

## **AIS-028**

### **CODE OF PRACTICE FOR USE OF GASEOUS FUELS IN INTERNAL COMBUSTION ENGINE VEHICLES**

### **REVISION-I PART C (OFF-HIGHWAYAPPLICATION)**

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**Status chart of the Standard to be used by the purchaser for updating the record**

<b>Sr. No.</b>	<b>Corrigenda</b>	<b>Amendment</b>	<b>Revision</b>	<b>Date</b>	<b>Remark</b>	<b>Misc.</b>
<b>GeneralRemarks:</b>						

## **INTRODUCTION**

**(To be included)**

The Government of India felt the need for a permanent agency to expedite the publication of standards and development of test facilities in parallel when the work on the preparation of the standards is going on, as the development of improved safety critical parts can be undertaken only after the publication of the standard and commissioning of test facilities. To this end, the erstwhile Ministry of Surface Transport (MOST) has constituted a permanent Automotive Industry Standards Committee (AISC) vide order No. RT-11028/11/97-MVL dated September 15, 1997. The standards prepared by AISC will be approved by the permanent CMVR Technical Standing Committee (CMVR-TSC). After approval, the Automotive Research Association of India, (ARAI), Pune, being the Secretariat of the AIS Committee, will publish this standard. For better dissemination of this information ARAI may publish this document on their Web site.

**Revision I** Part C of AIS-028 is prepared to include safety and procedural requirements for type approval of mono-fuel CNG/ Dual fuel / Dedicated dual fuel CNG / BIO-CNG/ LNG operated Construction equipment vehicles.

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<b>CODE OF PRACTICE FOR USE OF GASEOUS FUEL IN CONSTRUCTION EQUIPMENT VEHICLES</b>	
<b>1.0</b>	<b>SCOPE</b>
1.1	This part of the standard is applicable to the Construction equipment vehicles (CEV's) fitted with Dedicated/Dual fuel/bi-fuel internal combustion engines operating on GASEOUS Fuel systems.
1.2	It is not intended to cover the areas where major structural modifications are to be carried out to the vehicle (major structural modifications are those not defined in 1.3). In case of retrofitment, prior to commencement of such work guidance <b>may</b> be sought from the vehicle manufacturer.
1.3	<p>Any alterations or modification to any vehicle to install equipment shall be carried out in accordance with sound engineering practices and in compliance with Central Motor Vehicles Act, 1988, Central Motor Vehicles Rule, 1989 and their amendments and notifications issued.</p> <p>The following aspects shall be taken into consideration during alteration or modification:</p> <p>Where modifications are made to:</p> <p>(a) Suspension: mounting locations, geometry, ground clearance adjustment, axles and sub-axles, or steering mechanism;</p> <p>(b) Original fuel storage: the fuel tank assembly, fuel tank mounting, venting or filler assemblies;</p> <p>NOTE – In some instances the fuel tank constitutes a structural member of the vehicle.</p> <p>(c) Vehicle structure: Holes greater than 13 mm shall not be located within 40 mm of the edge of a panel, welded joint or direct load bearing point (such as a belt anchor). The only holes permitted greater than 13 mm diameter are of the installation of the filling valve or for venting purposes;</p> <p>(d) Braking system including the hand brake and its component;</p> <p>In this aspect, design guidelines supplied by vehicle manufacturers, vehicle safety standards or relevant standard, wherever applicable shall be referred.</p> <p>(e) Any alteration that hinder/obstruct the intended operation of the vehicle;</p>

