer's, owner's, and inspector's marking and rotation number (these markings shall be registered with PESO).
    b) Specifying that the cylinder has been manufactured for "CNG only".
    c) A symbol to indicate the nature of heat treatment (such as normalizing or tempering) given to the cylinder during manufacturing.
    d) The date of the last hydrostatic or hydrostatic stretch test, as the case may be, with the code mark registered with PESO.
    e) Working pressure and test pressure.
    f) Tare weight.
    g) Water capacity.
    h) All the markings, except the manufacturer's marking, which may be on the base shall be stamped on the neck end of the cylinder.

4. Marking on Valves

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

a) Specification of the valves.
b) Year and quarter of manufacture.
c) Manufacturer's symbol.
d) Working pressure.
e) The name of the chemical symbol of gas for which the valve is to be used.
f) The type of screw threads on the outlet namely left-handed (L.H) or right-handed (R.H).
g) Inspector's stamp.

5. Labelling of Cylinders

- Every cylinder shall be labelled with the name "CNG ONLY" with letters of at least 25mm high in a contrasting color and the name and address of the purchaser by whom the cylinder was filled with gas.
- A warning in the following terms shall be attached to every cylinder containing compressed natural gas:
    a) Do not change the color of the cylinder.
    b) This cylinder should not be filled with 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 neck of the cylinder, and if this date is over, do not accept the cylinder.
- Stationary cascade storage systems should be supplied in a three-bank arrangement: Low bank 50%, medium bank 30%, and high bank 20% of the total storage system.

6. 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 A 316 stainless steel tube (Sandvik make). Double compression ferrule fittings shall be of SS 316 of Swagelok, Parker only. The system should be "go-on-go" gaugeable to demonstrate that fittings are properly tightened. Valves and control devices should incorporate the same end connector system. The number of fittings used should be minimized. The preferred valve types for isolation are ¼ turn ball valves; such valves have similar material to the tube they are attached to. Ball valves must be suitable for natural gas operation of 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.

7. Pressure Relief Devices

- Each cylinder 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 or should be locked in the open position.

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

8. Safety Relief Devices for Cylinder Storage

- Cylinders manufactured in India, if fitted with 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. 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 work 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 allow assembly should be incorporated in the cylinder valve. 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 or as approved by CCOE, PESO.
- In addition to the above, a mechanical pressure relief valve which opens at the 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.
- The mobile storage capacity should be 4500 WL and the dimensions should not exceed L x W x H (according to the vehicle used). Fixing of SS Tubes & components will be finalized during detailed engineering.

9. 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.
- 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.

10. Valves

- All valves fitted to gas cylinders shall comply in all respects with the following specifications namely:
    - In respect of industrial Gas Cylinder, IS: 3224.
    - Valves for cylinders shall have outlets provided with left-hand screw threads for the pipes or connections.
    - The valves shall be attached to the cylinder neck by screwing and not by making any permanent attachment or inserting an adapter in between.

- The design of spindle-operated valves shall be such that when fitted to the cylinders it shall not be possible to withdraw the spindle under normal operating conditions.
- 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 the fence enclosure.
- Separate common valve system to be supplied for each storage bank complete with a non-return valve.

11. Cascade Frame

- The frame shall be rigid and sturdy and shall not allow lateral and rotational movement of cylinders during regular road transport under any circumstances. Vendors shall take into account the rough patches/bumps on roads.
- Frame shall be free-standing and have facilities for lifting by crane and forklift the complete assembled cascade. Bottom and top of the frame shall be reinforced to prevent any twisting or strain to interconnections among cascade cylinders during lifting by crane, forklift, and during transport.
- Frame structure of each cascade shall be capable of withstanding 4G impact (four times gravity) from any direction without any distortion. Vendor to submit 4G static test calculation of one complete assembled cascade with all the cylinders mounted & lifted. Vendor to test one frame for satisfactory performance, strength, and stability. Test results and reports shall be submitted to VCS/Client.
- Each storage system should be supplied with suitable lifting lugs. Bottom and top of the frame shall be reinforced to prevent any twisting or strain to interconnections among cascade cylinders during lifting by crane, forklift, and during transport.
- 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 undercoat.
- 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.
- 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.
- Frame shall be suitably covered with a canopy to avoid the ingress of rainwater.
- All items used in the frame shall be waterproof.
- Supplier shall submit a structural drawing of the frame giving details of the steel, welding procedure, and corrosion protection for approval of owner/owner's representative before commencing fabrication work.
- Frame shall support the cylinder adequately and allow the cleaning of the cylinder.

