

OISD STANDARD-179
FIRST EDITION July- 1998
REVISED EDITION - MARCH, 2016
FOR RESTRICTED CIRCULATION

**SAFETY REQUIREMENTS
ON
COMPRESSION, STORAGE, HANDLING & REFUELING
OF
NATURAL GAS (CNG) FOR USE IN AUTOMOTIVE SECTOR.**

PREPARED BY
FUNCTIONAL COMMITTEE



OIL INDUSTRY SAFETY DIRECTORATE

8th Floor, OIDB Bhavan,
Plot No. 2, Sector - 73
Noida – 201301 (U.P.)

Preamble

Indian petroleum industry is the energy lifeline of the nation and its continuous performance is essential for sovereignty and prosperity of the country. As the industry essentially deals with inherently inflammable substances throughout its value chain – upstream, midstream and downstream – Safety is of paramount importance to this industry as only safe performance at all times can ensure optimum ROI of these national assets and resources including sustainability.

While statutory organizations were in place all along to oversee safety aspects of Indian petroleum industry, Oil Industry Safety Directorate (OISD) was set up in 1986 Ministry of Petroleum and Natural Gas, Government of India as a knowledge centre for formulation of constantly updated world-scale standards for design, layout and operation of various equipment, facility and activities involved in this industry. Moreover, OISD was also given responsibility of monitoring implementation status of these standards through safety audits.

In more than 25 years of its existence, OISD has developed a rigorous, multi-layer, iterative and participative process of development of standards – starting with research by in-house experts and iterating through seeking & validating inputs from all stake-holders – operators, designers, national level knowledge authorities and public at large – with a feedback loop of constant updation based on ground level experience obtained through audits, incident analysis and environment scanning.

The participative process followed in standard formulation has resulted in excellent level of compliance by the industry culminating in a safer environment in the industry. OISD – except in the Upstream Petroleum Sector – is still a regulatory (and not a statutory) body but that has not affected implementation of the OISD standards. It also goes to prove the old adage that self-regulation is the best regulation. The quality and relevance of OISD standards had been further endorsed by their adoption in various statutory rules of the land.

Petroleum industry in India is significantly globalized at present in terms of technology content requiring its operation to keep pace with the relevant world scale standards & practices. This matches the OISD philosophy of continuous improvement keeping pace with the global developments in its target environment. To this end, OISD keeps track of changes through participation as member in large number of International and national level Knowledge Organizations – both in the field of standard development and implementation & monitoring in addition to updation of internal knowledge base through continuous research and application surveillance, thereby ensuring that this OISD Standard, along with all other extant ones, remains relevant, updated and effective on a real time basis in the applicable areas.

Together we strive to achieve NIL incidents in the entire Hydrocarbon Value Chain. This, besides other issues, calls for total engagement from all levels of the stake holder organizations, which we, at OISD, fervently look forward to.

Jai Hind!

**Executive Director
Oil Industry Safety Directorate**

FOREWORD

The Oil Industry in India is more than 100 years old. As such, a variety of practices have been in vogue because of collaboration/ association with different foreign companies and governments. Standardisation in design philosophies, operating and maintenance practices was hardly in existence at a national level. This, coupled with feedback from some serious accidents that occurred in the recent past in India and abroad, emphasised the need for the industry to review the existing state of art in designing, operating and maintaining oil and gas installations.

With this in view, the Ministry of Petroleum & Natural Gas in 1986 constituted a Safety Council assisted by the Oil Industry Safety Directorate (OISD) staffed from within the industry for formulating and implementing a series of self regulatory measures aimed at removing obsolescence, standardising and upgrading the existing standards to ensure safer operations. Accordingly, OISD constituted a number of functional committees comprising of experts nominated from the industry to draw up standards and guidelines on various subjects.

The present document “Safety Requirements on Compression, Storage, Handling & Refuelling of Natural Gas for Use in Automotive Sector” was prepared by the Functional Committee on “Safety Requirements on Compression, Storage, Handling & Refuelling of Natural Gas for Use in Automotive Sector”. This document was prepared based on the accumulated experience and knowledge of industry members, and various national and international codes and practices.

This document will be reviewed periodically for improvements based on the new experiences and better understanding. Suggestions from industry may be addressed to :

The Coordinator,
Committee on “Safety Requirements on Compression,
Storage, Handling & Refuelling of Natural Gas for Use
in Automotive Sector”
OIL INDUSTRY SAFETY DIRECTORATE
8th Floor, OISD Bhavan,
Plot No. 2, Sector - 73
Noida – 201301 (U.P.)

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These documents are intended to supplement rather than replace the prevailing statutory requirements.

1st Functional Committee
FUNCTIONAL COMMITTEE
ON
“Safety Requirements on Compression, Storage, Handing & Refuelling of Natural Gas (CNG) for Use in Automotive Sector”

| NAME | ORGANISATION |
|---|--|
| LEADER | |
| Sh. S.Singhal | Indian Institute of Petroleum, Dehradun |
| MEMBERS | |
| Sh. A.S.Ghoshal | Chief Controller of Explosives, Nagpur |
| Dr. S.Padam | Central Institute of Road Transport, Pune |
| Sh. B.P.Singh | Gas Authority of India Ltd, New Delhi |
| Dr. S.Sarkar | Gas Authority of India, Ltd New Delhi |
| Sh.Z.A.Mujawar (Upto December, 1996) | The Automotive Research Association of India, Pune |
| Sh. M.K.Chaudhari | The Automotive Research Association of India, Pune |
| Sh. R.Rajagopal | Engineers India Limited, New Delhi |
| Sh. M.Nasarulla | Hindustan Petroleum Corporation Ltd., New Delhi |
| Sh. V.K.Bhatnagar | Hindustan Petroleum Corporation Ltd., New Delhi |
| Sh. D.K.Aggarwal | Bharat Petroleum Corporation Ltd., New Delhi |
| Sh. Ravi Prasad | Indian Oil Corporation Ltd., New Delhi |
| Sh. G.Premchand | Madras Refineries Ltd., Chennai |
| Sh. G.K.Acharya | Indian Oil Corporation Ltd., Faridabad |
| Sh. K.Madhusudanan | Cochin Refineries Ltd., Cochin |
| Sh. T.Koshie | IBP Co. Ltd., New Delhi |
| MEMBER COORDINATOR | |
| Sh. S.Ghosh (Upto September, 1996) | Oil Industry Safety Directorate, New Delhi |
| Sh. A. Mishra | Oil Industry Safety Directorate, New Delhi. |