1.4	<p><b>APPROVED EQUIPMENT</b></p> <p>Only equipment and systems approved by the relevant Test Agency as listed under CMV Rule no 126 shall be used.</p>
1.5	<p><b>DEFINITIONS</b></p> <p>Refer AIS-028 Part-A version 6 as amended from time to time for definitions.</p>
1.6	<p><b>SPECIAL REQUIREMENTS</b></p> <p>The fitment of a GASEOUS fuel system shall be prohibited in any vehicle with a passenger compartment heating system, which draws air from the engine compartment unless the heating system is made inoperable and gas-tight to the passenger compartment.</p>
<b>2.0</b>	<b>CYLINDER</b>
2.1	<b>DESIGN APPROVAL</b>
2.1.1	Cylinders shall be approved / endorsed by the PESO as per Gas Cylinder Rules, 2016 as amended from time to time.
2.1.2	The weight of the GASEOUS cylinder(s) will affect the unladen weight of the vehicle and therefore consideration of the effect on the legal and manufacturer's rating and axle loadings should be considered.
2.1.3	In no circumstances, vehicle's critical load distribution affecting safety considerations shall be compromised.
2.1.4	Cylinders shall be re-tested as per Gas Cylinder Rules, 2016, as amended from time to time.
2.2	<b>FITTINGS ON CYLINDERS AND FILLING CONNECTION</b>
2.2.1	<p><b>Cylinder valve</b></p> <p>Each cylinder shall have a manual cylinder shut off valve mounted directly on it capable of shutting off all gas flow from that cylinder. Cylinders and shut-off valve assemblies shall be approved / endorsed by the PESO, as per Gas Cylinder Rules, 2016, as amended from time to time.</p>
2.2.1.1	Following Accessories fitted to the LNG tanks as approved / endorsed by PESO
2.2.1.1.1	<b>Automatic valve</b>

	<p>An automatic valve shall be installed in the fuel supply line, either directly on every LNG tank (in a protected position) or as close as practicable after the vaporizer in the LNG system.</p> <p>The automatic valve shall be operated such that the fuel supply is cut off when the engine is switched off, irrespective of the position of the ignition switch, and shall remain closed while the engine is not running. A delay of 2 seconds is permitted for diagnostic.</p>
2.2.1.1.2	<p><b>Excess flow valve</b></p> <p>The excess flow valve can be fitted inside or directly on the LNG tank (in a protected position).</p>
2.2.1.1.3	<p><b>Pressure relief valve (primary)</b></p> <p>The primary pressure relief valve outlet shall be connected to an open ended pipe-away system to move vented gas away to a high level. Consideration shall be given to preventing any blockage or freezing of the pipe-away. The LNG primary relief valve shall not vent into the gas tight housing (if fitted).</p>
2.2.1.1.4	<p><b>Pressure relief valve (secondary)</b></p> <p>The secondary relief valve may relieve gas immediately from its outlet. Protection from water ingress and damage shall be considered. The secondary relief valve outlet shall not be connected to the same pipe-away as the primary relief valve.</p> <p>The LNG secondary relief valve shall not vent into the gas tight housing (if fitted).</p>
2.2.1.1.5	<p><b>Manual fuel shut off valve</b></p> <p>The manual fuel shut off valve shall be mounted directly on the LNG tank (in a protected position). It should be readily accessible. The manual fuel shut off valve can be integrated into the automatic valve.</p>
2.2.1.1.6	<p><b>Manual vapour shut off valve</b></p> <p>The manual vapour shut off valve shall be mounted directly on the LNG tank (in a protected position). It should be readily accessible.</p>
2.2.1.1.7	<p><b>Vent line or connector</b></p> <p>The vent line or connector may be mounted inside or on the LNG tank (in a protected position). It should be readily accessible. The</p>