12. Draining Arrangement

- Draining arrangement for each cylinder shall be provided.
- Materials used for draining piping shall be stainless steel 316.
- The tubing material shall be of Sandvik make.

- All SS Tube fittings shall be of Swagelok/Parker make.

13. Piping / Tubing / Fitting / Pressure Gauges / Temperature Gauges

- All rigid piping, tubing, and other components on the storage system shall be designed for the full range of pressures, temperatures, and loadings to which they may be subjected, with a factor of safety at least 4 based on the tensile strength at 20°C. Any materials used, including gasket 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 welded piping should be fabricated and tested in accordance with ANSI/ASME B31.3, API 1104, or an equivalent standard. Whichever standard is chosen for use, it should be used in total.
- All piping should be tested after assembly to a pressure equal to that of the pressure relief device setting and proved leak-free.
- Materials used for the piping shall be Stainless Steel to specification ASTM A269 TP316 fully annealed seamless with maximum hardness of Rb80 or less and suitable for bending and flaring. OD tolerance shall not exceed +0.005%. Tubes shall be Sandvik Make.
- Double compression ferrule fittings shall be used in tube connection tubes.
- All fittings, including valves, shall be Swagelok, Parker make only.
- Open ends on fittings and vents shall be provided with caps.
- Liquid-filled pressure gauge of diameter 4" (0-400 kg/cm²) with a 2-way valve on each bank shall be used. Thus, each cascade shall have three pressure gauges. Pressure gauges shall be securely mounted.
- 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 tank or storage system. The gauge should be dial graduated to read approximately double the operating pressure.
- A good quality industrial pressure gauge should be used with a dial face of at least 100 mm or larger. Gauges should be built to requirements of BS 1780 or ANSI/ASME B40.1 or OISD-179 equivalent.
- A temperature gauge of diameter 4" with necessary arrangement on the high bank only shall be used. Thus, each cascade shall have only one temperature gauge on the high bank.
- All end connections, pressure & temperature gauges, valves, and fittings of the cascade shall be with tamper-proof, wire cage enclosure. These shall be on one side of the cascade for ease of operations.
- Vendors shall provide a suitable draining arrangement duly certified/approved by PESO for the purpose of removing moisture and other contaminants that may accumulate within the piping/tubing.
- Material of vent tubing shall be SS 316, and the make shall be of Swagelok/Parker make.
- The location of inlet/outlet tube manifold and pressure / temperature gauges shall be towards the length side of cascade for Mobile and width side of cascade for stationary.

14. Painting

Every cylinder is painted with the appropriate identification colours specified in IS: 4397 for industrial cylinders.

a) White colour on the cylinder body.

b) Red IS 537 on the cylinder neck portion.

c) Yellow colour on the frame.

- The paint shall be chosen, primed, and applied to have a service life of five (5) years. The exterior surface is required to be corrosion-free for five (5) years and to be fade-free without oxidation of the paint surface for five years in an environment of bright sunlight with an intensive UV content.
- Surface preparation as per grade SA 2 ½, Swedish standard SIS-05 5900-1967/ISO 8501-1 for cylinder frame. Cylinder painting shall be as per IS 7285 - Part -2, latest edition

15. Protection of Valves & 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 the risk of accidental rupture of the branch to which the valve or accessory is connected is minimized.
- Valves and accessories shall be mounted and protected by the rear cross member of the frame of the vehicle against damage.

16. Equipment

16.1. Piping, Fittings, Valves, and Instruments:

a) All piping, fittings, and meters mounted on the cascade shall be designed to withstand the most severe combined stresses imposed by the following:

- The maximum designated pressure of the vessel
- The superimposed pumping pressure of the shock loading.

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

16.3. Protection of Piping and Equipment:

- All piping and equipment shall be adequately protected to minimize accidental damage, which may be caused by rough usage, collision, or overturning.