2nd Functional Committee**“Safety Requirements on Compression, Storage, Handling & Refuelling of Natural Gas (CNG) for Use In Automotive Sector”**

| NAME | ORGANISATION |
|---------------------------|---|
| LEADER | |
| Shri P K Pandey | Indraprastha Gas Limited |
| MEMBERS | |
| Shri Ashendra Singh | The Petroleum and Explosives Safety Organisation (PESO) |
| Shri S. Murali | Mahanagar Gas Limited |
| Shri C.Sreekantan | Hindustan Petroleum Corporation Ltd. |
| Shri R K Sinha | Indian Oil Corporation Ltd. |
| Shri Santanu Purohit | Bharat Petroleum Corporation Ltd. |
| Shri R. Mohrana | GAIL Gas Ltd. |
| Shri Vivek Saraswat | GAIL Gas Ltd. |
| MEMBER COORDINATOR | |
| Shri Rakesh Agrawal | Oil Industry Safety Directorate |

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1.0 INTRODUCTION

Compressed Natural Gas (CNG) has been identified as one of the alternate fuels to liquid petroleum fuels, which has added environmental benefits. This fuel is being used internationally with the proven success as an automotive fuel.

CNG is a mixture of hydrocarbon gases and vapours consisting of principally methane in gaseous form which are compressed to a pressure of 200 to 250 Bar for use as a vehicular fuel. Besides, installation of conversion kit in an Automotive system, two major installations need to be erected i.e.

- 1) Compressors station for either on-line operation or to serve as mother station
- 2) Refuelling station either with on-line facility or with moveable cascade.

These facilities may be either co-located in the MS/HSD dispensing stations or at dedicated stations.

Safety at these installations is most important factor in view of the operating conditions such as pressure, storage of other flammable materials etc. The provisions in this standard shall provide a reasonable level of safety and protection from loss of life and property from fire and explosion.

2.0 SCOPE

This standard lays down the minimum safety requirements at installations (as described in 1 above) handling Natural Gas for dispensing into vehicles and minimum checks required in the vehicles by Refuelling stations. This standard does not certify the fitness of vehicles either for CNG use or otherwise. Further, this standard only supplements the existing statutory regulations and in no way supercedes them. The statutory regulations must be followed as applicable.

It is not intended that requirements of this standard should be applied rigidly to existing installations duly approved by Chief Controller of Explosives, where for a variety of reasons it may not be practicable to comply with. This standard will however, create awareness and help in selective implementation at existing installations as far as possible.

3.0 DEFINITIONS

3.1 ANSI B 31.3.

This code of American National Standards Institute on "Chemical Plant and Petroleum Refinery Piping" would be applicable for CNG Pipelines and tube work inside the installation of CNG compression and retail outlets.

3.2 Statutory Authority.

Govt. of India or its agency responsible for particular aspect. "Chief Controller of Explosives" is the statutory Authority for administering the Gas Cylinders Rules 2004 & SMPV (U) Rules 1981.

3.3 Bulk Storage.

Bulk storage is a facility for storing CNG in stationary and mobile storages exceeding the capacity of 1000 Lt. These pressure vessels shall conform to the "Static & Mobile Pressure Vessels (Unfired) Rules, 1981 as amended.

3.4 Capacity.

The gross capacity of a storage container in water litres at 15 deg. C.

3.5 Cascade (Gas Storage Unit -Bundles of cylinders, Multi-Element Gas Cylinders-MEGCs, Tube Modules or Skids)

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This is a group of gas cylinders interconnected by high-pressure tubing to form a single gas storage unit referred as cascade hereafter.

The cascade is also used for transportation of CNG in the structural frame work having facility for lifting and placement.

3.6 Cascade Storage Unit Isolation Valve.

This is a quick action valve for stopping gas flow from a gas storage unit.

3.7 Compressed Natural Gas (CNG).

Mixtures of hydrocarbon gases and vapours, consisting mainly of Methane in gaseous form which has been compressed for use as automotive fuel conforming to IS: 15958 / IS: 15320:2012.

3.8 Cylinder Appurtenances.

Devices connected to cylinder for safety, control or operating purposes.

3.9 Cylinder.

“Cylinder” means any closed container having capacity exceeding 500 ml but not exceeding 1000 lts., constructed as per IS 7285-1, IS 7285-2, ISO 11119-1, ISO 11119-2, ISO 11119-3, ISO 11120, EN 12245, EN 12247 or other international standards having approval from statutory authority under Gas Cylinders Rules. These may be of varied capacities to suit vehicles and storage systems. Water capacity of cylinders used for storage of CNG, may exceed 1000 litres up to 2500 litres provided the diameter of such cylinder does not exceed 60 cm.

3.10 Dew point.

The temperature at which the water vapours begins to condense.

3.11 CNG “Mother” Station:

CNG facility connected to natural gas pipeline and having a compressor meant primarily to fill mobile cascades. Such facilities, in addition to act as ‘mother’ station can also fill stationary cascades for CNG dispensing into vehicles.

3.12 CNG “On line” Station:

CNG facility connected with natural gas pipeline and having a compressor primarily to fill stationary cascades for dispensing CNG to vehicles. In case the ‘on line’ station has enough space to accommodate mobile cascades filling, it can be used to act as mother compressor station.

3.13 CNG daughter station:

CNG facility not connected to natural gas pipeline and dispensing CNG to the vehicles (s) through mobile cascades.

3.14 CNG daughter booster Station:

CNG facility not connected to natural gas pipeline and dispensing CNG to the vehicle (s) through CNG booster compressor and mobile cascade.

3.15 Emergency Shut Off Valve.

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A quick action shut off valve, which operates from full open to full closed condition in less than one complete turn.

3.16 Fire Resistance Rating (FRR).

The minimum period of time for which all sides of an element of structure, any of which is subjected to a standard fire, continues to perform its structural function and does not permit the spread of fire. Where a period of time is used in conjunction with the abbreviation FRR it is required that the element of structure referred to shall have a fire resistance rating of not less than the period stated. (In accordance with IS 1642:1989)

3.17 Hazardous.

Substance or circumstance which may cause injury or damage due to being explosive, flammable, poisonous, corrosive, oxidizing, or otherwise harmful.