	vent connector shall be suitable for the purpose at temperatures indicated in Annex 50 of ECE R110 for the working pressure of the LNG tank.
2.2.1.1.8	<p><b>Venting management system</b></p> <p>The primary pressure relief valve shall be piped to a vent stack which extends to a high level. The primary and secondary relief valve outlets shall be protected from fouling by dirt, debris, snow, ice and/or water. The vent stack shall be sized to prevent flow restriction due to pressure drop. Gas exiting the vent stack or secondary relieve valve shall not impinge on enclosed areas, other vehicles, exterior-mounted systems with air intake (i.e. air-conditioning systems), engine intakes, or engine exhaust. In the case of dual tanks, the primary relief valve outlets piping for each tank may be manifold to a common stack.</p>
2.2.2	<p><b>Filling Connection</b></p> <p>The filling connection shall be of the NZS/NGV-1 or any other type as specified by the Government of India from time to time for CNG /Bio CNG vehicles. It is mandatory to use Automatic CNG/Bio CNG Cylinder Valve with Pressure Relief Device (PRD) as approved / endorsed by PESO under Gas Cylinder Rules, 2016 as amended from time to time.</p> <p>The basic dimensions for NZS type are as given in Appendix D and recommended sizes of NGV – 1 type of filling connection are SAE 9/16” and 7/8”. However, the vehicle manufacturer / kit installer may seek the guidance from The Gas Authority of India Ltd. / Ministry of Petroleum and Natural Gas about the use of specific type of NGV – 1 nozzle.</p> <p>In case of LNG, the refilling receptacle shall be as per ECE R 110 or equivalent standard, The LNG filling receptacle shall be made out of non-sparking material and should comply with the no igniting evaluation tests described in ISO 14469-1:2017 or equivalent standard. However, the vehicle manufacturer / kit installer may seek the guidance from PESO / Ministry of Petroleum and Natural Gas about the use of specific type of LNG receptacle.</p>
2.2.3	The NZS type filling connection shall be provided with a captive dust plug and NGV-1 type filling connection shall be provided with dust protection cap.



2.2.4	<p><b>Position of filling connection</b></p> <p>The filling connection shall be located in suitably protected and ventilated location, usually the engine compartment. In case of LNG both tank mounted and remote mounted options of LNG receptacles shall be allowed. Remote mounted receptacle shall be permitted in case of multi tank vehicle configuration. It shall comply with the following:</p>
	(a) The filling is to be supervised from outside the vehicle.
	(b) The filling connection is protected by being located in a recess below the surface of a body panel, or by being located so that equivalent protection is provided by the construction of the vehicle.
	<p>(c) The filling connection shall be attached in such a manner as to resist, without permanent deformation of the mounting attachment, a proof load of 50 kgf applied in the forward and reverse directions of travel of the vehicle.</p> <p>The proof load shall be applied by full engagement of the filling connection and shall be representative of attempted movement of the vehicle while refueling.</p>
	(d) The filling operation can be carried out without requiring the operator to lie or crawl under the vehicle or be otherwise subjected to inconvenience, discomfort or hazard.
2.2.5	<p><b>Refueling Interlock Device (Not applicable to LNG vehicle)</b></p> <p>Filling connections shall be fitted with a system that prevents the engine starting when the dust plug or dust protection cap is removed. This system shall isolate the starting device of the vehicle. Any other system that isolates the engine starting shall be considered.</p>
2.2.6	<p><b>Non-return valve/ Check valve</b></p> <p>There shall be a non-return valve fitted on the refueling line to prevent the return flow of gas from the cylinder to the filling connection. The non-return valve shall be located as close to the filling connection as it is practicable.</p> <p>In case LNG, the check valve shall meet the requirements of ECE R110 or equivalent standard.</p>
2.2.7	<p><b>Excess flow valve</b></p> <p>A device may be fitted in the fuel line preferably at the outlet of the cylinder valve which prevents the total contents of the</p>