16.4. Marking 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.

17. Inspection & Testing

- Before bringing the CNG cascade to the site, factory testing should be carried out to demonstrate the function of all equipment/items within the system (if desired).
- Vendor shall be given 2 weeks' notice of the date and location of tests so that the equipment may be witnessed if desired.
- Upon delivery to the site, all the equipment should be assembled into a complete system. Thereafter, a final site acceptance test would be carried out. Such tests should be witnessed and

signed off by the company representative. The supplier should rectify and replace all defects, faults, failures, etc., without any cost implication. The cost should include accommodation, traveling, expenses, etc.

- Vendor shall carry out 4G static calculation of one complete assembled cascade with all the cylinders mounted and filled and submit the same for owner review.
- Vendor shall carry out cylinder bursting test of one cylinder from the entire batch produced for supply in case offered cylinders are of new design (conforming to the requirement of IS 7285:2004). Vendor shall inform the schedule of the testing well in advance to enable the owner or their authorized representative to depute technical personnel for witnessing the test.
- Vendor shall carry out all standard shop tests/QA/QC as per recommendations of the manufacturer/chief controller of explosives. Copies of the testing/inspection carried out shall be furnished to VCS/Client.
- Vendor shall furnish a record of storage capacity check of each cylinder in a cascade and the same needs to be demonstrated to the owner or their authorized representative.
- Each assembled storage cascade with all tubing and valves shall be pressure tested to ensure no leakage exists prior to dispatch.
- The manifold of the cascade shall be tested to 250-bar g. The manifold shall be checked for sequencing.
- There shall be no backflow between any two banks with all valves open for three banks of cascades.
- Dispatch clearance to be given by Client after final inspection to be witnessed by Client/third-party inspection agency appointed by Client. However, the cost of Third-Party Inspection Agency shall be borne by the bidder.

18. CALIBRATIONS, TEST CERTIFICATES AND THIRD-PARTY CERTIFICATION:

Every cylinder should be carried with hydrostatic or hydrostatic stretch test and a certificate should be provided:

18.1. Leak test should be carried for each cylinder or cascades with all tubing's, valves and a certificate should be furnished to the owner.

18.2. All instruments' gauges, valves, pressure gauges, safety relief devices, shut off valves tubing's and piping etc. should be pressure tested, calibrated and such test calibration certificates, should be presented upon delivery to site. If any of the test certificates is not in order, the suppliers should replace the affected equipment with valid certificate without any cost implication.

18.3. Calculation shall be carried for 4G stationary of one complete cascade with all cylinders mounted and filled and the same should be submitted for review of the owner.

18.4. 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 test.

18.5. All standards shop sites/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.

18.6. Record of storage capacity check of each cylinder in a cascade shall be furnished and same shall be demonstrated to the owner/its representative.

19. ENVIRONMENTAL CONDITIONS

The equipment considered and the complete installation shall be suitable for continuous operation under the ambient conditions prevailing at site.

20. PROTECTION DURING SHIPPING

The cascade shall be packaged to withstand rough handling during ocean shipping and inland journey. It shall be the vendor's responsibility to avoid and protect the system with any deterioration that occurs during shipment. Sling points shall be clearly indicated on crates. Necessary precautions and pre-requisites shall be considered by Supplier for package delivery to the Client site / location / workshop. Vendor shall provide and submit his standard "Marking, Packing and Shipping Procedures" for review by Client. The vendor shall specify any conditions, normal or special, to be verified in intermediate storage and during transport. Equipment shall be suitably packed including any dismantling, transit fastening and bracing necessary to prevent distortion or damage during transit. Adequate protection should be provided to prevent mechanical damage and atmospheric corrosion in transit and at the job site. Preparation for shipment and packing will be subject to inspection and rejection by Company's inspectors. All costs caused by such rejection shall be to account of the Vendor.

21. WARRANTY

The vendor shall guarantee that the complete scope of supply shall be safely and reliably meet all of the requirements of this Company Specification. The vendor shall provide warranty support for a period of 12 months from the date of commissioning or 18 months from the date of supply, whichever is earlier. Warranty shall apply to defective material workmanship and facility design. The cost of correction / replacement of any warranty items shall be borne by the Vendor. The job specifications / data sheets shall be referred for any specific warranty / guarantee.