3.18 Installation.

System that includes natural gas containers, pressure booster, compressors, dispensers and all attached valves, piping, and appurtenances. When filling containers or transferring natural gas directly from distribution lines by means of a compressor, an installation includes the compressor and all piping and piping components beyond the shut off valve between the distribution system and the compressor.

3.19 Manifold.

The assembly of piping / tubing and fittings used for interconnecting all cylinders/ vessels to a common pipeline.

3.20 Non Return Valve (NRV).

This valve permits gas flow in one direction only.

3.21 Natural Gas.

Mixture of gaseous hydrocarbons and vapours consisting primarily of Methane

3.22 Non-combustible Material.

Material, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapours when subjected to fire or heat.

3.23 Point of Transfer.

The point where the filling/fuelling connection is made, to vessel(s)/ vehicle (s).

3.24 Pressure Relief Device.

Device designed to prevent rupture of vessel / container by releasing excessive pressure build-up.

3.25 Set Pressure.

The valve opening pressure in a relief valve which shall not exceed the marked service pressure.

3.26 Shall.

Indicates mandatory requirement.

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**3.27 Should.**

Indicates recommendation or that which is advised but not mandatory.

3.28 SMPV (U) Rules.

The Static and Mobile Pressure Vessels (Unfired) Rules, 1981, (with latest amendments) abbreviated as SMPV (U). These are Rules governing the fabrication of unfired vessels, storage, transportation, handling etc. of compressed gas in vessels exceeding 1000 litres water capacity. These rules are framed under “The Explosives Act”, 1884 and administered by “Chief Controller of Explosives”.

3.29 Gas Cylinders Rules, 2004:

Rules governing the fabrication / manufacture, storage, transportation, handling etc. of cylinders. These rules are framed under “The Explosives Act”, 1884 and administered by “Chief Controller of Explosives”.

3.30 Sources of Ignition.

Devices or equipment which, because of their mode, use or operation, are capable of providing required thermal energy to ignite flammable " Natural Gas-Air mixtures" when introduced to such a mixture or when such a mixture comes into contact with them.

3.31 Transportation unit.

A cascade/ bulk storage mounted and installed on a Light/ Heavy Commercial Vehicle, trailer, or semi trailer for movement of CNG on road and governed by statutory regulations.

3.32 Trailer

Trailer or semi-trailer motor vehicle designed specifically for the transportation of Cylinder bundles with its associated structural framework.

3.33 Maximum Working Pressure.

The pressure for which the equipment was fabricated / manufactured or if conditions have changed, the maximum permitted pressure at specified design temperatures.

3.34 Vehicle Refuelling Probe.

This is a CNG refuelling device fitted at the end of the refuelling hose at the dispenser units.

3.35 Vehicle Refuelling Shut Off Valve.

A quick action valve for stopping gas flow and having the facility for venting residual high pressure gas in the refuelling line after completion of the vehicle refuelling operation.

4.0 APPROVAL

4.1 The systems and components of CNG facility(ies) are required to be certified for CNG use and marked accordingly by applicable statutory authority (PESO) or the agency authorized by him . The various components of the CNG system which need such certification/ approval are given below:

- a) Cylinders
- b) All parts under pressure carrying CNG including valves.
- c) Electrical equipment related to CNG systems installed in hazardous area.

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- 4.2 Any other device not specified above must be constructed to provide safety equivalent to that required for other parts of a system and should have a similar certification/ approval as detailed above.

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5.0 NATURAL GAS QUALITY FOR CNG FACILITIES

5.1 Natural gas is a complex mixture of hydrocarbons, primarily methane, but generally also including ethane, propane and higher hydrocarbons in much smaller amounts and some non-combustible gases, such as nitrogen and carbon dioxide. Compressed Natural Gas (CNG) for Automotive purposes is governed by IS:15958.

Requirements for Compressed Natural Gas for Automotive Purposes (Refer IS: 15958)

| Sl No | Characteristic | Requirement | Method of Test, Ref to |
|-------|--|-------------|------------------------|
| i | Wobbe index ¹⁾ , MJ/ m ³ , Min | 48.8-51.0 | IS 14504 |
| ii | Water content ¹⁾ , mg/m ³ , Max | 5.0 | IS 15641 (Part 2) |
| iii | Hydrocarbons (volume percent of total organic carbon present): | | IS 15130 (Part 3) |
| | a) Methane, Min | 90.0 | do |
| | b) Ethane, Max | 6.0 | do |
| | c) C3 and higher HC, Max | 3.0 | do |
| | d) C6 and higher HC, Max | 0.5 | do |
| iv | Corrosive components: | | |
| | a) Total sulphur ²⁾ , mg/m ³ , Max | 20.0 | ASTM D3246-05 |
| | b) Oxygen, volume percent, Max | 0.5 | IS 15130 (Part 3) |
| v | Carbon dioxide and nitrogen, volume percent, Max | 3.5 | do |
| vi | Other species (mole percent): | | |
| | a) Hydrogen, Max | 0.1 | do |
| | b) Carbon monoxide, Max | 0.1 | do |
| vii | Methane number, Min | 90.0 | IS 15320 |

¹⁾ Requirements are according to IS 15126.

²⁾ Total sulphur includes the sulphur content of odorant.

5.2 ODOURISATION:

5.2.1 Natural gas introduced into any system covered by this standard should have a distinctive odour strong enough to detect its presence down to a concentration (of CNG) in air not exceeding 20% of the lower limit of flammability. To achieve this, the injection of odorizing agent shall be done in a quantity to ensure perception of CNG leakage by smell.

5.2.2 Suitable type of filters shall be used for limiting liquid particulate as mentioned in the clause 5.2.1.

5.2.3 The odorisation and filtration system shall be located in a separate working area from the compressor or CNG storage unit but within the same fencing. There should be a clear safety distance of 1.5 M around the odorisation and filtration system to facilitate easy maintenance and personnel movement.

5.2.4 The odorisation pumping as well as filtration system shall have 100% stand-by capacity.

6.0 FACILITY PLANNING

6.1 The CNG Refuelling system shall comprise of a gas compression apparatus, static/ mobile cascade/ pressure vessel and a gas dispenser incorporating a measuring device. The CNG station can also have an air compressor and an air dryer system for actuation of valves. The system shall be 'ON-LINE' mother refuelling or daughter dispensing system attached to a mobile cascade.