	<p>cylinder from discharging to atmosphere in the event of rupture to any part of the fuel line or components.</p> <p>In case LNG, the excess flow valve shall meet the requirements of ECE R110 or equivalent standard</p>
2.2.8	<p><b>Diesel Fuel cut off</b></p> <p>A device/mechanism to be provided in the Dual fuel system for cutting of the diesel supply while filling GASEOUS fuel in the vehicle.</p>
2.3	<p><b>Location, Ventilation and Mounting of Cylinders</b></p>
2.3.1	<p>Cylinder shall be mounted in a protected location inside the perimeter of the vehicle. Cylinders shall not be located so that the vehicle driving characteristics are adversely affected.</p> <p>Note: A cylinder shall not be fitted in any internal location when a suitable external location is available.</p>
2.3.2	<p>Provisions on components fitted to the LNG tank approved by PESO.</p>
2.3.2.1	<p>The LNG tank shall be equipped at least with the following components, which may be either separate or combined (special care shall be taken to prevent LNG trapping):</p> <ul style="list-style-type: none"> <li>Pressure relief valve;</li> <li>Manual valve;</li> <li>Automatic valve;</li> <li>Excess flow device.</li> </ul> <p>The tank may be equipped with a gas-tight housing, wherever necessary.</p>
2.3.2.2	<p><b>Leakage and venting from LNG tanks</b></p> <p>In the case of LNG tanks are located in enclosed spaces for extended periods of time (e.g. for service), leakage and venting of natural gas (or other flammable substances) from the tank shall be dealt with properly to avoid the dangers due to releasing flammable substances in enclosed spaces.</p>
2.3.2.3	<p>Reserved.</p>
2.3.2.4	<p><b>LNG Tank supports</b></p> <p>The manufacturer shall specify the means by which the tank(s) shall be supported for installation on vehicles. The manufacturer shall also supply installation instructions, including maximum clamping force and torque to not cause unacceptable stress in the tank or damage to the tank surface.</p>

2.3.3	Cylinder shall not be fitted in any position behind the driver seat (seat adjusted to rear most position), which will hinder the driver seat adjustment unless specifically approved by the testing agency.
2.3.3.1.	<b>For internally mounted cylinders:</b>
	<p>Where a cylinder is located within the operator cabin of a vehicle, either:</p> <p>(a) The whole body of the cylinder together with its attached components and fittings shall be enclosed in a compartment; or</p> <p>(b) The valves and pipe connections associated with or attached to the cylinder shall be enclosed in a localized sub-compartment, which is attached to the cylinder and vented to the atmosphere.</p> <p>Provision shall be made for ready access to the cylinder valve in all installation arrangements.</p>
2.3.3.2.	<b>For externally mounted cylinders</b>
2.3.3.2.1	<p>In no case shall cylinder valves be positioned less than 200 mm from the extremities of the vehicle unless they are protected to minimize the possibility of damage due to collision, overturning or other accident.</p> <p>Where the operation of the vehicle is such, that the cylinder will be subjected to impact damage from loose metal or other objects being thrown up from the road, effective shielding against these shall be provided.</p>
2.3.3.2.2	The cylinder shall be situated and vented so that any gas escaping due to leakage from the cylinder valve shall not enter the vehicle operator compartment.
2.3.3.3	<b>Vehicle mounted cylinders</b>
2.3.3.3.1.	A cylinder installed in a vehicle shall be permanently mounted and filled in that position.
2.3.3.3.2.	<p><b>Cylinder location ground clearance</b></p> <p>Cylinders shall be located in accordance with all the following requirements:</p> <p>(a)The vehicle mass for determining ground clearance shall be the unladen mass, including permanent attachments to the vehicle with all fuel, water and oil containers full.</p>

	<p>A fuel cylinder shall be installed with as much ground clearance as is practicable, but never less than the minimum ground clearance of the vehicle in the vicinity of the cylinder. This minimum clearance shall be measured to the bottom of the cylinder or the lowest cylinder fitting.</p>
	<p>(b) Cylinders installed between and behind axles shall not be lower than the lowest of the following points and surfaces forward of the cylinder (refer figure 2)</p> <ul style="list-style-type: none"> <li>(i) The lowest structural component of the body;</li> <li>(ii) The lowest structural component of the frame or sub-frame, if any;</li> <li>(iii) The lowest point of the engine;</li> <li>(iv) The lowest point on the transmission (including the clutch housing or torque converter housing as applicable) but excluding differential housings.</li> <li>(v) The original fuel tank or tanks and or brackets;</li> <li>(vi) Approach and departure clearances shall be below planes defined in figure 2;</li> </ul> <p>NOTE- Suspension spring U bolts are not classified as structural components</p> <p>(vii) In any case the lowest point of the cylinders shall not be lower than a horizontal line taken at the lowest point of the front and rear wheel rims (line AB in Figure 2).</p>
	<p>(c) All clearances shall be measured to the bottom of the cylinder or to the lowest fitting, support or attachment on the cylinder or cylinder housing, whichever is lowest.</p>
2.4	<b>Construction of compartments and sub-compartments</b>
2.4.1	A cylinder compartment or sub-compartment shall comply with the following requirements:
	<p>(a) Construction shall be such that any gas which might leak from any fittings, component or piping, cannot pass to any other enclosed compartment, passenger space or goods space of the vehicle</p>
	<p>(b) When a sub-compartment has been subjected to hydrostatic internal pressure of 30 kPa applied for 5 min, sealing materials or gaskets shall not be displaced or otherwise lose integrity during the test.</p>
	<p>(c) Hatches, covers, or construction joints, which may need to be opened or dismantled during maintenance or inspection, shall be capable of being opened at least 10 times without adverse effects on durability. Hinges and locking devices of hatches and covers shall be</p>