22. DATA SHEET

Data Sheet of 3000 Water Liter Capacity Cascade			
Sr. No.	**Description**	**Specification**	**Offered**
1	Type Of Service	CNG	
2	Capacity (in water liter)	3000 (-0%, +5%)	
3	No. of Banks	3	
4	Cascade Dimensions	OISD-179	
5	Cascade frame structure is able to withstand 4G (four times of gravity) test from any direction without any distortion	YES	
6	No. Of cylinders in each bank		
a.	Low Pressure Bank	#	
b.	Medium Pressure Bank	#	
c.	High Pressure Bank	#	
7	Cylinder		
a	Cylinder Make	#	
b	Compliance Code	IS 7285:2004	
c	Cylinder size at 15°C (in water liter)	75 liters	
d	Cylinder operating condition	250 bar g at 15°C	
e	Cylinder testing parameters	AS PER IS: 7285 : 2004	
f	Cylinder Material	SEAMLESS ALLOY STEEL (Cr-Mo)	
g	PESO approval	YES	
h	Gas quantity stored in the cylinder at 15 °C	#	
8	Cylinder shut-off valve		
a.	Make	VANAZ / TEKNO	
b.	Compliance Code	IS 3224:2002	
9	Combination bursting disc and fusible plug		
a	Burst pressure (in bar g)	#	
b	Fuse melting Temperature (in °C)	#	
10	Interconnecting tube size	Minimum 3/4" OD	
a.	Tube Material	ASTM A 268 TP 316	
b.	Tube Make	Sandvik	
c.	Tube fitting	Double compression Ferrule	
d.	Tube fitting Make	Swagelok/Parker	
e.	Isolation Valve/Non return Valve	SS 316	
f.	Make	Swagelok/Parker	
11	Pressure drop for each bank		
a.	Low Pressure Bank	#	

b.	Medium Pressure Bank	#	
c.	High Pressure Bank	#	
12	Coefficient of flow (Cv)		
13	Notes		
	1. All tubing, tube fittings, piping shall be designed and meet the requirement as per ASME B 31.3		
	2. (#) marked data to be furnished by Vendor		
	3. Draining system of each cylinder shall be provided by vendor		
	MECHANICAL DATA SHEET OF CASCADE		
1	**Vendor to provide the data as marked "#".**		
2	**This data sheet to be read in conjunction with the Material Requisition and Technical Specification**		
3	**All tubing fittings & other piping components shall conform to recommendations of ANSI B31.3.**		
4	**Flanges and gaskets shall conform to ASME B16.5 & ASME B16.20 respectively.**		
5	**Bidder to provide load calculations for nozzles mentioning allowable forces and moments.**		
6	**All gaskets used for hydrostatic testing shall be the same as service gaskets.**		
7	**All butt-welded joints shall be full penetration weld & root run shall be carried out by TIG. If accessible from other sides, it shall be back chipped to sound metal & rewelded.**		
8	**Fillet welds shall be examined by MPI / DP method.**		
9	**Earthing lug shall not be galvanized or painted.**		
10	**Draining system of each cylinder shall be provided by the supplier.**		
11	**All fasteners shall be zinc coated / hot dip galvanized as per ISO 10683 / ASTM A153.**		

Data Sheet of 4500 Water Liter Capacity Cascade			
Sr. No.	**Description**	**Specification**	**Offered**
1	Type Of Service	CNG	
2	Capacity (in water liter)	4500 (-0%, +5%)	
3	No. of Banks	1	
4	Cascade Dimensions	OISD-179	
5	Cascade frame structure is able to withstand 4G (four times of gravity) test from any direction without any distortion	YES	
6	No. Of cylinders in each bank		
a.	Low Pressure Bank	#	
b.	Medium Pressure Bank	#	
c.	High Pressure Bank	#	
7	Cylinder		
a	Cylinder Make	#	