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6.2 LAYOUT AND INTERDISTANCES

- 6.2.1 Inter-distances between various equipment, storage cylinders/ cascade etc. shall be as per Table - I, II.
- 6.2.2 Safety distances not indicated above should be as approved by Chief Controller of Explosives on case to case basis after due consideration of all influencing factors.
- 6.2.3 When inside a MS-HSD Service Station, the CNG storage and dispensing facilities shall be located in an isolated area not interfering in the vehicular movement on the drive way and not coming within the hazardous areas of petroleum facilities as prescribed in the Fourth schedule of the Petroleum Rules, 2002. The CNG facilities shall not be located beneath bare electric power lines or where exposed by their failure.
- 6.2.4 The compressor fencing may be limited to avoid obstruction in the driveway if the required clear space is available thereafter within the service station premises. The dispensing unit may also be located farther from the fence enclosure on a separate pedestal observing the minimum safety clearance mentioned in Table II.
- 6.2.5 CNG Compressors / Storage units installations shall be permitted to use alternate equipment locations (e.g. when installed on the top of the RCC canopy) with validation by a qualified engineer(s) with proven expertise in mechanical systems, structural system, electrical systems, gaseous storage systems, fire protection, and gas detection. If compressor is installed on the top of the canopy, installation of cascades above such compressor shall not be permitted.
The validation shall at a minimum include the following:

- (1) Process safety analysis and hazard and operability studies (HAZOPS)
- (2) Mitigating fire protection measures such as suppression system as per NFPA-17. Further, if compressor is mounted inside soundproof canopy/ enclosure automatic CO₂ flooding system as per NFPA-12 shall be provided.
- (3) Fire and gas detection systems designed to interface with an emergency shutdown device (ESD)
- (3) The structure supporting such installations shall meet 4 Hr Fire rating in line with IS 1642:1989-Code of practice for fire safety of buildings.
- (4) IS 875- Part 1 to 5 (1987): Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures including for movable and immovable loads, vibrations at partial / full loading conditions of the CNG compressor.
- (5) The structure, Foundation shall be designed for the seismic zone as per IS 1893 (Part 1) 2002 for Seismic loads.
- (6) Alternate Emergency escape routes shall be provided for operating crew in case the equipment is installed at Top of the canopy / elevated platform.
- (7) Protective hand railings shall be provided on such elevated roof top's / elevated platforms to prevent accidental fall of operating crew.
- (8) Weather protection from sun & rain (ventilated canopy) shall be provided for cascades.
- (9) Emergency shut down (ESD) system shall be provided: This device, when activated, shall shut off the power supply to the compressor and gas supply to the dispenser immediately.
- (10) An emergency manual shutdown device shall be provided within 3.0 m of the dispensing area and also at a suitable remote manned location.

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(11) Control circuits shall be arranged so that, when an emergency shutdown device is activated or electric power is cut off, systems that shut down remain off until manually activated or reset after a safe condition is restored.

(12) The main stairs for accessing such elevated platform shall be minimum 1.2 m wide.

6.2.6 Provisions related to Convenience store / ATM / office cabin:

- a. The items to be sold from a Convenience Store (C-Store) in a retail outlet shall be decided keeping in view hazards associated with the items being stocked and sold. Open flame appliances shall not be used in the retail outlet.
- b. Provision for car parking shall be made in retail outlet with C- Store @ one slot distinctly marked for each 25 sq metre of C-Store area.
- c. Separate pathways outside dispensing area shall be provided for movement of customers for C-Store.
- d. The CNG dispensers shall maintain a minimum distance of 4 mts from any above ground structure/ property boundary.
- e. Any building or room intended to serve as a control point for a retail outlet shall preferably be so located that an attendant in the sales room can see the forecourt and dispensing area clearly.

TABLE - I

INTER DISTANCES

FROM BUILDINGS AND OUTER BOUNDARIES TO GAS STORAGE UNITS

| Total capacity of gas storage units (In litres) (1) | Min. distance from buildings and boundaries (In Meters) (2) |
|--|--|
| Upto 4500 | 2.5 |
| 4500 to 10000 | 4.0 |
| 10000 to 100000 | 10.0 |

NOTE:

1. If on the side (s) towards the boundary of the installation, the clearance as above is not available, the same may be reduced to 2 meters provided a 4 H-FRR (As per IS 1642 (1989)) RCC wall of adequate height and length covering the cylinder cascades is constructed at the boundary and adequate clear space is available on the other side of the wall.

2. If Multiple cascades are located maintaining inter-distance of minimum 1 m then the required safety distances shall be considered as applicable in case of the water capacity of the higher capacity individual cascade.

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**TABLE - II****INTER DISTANCES
BETWEEN VARIOUS FACILITIES OF NATURAL GAS HANDLING AT
INSTALLATION**

| | Distance from - In metres | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|----------------------------------|----------------|---------------------|-----------------|--------------------------|------------------|-----------------------------------|--------------------------|
| | | CNG Compressor | CNG Dispensing Unit | Storage Cascade | Outer boundary wall/ CLF | MS/HSD dispenser | Vent of MS/HS D u/g Storage tanks | Filling point of MS/HS D |
| 1 | CNG Compressor | - | 3 | 2 | 3 | 6 | 6 | T1 (Min-3) |
| 2 | CNG Dispensing Unit | 3 | - | 2 | 4 | 6 | 4 | -do- |
| 3 | Storage Cascade | 2 | 2 | - | T1 | T1 (min-6) | T1 (Min-4) | -do- |
| 4 | Outer boundary wall/ CLF | 3 | 4 | T1 | - | 6 | 4 | -do- |
| 5 | MS/HSD dispenser | 6 | 6 | T1 (Min-6) | 6 | - | 6 | -do- |
| 6 | Vent of MS/HSD u/g Storage tanks | 6 | 4 | T1 (Min-4) | 4 | 6 | - | 6 |
| 7 | Filling point of MS/HSD | T1 (Min-3) | T1 (Min-3) | T1 (Min-3) | T1 (Min-3) | T1 (Min-3) | 6 | * |

NOTES :

- i) T-I denotes Table-I
- ii) Distances shown as “-” shall be any distance necessary for operational convenience.
- iii) A suitable curbing platform shall be provided at the base of the dispensing unit to prevent vehicles from coming too near the unit.
- iv) A CNG cascade having cylinders of total water capacity not exceeding 4500 liters can be mounted on top of the compressor super structure. The assembly shall observe 3-meter clearance around and also from the dispensing unit. This can be reduced to 2 meter as per Note- I of Table – I.
- v) * As per OISD-STD-225
- vi) CLF = Chain Link Fence

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7.0 CNG STORAGE SYSTEM (Static) :

- 7.1 The cascade having horizontal cylinders and sited parallel to other cascade, cylinder fittings should be arranged so that they do not face cylinder fittings of other cascade.
- 7.2 Cylinder installed horizontally in a cascade shall be separated from another cylinder in the cascade by a distance of minimum 20mm.
- 7.3 Cascade with horizontal cylinders shall have the valves fitted on the same side within the cascade opposite to the refuelling point and arranged in a manner that any gas leakage is discharged upwards.
- 7.4 Cascade/bulk units shall be installed on a firm, compacted, well-drained non-combustible foundation. This foundation may be in the form of a plinth with the raised edge at 2 M from the front and sides of the cascade forming a kerb upto which vehicles should be permitted. The cascade shall be securely anchored to prevent floating in case flooding is anticipated.
- 7.5 Gas storage facility shall be protected from the effects of the weather by a roof or canopy designed to facilitate the dispersion of free or escaped gas and shall not permit gas to be trapped.
- 7.6 Adequate means shall be provided to prevent the flow or accumulation of flammable or combustible liquids under containers such as by grading, pads or diversion curbs.
- 7.7 Clause 8.5subclause iv, v, vi, viii, ix and x shall also be applicable for static CNG storage system.

8.0 CNG STORAGE SYSTEM (Mobile)

- 8.1 Only dedicated trailer, truck or any other vehicle to be used for transportation of CNG storage units. These units should have lugs fitted for lifting and in no case magnetic device to be used for lifting purposes.
- 8.2 The vehicle with the cascade thereon, shall be placed with easy access and egress on a low platform or hard compacted ground, which shall extend to atleast another one meter on all sides and this platform or hard ground shall be under a light roof or canopy as described in 7.5 above.
- 8.3 For other inter-distances refer Table I, II, above.
- 8.4 The trailers/ vehicle carrying CNG should be made immovable by application of brake and wheel choke prior to initiation of filling or dispensing operation.
- 8.5 Whether attached to a trailer or mounted on a vehicle chassis frame the Cascade shall be designed to meet the following :
 - i) The Cylinders in a cascade must be structurally supported and held together as a unit and secured in a manner that prevents movement in relation to the structural assembly and movement that would result in the concentration of harmful local stresses. The frame design must ensure stability under normal operating conditions.
 - ii) The frame must securely retain all the components of the bundle and must protect them from damage during conditions normally incident to transportation. The method of cylinder restraint must prevent any vertical or horizontal movement or rotation of the cylinder that could cause undue strain on the manifold

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or cylinder shell. The total assembly must be able to withstand rough handling, including being dropped or overturned. (Refer CGA TB 25 Design Considerations For Tube Trailers / Tube Modules)

- iii) The frame must include features designed for the handling and transportation of the bundle.
- iv) The frame structural members must be designed for a vertical load of 2 times the maximum gross weight of the bundle. Design stress levels shall not exceed as per IS 800.
- v) The frame must not contain any protrusions from the exterior frame structure that could cause a hazardous condition.
- vi) The frame design must prevent collection of water or other debris that would increase the tare weight of bundles filled by weight.
- vii) The floor of the bundle frame must not buckle during normal operating conditions.
- viii) Each new Cascade design beyond 4500 litre water capacity must have a design approval certificate. The manufacturer shall obtain approval of a new design along with the Copies of all engineering drawings, calculations, and test data necessary to ensure that the design meets the relevant specification from a firm of repute e.g FM / UL .
- ix) The cylinders shall be manufactured as per IS 7285-1, IS 7285-2, ISO 11119-1, ISO 11119-2, ISO 11119-3, ISO 11120, EN 12245, EN 12247.
- x) Individual Cascade shall have all cylinders of a particular make, type and capacity. All cylinders in a cascade shall conform to a single design code (mentioned above in para (8.5 ix)).
- xi) Seamless cylinders longer than 2 m (6.5 feet) shall be mounted horizontally for transportation on a motor vehicle or in an ISO framework or other framework of equivalent structural integrity in accordance with CGA TB-25
- xii) Refer ISO 6346 for the dimensions of ISO framework for transportation.

9.0 CYLINDERS

- 9.1 The cylinders and their fittings for CNG use shall be designed, manufactured, tested including hydrostatic stretch test at a pressure in full conformity to IS 7285-1, IS 7285-2, ISO 11119-1, ISO 11119-2, ISO 11119-3, ISO 11120, EN 12245, EN 12247 or other national / international standards having approval from statutory authority under Gas Cylinder Rules 2004 ie Chief Controller of Explosives considering the maximum allowable operating pressure of 250 bar.
- 9.2 These cylinders are to be permanently and clearly marked for “CNG only” and also labelled "CNG ONLY" in letter at least 25 mm high in contrasting colour in a location which shall be visible after installation.
- 9.3 The cylinder shall be fabricated from steel / composite materials as per the national / international design codes referred above in cl 9.1 any other standard-duly approved by the Chief Controller of Explosives.
- 9.4 The cylinders shall be re-examined /re-tested every three years and in accordance with Gas Cylinder Rules, 2004 by a competent person in line with the directives of the Chief Controller of Explosives with due markings. No cylinder shall be used which has not been duly re-tested as indicated.
- 9.5 Cylinders shall be painted white to reduce solar heating effect and protect it from atmospheric corrosion.

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10.0 CNG PIPING / TUBING

- 10.1 All rigid piping, tubing, fittings and other piping components shall conform to the recommendations of ANSI B 31.3. All the elements of piping should be designed for the full range of pressures, temperatures and loading to which they may be subjected with a factor of safety of at least 4 based on the minimum specified tensile strength at 20 deg. C.
- 10.2 Gaskets, packing and any other materials used shall be compatible with natural gas and its service conditions.
- 10.3 All the piping and tubing shall have minimum turns with adequate provision for expansion, contraction, jarring, vibration and settling. Exterior piping may be either buried with suitable corrosion protection or installed 30 cm. above the ground level with supports and protection against mechanical and corrosive damage.
- 10.4 Rigid pipelines shall have welded joints between their respective components.
- 10.5 All the piping and tubing shall withstand a pressure equal to that of safety relief device and tested accordingly after assembly. The testing to be done by inert gas, in case natural gas is used the suitable safety measures to be adhered to.