b	Compliance Code	IS 7285:2004	
c	Cylinder size at 15°C (in water litre)	75 litres	
d	Cylinder operating condition	250 bar g at 15°C	
e	Cylinder testing parameters	AS PER IS: 7285 : 2004	
f	Cylinder Material	SEAMLESS ALLOY STEEL (Cr-Mo)	
g	PESO approval	YES	
h	Gas quantity stored in the cylinder at 15 °C	#	
8	Cylinder shut-off valve		
a.	Make	VANAZ / TEKNO	
b.	Compliance Code	IS 3224:2002	
9	Combination bursting disc and fusible plug		
a	Burst pressure (in bar g)	#	
b	Fuse melting Temperature (in °C)	#	
10	Interconnecting tube size	Minimum 3/4" OD	
a.	Tube Material	ASTM A 268 TP 316	
b.	Tube Make	Sandvik	
c.	Tube fitting	Double compression Ferrule	
d.	Tube fitting Make	Swagelok/Parker	
e.	Isolation Valve/Non return Valve	SS 316	
f.	Make	Swagelok/Parker	
11	Pressure drop for each bank		
a.	Low Pressure Bank	#	
b.	Medium Pressure Bank	#	
c.	High Pressure Bank	#	
12	Coefficient of flow (Cv)		
13	Notes		
	1. All tubing, tube fittings, piping shall be designed and meet the requirement as per ASME B 31.3		
	2. (#) marked data to be furnished by Vendor		
	3. Draining system of each cylinder shall be provided by vendor		
	MECHANICAL DATA SHEET OF CASCADE		
1	**Vendor to provide the data as marked "#".**		
2	**This data sheet to be read in conjunction with the Material Requisition and Technical Specification**		
3	**All tubing fittings & other piping components shall conform to recommendations of ANSI B31.3.**		
4	**Flanges and gaskets shall conform to ASME B16.5 & ASME B16.20 respectively.**		
5	**Bidder to provide load calculations for nozzles mentioning allowable forces and moments.**		
6	**All gaskets used for hydrostatic testing shall be the same as service gaskets.**		

7	**All butt-welded joints shall be full penetration weld & root run shall be carried out by TIG. If accessible from other sides, it shall be back chipped to sound metal & rewelded.**
8	**Fillet welds shall be examined by MPI / DP method.**
9	**Earthing lug shall not be galvanized or painted.**
10	**Draining system of each cylinder shall be provided by the supplier.**
11	**All fasteners shall be zinc coated / hot dip galvanized as per ISO 10683 / ASTM A153.**

Pressure Safety Valve Data Sheet				
GENERAL				
1	Tag Number		**	
2	P&ID Number	Quantity	**	**
3	Line No	Equipment No.	**	**
4	Inlet Line Size/Sch	Outlet Line Size/Sch	**	**
5	Inlet Line Material	Outlet Line Material	**	**
6	Safety / Relief		Safety relief	
9	Service		Natural Gas	
PROCESS DATA				
10	Fluid	Phase	Gas	Single
11	Corrosive	Erosive	N/A	N/A
12	Required Capacity (m3/hr)		**	
13	Pressure : Op. / Max. / Des. (Kg/cm2g)		250 / 400 / 400	
14	Set Pressure	% Allow Overpressure	400 Kg/Cm2g	21%
15	Back Pressure (Kg/cm2g)	Constant	1	
16		Variable	0	
17		Total	1	
18	Oper Temperature	Relief Temperature	**	**
19	SG @ Relief	Visc @ Relief	**	**
20	MW @ Relief	Density @ Relief	**	**
21	Sp HT Ratio (Cp/Cv)	Compressibility (Z)	**	**
22	Design Pressure	Design Temperature	**	**
23	Latent Heat of Vap	Barometric Pressure	**	**
24	Cold Differential Test Pressure (CDTP)		*	
25	Vess. Wall Temp.		*	
26	Surf. Area-m2		*	
DESIGN BASIS				
27	Nozzle		Full nozzle full lift	
28	Type		Conventional	
29	Bonnet Type		Closed	
30	Design Code		API 520 I/II, API 521, API 526 & API 527	
31	Sizing Basis		Fire	