10.6 VALVES

- 10.6.1 A minimum of four shut off valves shall be fitted between the gas storage unit and vehicle refuelling filling nozzle as explained below:
 - a) Each CNG storage unit to have quick action isolation valve in the steel supply pipe immediately adjacent to such storage unit to enable isolation of individual storage unit. These valves shall be within fencing of storage unit.
 - b) Master shut off valve with locking arrangement in close position, shall be installed in steel outlet pipe outside but immediately adjacent to the gas storage unit to isolate all downstream equipment from the gas storage unit. This valve shall be outside the fencing.
 - c) A quick action emergency and isolation shut off valve shall be installed near dispensing unit with easy approach and to remain closed when refuelling is not being done.
 - d) A vehicle refuelling shut off valve shall be installed for each flexible vehicle refuelling hose to control the refuelling operation and shall have venting provision to allow for the bleeding of the residual high pressure gas after refuelling is complete.
- 10.6.2 All these valves and other elements of piping shall be suitable for the full range of pressure and temperature to which they may be subjected. These valves are to have permanent marking for service rating etc.

11.0 CNG HOSES

- 11.1 Internally braided, electrically continuous, non-metallic and metallic hoses resistant to corrosion and suitable to the natural gas service shall be used for CNG service in the downstream of emergency and isolation shut off valve.

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- 11.2 These flexible hoses and their connections shall be suitable for most severe pressure and temperature service condition expected with a burst pressure of at least four times the maximum working pressure.
- 11.3 The flexible hoses with their connections shall be tested after assembly and prior to use to atleast two times the working pressure and also tested to a pneumatic pressure of atleast 400 bar under water. Thereafter, all the hoses shall be examined visually and tested for leaks with soapsuds or equivalent at an interval not exceeding one year. Hoses shall be rejected and destroyed in the event of any leakage. These tests are to be recorded and such records shall be available at installations at all times.
This shall be done safely in a controlled environment by the trained technicians having adequate expertise with respect to the assembly of hoses, breakaways, valves and fuel nozzles.
- 11.4 Flexible hoses shall have permanent marking indicating the manufacturer's name/ identification, working pressure and suitability for use with CNG.

12.0 PRESSURE GAUGES

- 12.1 Every CNG storage unit including each cascade or bulk storage tank shall be provided with a suitable pressure gauge directly in communication with them.
- 12.2 The CNG storage unit shall have an opening not to exceed 1.4-mm diameter at the connection where pressure gauge is mounted.
- 12.3 The pressure gauge shall have dial graduated to read approximately double the operating pressure but in no case less than 1.2 times the pressure at which pressure relief valve is set to function.
- 12.4 All pressure gauges in the installation shall be tested and calibrated atleast once a year and records maintained.

13.0 COMPRESSOR STATION

- 13.1 The piping and its fittings upto the battery limit of CNG installation shall conform to ASME B 31.8 or equivalent.
- 13.2 Compressor shall be designed for use in CNG service and for the pressures and temperature to which it may be subjected under normal operating conditions conforming to API 618/ API 813 / API 11 P or equivalent standard and Flame proof electric motor and associated fittings should conform to IS/IEC 60079 suitable for Gas Group IIA as applicable for Natural Gas.
- 13.3 Compressor shall be fitted with the following minimum devices :
- a) Pressure relief valves on inlet and all stages to prevent pressure build up above the predetermined set point.
 - b) High discharge temperature shut down
 - c) High cooling water temperature switch fitted to cooling water return line to shut the compressor in the event of a fault.
 - d) High, inlet, inter stage & discharge pressures shut down.
 - e) Low lube oil pressure shut down
 - f) Low cooling water flow switch fitted to the cooling water return line to shut the compressor in the event of fault.
 - g) A remote isolation switch for emergency shut down to be provided with manual reset at control panel.

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- 13.4 Compressor shall be provided atleast the following clear and permanent markings readily accessible and easy to read in the installed position :
- a) Manufacturer's name
 - b) Model
 - c) Serial No./ month & year of manufacture
 - d) Certificate of approval no.
 - e) Rated capacity (cubic meter per hour)
 - f) Operating speed (RPM)
 - g) Required driving power(in kW)
 - h) Maximum & minimum supply pressures
 - i) Maximum outlet pressure
 - j) Certification for Natural Gas use

- 13.5 A compressor and its all fittings shall be tested for compliance of relevant standard suitable for CNG use by a qualified engineer.

14.0 PRESSURE RELIEF DEVICE

- 14.1 Safety Relief Devices may consist of either burst disc or safety relief valve and should conform to the requirements of OISD-STD-132.
- 14.2 Safety relief devices shall be installed with unobstructed full size discharge to a safe place on bulk tanks and cylinders in the vertical position with suitable rain caps. These devices should have their outlet arranged in a manner so that in case of emergency a high-pressure gas escapes from these should not directly hit on operators/ persons in the close vicinity.
- 14.3 Cylinder should have safety relief devices fitted in conformity to the Gas Cylinder Rules.
- 14.4 Piping shall be protected by safety relief devices in conformity to OISD-STD-132.
- 14.5 Safety relief valves shall have a locking arrangement to prevent tampering by unauthorised persons. Any adjustments to the safety relief valve shall be made by manufacturer or a competent person. These valves should have a permanent tag indicating pressure setting, date of re-setting/ setting and capacity.
- 14.6 All safety relief devices shall be tested at least once a year for proper operations and records to be maintained.
- 14.7 All the safety relief devices shall have manufacturer's permanent marking indicating following:
- a) Set pressure to start discharge
 - b) Discharge capacity in CuM / min.
- 14.8 No shut off valves shall be installed between the safety relief device and the gas storage unit or bulk tank.
- 14.9 All natural gas devices not otherwise specifically mentioned shall be constructed and installed to provide a safety equivalent to that other parts of the system.
- 14.10 Gas detectors interlocked with compressor cut out switch in the electrical system of the compressor are to be installed which would automatically switch off the unit in case of major gas leak.

15.0 ELECTRICAL EQUIPMENT

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- 15.1 All electrical wiring and equipment, gas storage dispensing unit located in hazardous area Division I and II shall be in accordance with the Indian Electricity Rules, Gas Cylinder Rules, IS:5571, IS:5572 , NFPA - 52.
- 15.2 The earthing at the installation, protection against ignition arising out of static, lightning and stray currents shall be as described in OISD-STD-110 and further maintained as per the guidelines given in OISD-STD-137.