32	Relieves To		Vent to Atmosphere	
33	Calculated Area	Selected Area	**	**
34	Orifice Designation		**	
35	Calculated Capacity		**	
36	No. of Valves Regd. for capacity		**	
37	Actual Flow Capacity		**	
38	Size	Inlet / Outlet	**	**
39	Type		RF*	RF*
40	Rating		*	
41				
42				
BODY				
43	Body	Bonnet	A351 CF8M	A351 CF8M
44	Nozzle (Seat)	Nozzle Ring	SS316	*
45	Spring	Disc	SS304	SS316
46	Bellows	Guide	*	*
47	Main Valve Seat / Seal	*		
MISCELLANEOUS				
48	Cap Over Adj. Bolt: Screwed/Bolted		Yes / Bolted	
49	Lever	Lever Type	Yes	*
50	Test Gag	Range	Yes	*
51	Rupture Disc	Tag No	N/A	*
52	Manufacturer	Model No.	*	*
Notes:				
1	Vendor to specify. */**			
2	Tag plate (SS 316) stamped with instrument tag number and service in 10mm characters shall be attached via SS wire (1 mm).			
3	PSV shall be sized as per API 520 & 526. Vendor to provide sizing calculations and select material as per detail engineering.			
4	Vendor shall submit sizing calculation & detailed catalogue with model recodifications sheet with datasheet.			
5	Vendor shall submit detailed GA drawing along with part names and MOC of the parts along with datasheets.			

DATASHEET OF TEMPERATURE GAUGE				
GENERAL				
1	P&ID Number	Vendor	**	*
2	Manufacturer	Model No.	**	*
GAUGE				
3	Type	Well	Mercury Filled	**Required**
4	Mounting		Local	
5	Case Material		SS316	
7	Dial Size	Scale Type	100 mm	**All Angle Rotatable**
8	Scale Color		White with Black Marking	
9	Dial Material		Aluminum	
10	Lens / Window Material		Shatter Proof Glass	
11	Accuracy		±1% FSD	
12	Over Range Protection		130 % of Range	
13	Enclosure Class		IP - 65 as per IEC 60529 / IS 13947	
14	Location		Bottom	
15	Stem Type		N/A	
16	Stem Material		N/A	
17	Stem Size		N/A	
18	Stem Dia		N/A	
FILLED SYSTEM				
19	Compensation	SAMA Class	Case	V
20	Bulb Type	Bulb Material	Adjustable union	SS316
21	Bulb Extension Type	Bulb Dia	Rigid	To suit thermowell
22	Capillary Length		*	
23	Capillary Material	Armour Flexible	SS316	

24		Armour Material	SS316	
25	Bulb Union Threaded To		1/2" BSP (M)	
THERMOWELL				
26	Type		Tapered	
27	Construction	Material	Drilled Bar Stock	SS316
28	Process Connection	Instrument Conn.	1 1/2 " Flanged	1/2" BSP (F)
29	Outside Dia (OD)	Bore	*	*
30	Tip Diameter	Tip Thickness	*	*
31	Maximum Allowable Insertion (U Max)		500 mm	
MISCELLANEOUS				
36	Liquid Filled		Yes	
37	Make / Model		*	

Notes:	
1	Vendor to specify."*"
2	Calibration, material, and hazardous area certificates shall be provided by the Vendor.
3	Temperature gauge shall be selected in such a manner that normal operating temperature is approximately in the middle third of full scale (30% - 70% of range).
4	Vendor to perform natural frequency and wake frequency calculations of thermowell as per ASME PTC 19.3.
5	Element length shall be suitable for thermowell.
6	U-length shall be selected in such a way that the thermowell tip shall be preferably at the centre of pipe to sense the temperature accurately.

Pressure Gauge Data Sheet				
GENERAL				
1	P&ID Number	Vendor	**	**
2	Manufacturer	Model No.	**	**
3	Quantity		**	
GAUGE				
4	Type		**Bourdon**	
5	**Case**	**Type**	Direct	
6		**Material**	SS316	
7		**Mounting**	Local	
8		**Bezel**	Bayonet Type SS316	
9		**Glass Type**	Shatter Proof Glass	
10		**Blowout Device**	Required	
11		**Gasket Material**	*	
12	**Dial Size**	**Dial Color**	**100 mm**	**White with Black Marking**
13	Enclosure Class		IP - 65 as per IEC 60529 / IS 13947	
14	Range		Refer Table below	
ELEMENT				
15	Type	Accuracy	C-type Bourdon*	±1% FSD
16	Element Material	Socket Material	SS316	SS316
17	Movement Material		SS316	
18	Connection Size Type	Connection Location	1/2 INCH NPTM	Bottom
19	Zero Adjustment		Micro pointer	
20	Blow Out protection	Over-Ring Protection	Required	Required, 130% of Full Scale
MISCELLANEOUS				
21	Manifold		2-way Manifold	
Tag No	**Service**	**Design Temp (Deg C)**	**Pressure (Kg/cm2g) (Op./Max./Des.)**	**Range (Kg/cm2.g)**
*	Natural Gas	*	250/400/400	0-400
Notes:				
1	Vendor to specify."*/**"			
2	Calibration, material, and hazardous area certificates shall be provided by the Vendor.			
3	Tag plate (SS 316) stamped with instrument tag number and service in 10mm characters shall be attached via SS wire (1 mm)			