16.0 SAFETY AT VEHICLE FOR REFUELLING

- 16.1 The vehicles shall have approved type of CNG kit fitted in accordance with the guidelines of Ministry of Surface Transport, Govt. of India by an authorised workshop and such workshop should issue a fitness certificate to the vehicle for its suitability for CNG use. Such certificate should be always carried by the driver of the vehicle at all times.
- 16.2 Driver of the vehicle should also carry the record showing the last examination of the vital parts of the system fitted in the vehicle for CNG use and their next due date for such examination. The details must include the test periodicity of cylinder, pressure relief devices, pressure gauges, piping etc.
- 16.3 The cylinder with valves and connected facilities fitted in the vehicle shall be in accordance with Gas Cylinder Rules. These cylinders should be subjected to hydraulic test at least once every three years.
- 16.4 Every vehicle using CNG fuel system should display “CNG” labels prominently in compliance to Central Motor Vehicle Rules.
- 16.5 Manufacturing of Type-1 & Type 2 Nozzles shall be in accordance with NGV1 & ISO14469-2 standards.

17.0 DISPENSING UNIT

- 17.1 Dispensers shall be installed on a suitable foundation observing the minimum safety distances etc. as given in 6.0 above. Dispensing unit to be protected against possible damage by vehicular movement. Dispenser mounting and installation shall be in accordance with NFPA 52, and NFPA30A
- 17.2 The flexible hoses fitted on the dispenser shall be mechanically and electrically continuous. The design, material and construction of hoses shall be suitable for CNG and shall withstand not less than four times the maximum working pressure of the system.
- 17.3 The dispensing unit shall be of a type approved by the Chief Controller of Explosives / Statutory Authorities .
- 17.4 Dispensing unit shall be suitable for use of CNG in accordance with NGV 4.1, Hoses as per NGV 4.2 and Breakaway as per NGV 4.4.

18.0 CNG REFUELLING INTO VEHICLES

- 18.1 The vehicle refuelling shall be done by an experienced operator duly certified by the oil / gas company having control over the refuelling station.
- 18.2 The operator of the CNG dispensing unit shall check the following prior to refuelling the gas:
- a) The driver of the vehicle is carrying updated history record as given in clause 16.

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- b) There is no smoking, naked flame or any other source of ignition within six meter of the refuelling point.
- c) There is no leakage in the CNG fuel system reported by the driver of the vehicle.
- d) The fuel connection is in good condition and matches the dispensers filling nozzle. Fuel connection shall be tight without any leakage.
- e) The engine is switched off, hand brake is firmly applied, the vehicle parked in gear or in "P" with automatic transmission.
- f) No passenger remains inside the vehicle.
- 18.3 Detailed precautions (refer 18.2) and procedure of refuelling to be displayed near the dispensing unit and strictly followed by the operator.
- 18.4 The operator of the dispensing machine should not leave the vehicle being refuelled.
- 18.5 The cylinder on the vehicle shall not be charged in excess of maximum allowable working pressure at normal temperature for the cylinder.
- 18.6 Before the refuelled vehicle is driven away from the dispensing point the operator and driver should ensure that there are no apparent gas leaks either on the vehicle or on the dispensing point that may have been caused through faulty filling or the faulty action of connecting or disconnecting.
- 18.7 Warning signs with the words "STOP VEHICLE", "NO SMOKING", "NO OPEN FLAME PERMITTED", "FLAMMABLE GAS", "NO MOBILE PHONE", "SWITCHED OFF THE MOBILE PHONES" shall be displayed at dispensing station and compressor areas. The location of the signs shall be such that these are prominently visible from each point of transfer/ operation.
- 18.8 The operator shall take all measures for ensuring smooth vehicle movement in the outlet including restriction on number of vehicles near the fill points.

19.0 FIRE PROTECTION

- 19.1 Fire fighting facilities need to be carefully planned after considering the availability of municipal fire tenders etc. However, atleast the following Portable fire extinguishers shall be positioned:

| S.No. | Location | Type of Extinguishers |
|-------|------------------------------|---|
| 1 | Dispensing Unit | 1 x 10 kg. DCP |
| 2 | Compressor (on-line) | 1 x 10 kg. DCP |
| 3 | Mother station | 1x 75 kg DCP |
| 4 | CNG Storage | 1 x 10 kg. DCP |
| 5 | Cascade refuelling area | 1 x 10 kg. DCP |
| 6 | MCC/ Electrical Installation | 1 x 4.5 kg CO ₂ Per 25 Sq.M floor area |

- 19.2 Any other flammable materials not specified in this standard in the CNG installation shall be stored in a non-flammable chamber with a minimum safety distance of 15 M from compressor station/ MCC/ electrical installation.
- 19.3 All approaches to machines, compressors, storage facilities and work places shall be free from obstacles, so that they are readily accessible in an emergency.

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- 19.4 The electrical installations shall be inspected by an Electrical Inspector as per IE Rules and compliance shall be made as pointed out in the inspection. Records shall be maintained for all periodic inspections.
- 19.5 The flameproof characteristics of electrical equipment shall be checked through visual checks, condition of gasket, completeness and tightness of bolts, glands and as recommended by manufacturer's test certificates.
- 19.6 No unauthorised additions or modifications of the service station whether temporary or permanent shall be taken up.
- 19.7 Proper illumination to be ensured for all operating and non-operating areas.
- 19.8 All electrical maintenance at the Automotive Station shall be undertaken by licensed electrical technician under supervision of authorised person.
- 19.9 Each installation shall have minimum two numbers hand held explosive meter in working conditions at all times.
- 19.10 The work permit shall be followed (Refer OISD-STD-105).