4	Pressure gauge shall be selected in such a manner that normal operating pressure is approximately in the middle third of full scale (30% - 70% of range).
5	Pressure gauge shall be fitted with blow-out protection at back and shall have a over-range protection of 130% of max. reading

23. QUALITY ASSURANCE PLAN

QUALITY ASSURANCE PLAN – CNG STORAGE CASCADES								
S. No.	**Operation / Parameter**	**Characteristics / Parameters**	**Acceptance Criteria & Certification**	**Inspection Frequency**	**Vendor**	**TPAI**	**Client**	**Remarks**
1	Raw Material	Chemical Composition	Chrome Moly Steel, Grade-DS-202/IS: 7285-2004 Cl. 5.2 Table-1	One sample per heat No.	P	R	R	Verification of RMT certificate Received from RM supplier.
2	Raw Material Cutting (seamless Tube)	Length	As per process heat	4-5 jobs during setting approval & every two hours.	P	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 hours.	P	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 four hours.				
		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 hours.	P	R	R	
		Neck Diameter	As per Approved Drawing	4-5 jobs during setting approval & every two hours.				

		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 hours.				
		Ultrasonic Examination	IS: 7285: 2004	Each cylinder				
5	Heat Treatment	Hardness	As per approved drawing	Every cylinder	P	R	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 to mechanical properties like tensile test, impact test, bend test etc, in presence of inspecting officer.				
		Yield Strength						
		% Elongation						
		Impact test (at -20˚C)	IS: 7285: 2004					
		Bend Test	IS: 7285: 2004					
		Burst Test	IS: 7285: 2004					
6	Ultrasonic Testing	Crack Deduction	As per IS: 7285: 2004	Every cylinder	P	R	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	R	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	Tolerance on water capacity +5% IS-7285: 2004	Every cylinder	P	R	R	
			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	Free from Leakage.	Every cylinder	P	R	R	
			IS: 7285: 2004	Audit check by Q.A staff				
10	Bursting Test	Hoop Stress shall Not be less than 0.95 of the minimum specified tensile strength of the cylinder material.	IS-7285-2004	One cylinder of the first batch.	P	R	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 a minimum of 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 imperfections.	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.	Every cylinder check by Q.A staff	P	R	R	
17	Weighing	Tare Weight / Calibration	As per approved drawing	Every cylinder check	P	R	R	
18	Painting (Primer & Finish)	Paint Coating Thickness	As per process sheet	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	Visual (Welding etc.), Dimensional Physical Test, Chemical Test	Approved Drawing/Manufacturers standard. Owner's specification approved drawing	100%	P	W/R	R	
22	Cascade Painting Polyurethane/Epoxy paint	Coating thickness	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 / Manufacturer's 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	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	Leakage Test of Vent Manifolding assembly		Pressure to 5 Bar for leakage test, check all joints for visible signs of leakage with soap solutio	Owner's specification/instruction	P	W	R	
29	Leakage test of manifolding assembly at 250 bar		Hold for 5 mins and check all leakages by soap solution and there shall not be any sign of Pressure drop. After testing, check the manifold sequence and there must not be any back flow from medium bank to low bank or from high bank to medium bank	Owner's specification/instruction	P	W	R	
30	Cylinder valves		As per approved CCOE Drawing, Bill of Material.	Owner's specification/instruction	P	100% W	R	
31	Gauge	Visual Dimensional Fitment & Alignment	Approved Drawing, Bill of Material.	Owner's specification/instruction	P	100% W	R	
32	Final Inspection of Finished Cylinders: Visual Inspection for Internal cleaning and PAINTING OF Cylinder and Cascade frame.		IS: 7285-2004	Each cylinder	P	100% W		

	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						

LEGENDS: P=Perform, W=Witness, R=Review of documents, 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)