20.0 EMERGENCY PLAN AND PROCEDURE

- 20.1 The Oil Companies / CNG Retailing companies having control over the refuelling station shall draw an operational emergency plan in consultation with adjoining establishments and local authorities e.g. fire brigade, police, and other District Emergency Authorities etc. for the following circumstances:
 - a) Loss of or interruption to the gas supplies due to leaks or failure of pipeline
 - b) Over-odorisation of the gas
 - c) Major failure of CNG fittings
 - d) Accidents or other emergencies, which can affect the CNG refuelling, station
 - e) Civil emergencies
 - f) Any other risk arising from the existence or use of the CNG refuelling station.
- 20.2 The above emergency plan shall be disseminated amongst all personnel involved and ensured that they understand their roles and responsibilities in the event of an emergency.
- 20.3 The operator of the refuelling station should have close liaison with Fire Service, the Police, the Municipal Authorities and the person supplying gas to CNG facility.
- 20.4 Important telephone numbers for emergency use shall be displayed prominently.
- 20.5 Means of communication shall be always at the disposal of the Incharge of the installation on 24 hours basis.
- 20.6 The emergency plan should be tested with drill atleast once a year.

21.0 TRAINING

- 21.1 The objective of training is to provide good understanding of all the facets of dispensing activities including operations, procedures, maintenance and hazards of CNG and the risks associated with handling of the product. Training shall ensure that the jobs are performed in accordance with the laid down procedures and practices.

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21.2 Training shall be imparted to the staff attached with the CNG dispensing station at the time of induction, which is to be followed up by periodic refresher courses once every year. The training programme shall inter alia cover following aspects:

- a) Hazardous characteristics of CNG.
- b) Familiarisation with operational procedures & practices.
- c) Commissioning of new facilities and equipment.
- d) Hands on experience on operation of equipment.
- e) Routine maintenance activities of the facilities.
- f) Knowledge of emergency and manual shut down systems
- g) Immediate and effective isolation of any CNG leak.
- h) Accounting of product
- i) Safety regulations and accident prevention.
- j) Fire fighting facilities, methods of fire fighting and its upkeep.
- k) Evacuation and safe egress of the vehicles.
- l) Housekeeping
- m) Safety in transportation of CNG.
- n) First aid.
- o) Emergency plan /drills
- p) Natural gas leakage possibility and its containment.
- q) Filling nozzles, types of gasket/ seal etc.
- r) Fitness of vehicles - Mandatory testing requirements of CNG cylinders fitted on Vehicles.

21.3 Appropriate training techniques shall be adopted which will include:

- a) Classroom training
- b) Hands on/ practical training
- c) Demonstration
- d) Case studies
- e) Training aids

21.4 Proper records for the training and refresher courses shall be maintained at the installation.

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REFERENCES

| S.No | Ref Code No. | Title |
|------|--|---|
| 1 | GCR 2004 | Gas Cylinder Rules 2004 under The Explosives Act 1884 of Govt of India |
| 2 | IS 15958 (2012) | Compressed Natural Gas (CNG) for Automotive Purposes -Specification |
| 3 | IS 15320-1 (2012): ISO 15403-1 : 2006 | Natural Gas – Natural Gas for use as a Compressed Fuel for Vehicles, Part 1: Designation of the Quality |
| 4 | IS 7285-1 (2004): | Refillable Seamless Steel Gas Cylinders, Part 1: Normalized Steel Cylinders |
| 5 | IS 7285-2 (2004): | Refillable Seamless Steel Gas Cylinders, Part 2: Quenched and Tempered Steel Cylinders with Tensile Strength Less Than 1 100 MPa (112 kgf/mm ²) |
| 6 | IS 1642 (1989): | Code of practice for fire safety of buildings (general): Details of construction |
| 7 | IS 875- Part 1 to 5 (1987): | Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures |
| 8 | IS 1893 (Part 1) 2002 | Criteria for Earthquake Resistant Design of Structures, |
| 9 | IS 800 | General Construction In Steel |
| 10 | IS:5571 | Guide for selection of electrical equipment for hazardous areas |
| 11 | IS:5572 | Classification of Hazardous areas (other than mines) having flammable gases and vapours for electrical equipment. |
| 12 | IS/IEC 60079- (2007): | Explosive Atmospheres, Equipment Protection |
| 13 | NFPA 12 | Standard on Carbon Dioxide Extinguishing Systems |
| 14 | NFPA 17 | Standard for Dry Chemical Extinguishing Systems |
| 15 | NFPA 52 | Vehicular Gaseous Fuel Systems Code |
| 16 | ISO 11439:2013 | Gas cylinders - High pressure cylinders for the on-board storage of natural gas as a fuel for automotive vehicles |
| 17 | ISO 11119-1 | Gas cylinders--Gas cylinders of composite construction--Specification and test methods--Part 1: Hoop-wrapped composite gas Cylinders |
| 18 | ISO 11119-2 | Gas cylinders—Gas cylinders of composite construction—Specification and test methods—Part 2: Fully wrapped fibre reinforced composite gas cylinders with load-sharing metal liners |
| 19 | ISO 11119-3 | Gas cylinders of composite construction - Specification and test methods - Part 3: Fully wrapped fibre reinforced composite gas cylinders with non-load-sharing metallic or non-metallic liners |
| 20 | ISO 11120 | Gas cylinders - Refillable seamless steel tubes of water capacity between 150 L and 3000 L Design, construction and testing |
| 21 | EN 12245 | Transportable gas cylinders - Fully wrapped composite cylinders |
| 22 | EN 12257 | Transportable gas cylinders - Seamless, hoop-wrapped composite cylinders |
| 23 | CGA TB-25 | Design Considerations For Tube Trailers |
| 24 | NZS5425: Part 1:1980 | Code of Practice for CNG Compressor and Refuelling Stations Part 1: On Site Storage and Location of Equipment. |
| 25 | NZS5425: Part 2:1982 | Code of Practice for CNG Compressor and Refuelling Stations Part 2: Compressor Equipment. |
| 26 | Petroleum Rules 2002 | The Petroleum Rules 2002 under Petroleum Act 1934, Govt of India |
| 27 | CCOE Guidelines | Chief Controller of Explosives, Govt. of India, for CNG Refuelling Stations. |
| 28 | ISO 6346 | Coding, Identification and Marking of Containers: International Container Bureau (BIC). |
| 29 | OISD-STD-105 | Work Permit system |
| 30 | NGV 1 | Compressed Natural Gas Vehicle (NGV) Fueling Connection Devices |
| 31 | NGV 4.1 | Dispensing Systems |

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| 32 | NGV 4.2 | Hoses for Natural Gas Vehicles and Dispensing Systems |
| 33 | NGV 4.4 | Breakaway Devices for Natural Gas Dispensing Hoses and Systems |
| 34 | ISO 14469-2 | Road vehicles - Compressed natural gas (CNG) refuelling connector - Part 2 |

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