	designed to prevent the dislodgment of the hatch or cover when in the closed and locked position.
	(d) The construction shall be such that when subjected to a pushing force of 60 kgf, applied at any point on any external face of the sub-compartment, any resultant damage shall not be of a nature to permit gas leakage in the event of pressure testing as in (b) above. The pushing force shall be applied by a measuring instrument having a flat circular face of 20 mm diameter.
	<p>(e) It shall be possible to operate the cylinder service shut-off valve in the installed position. The valve may be arranged so that it can be operated from some internal area of the vehicle provided that the sealing of the compartment or sub-compartment shell is maintained by one of the following means, as appropriate:</p> <ul style="list-style-type: none"> <li>(i) If a valve actuating device passes through the shell a gas-tight seal shall be provided;</li> <li>(ii) If the actuating handle is wholly within the shell, access shall be a gas-tight captive hatch. The design shall not need tools to open the hatch;</li> </ul>
	<p>(f) A compartment or sub-compartment shall not contain ignition sources or electrical equipment or wiring unless it is intrinsically safe.</p> <p><b>NOTE</b> – Items (b), (c) and (d) are intended to be the basis of approval for proof of design.</p>
2.4.2	<p><b>Ventilation</b></p> <p>One or more vents to the outside of the vehicle shall be provided, the aggregate area of which is not less than 550 mm<sup>2</sup>. The vents shall be so located as to exhaust any gas, which may accumulate in the compartment or sub-compartment to atmosphere and shall exit not less than 75 mm from an exhaust pipe or other heat source. (Refer also to 2.4.3 (c)). Holes for venting shall be positioned not less than 40 mm from the edge of a panel or a welded joint or direct load bearing point (refer also to 1.3 (c)).</p>
2.4.3	<b>Ducting</b>
2.4.3.1	All piping or hoses that pass through an enclosed area of the vehicle shall be within a conduit gas-tight from the vehicle interior, vented unobstructed to outside atmosphere and protected from external damage and shall comply with the following requirements:
	(a) The ducting shall be as short as practicable.
	(b) The connections shall be mechanically clamped and shall not

	depend on adhesives or sealing compounds to retain them in place. Protection in the form of a gasket shall be provided to prevent damage to the ducting material by the clamping device.
	<p>(c) The material of the conduit used for ducting shall be sufficiently strong to resist mechanical damage, preserve venting integrity, protect the piping or hose within it, shall not support combustion and shall meet the following minimum criteria:</p> <ul style="list-style-type: none"><li>(i) The conduit shall withstand an internal pressure of 30 kPa;</li><li>(ii) The conduit shall not suffer sufficient damage to permit leakage when tested by applying a 60 kgf static force applied through 20 mm diameter, in the following manner-<ul style="list-style-type: none"><li>(1) Applied to a free length of conduit (minimum length of 500 mm);</li><li>(2) With the conduit connection clamped up in position the force then applied 5 mm from the end of this coupling so as to place the connection in tension;</li></ul></li><li>(iii) Flammability. The material shall conform to SAE J 369a class SE/NBR;</li><li>(iv) Presence of resistance to ultraviolet degradation agent shall be confirmed;</li></ul> <p>NOTE – Item (c) shall be the basis of approval for proof of design of the conduit.</p>
2.4.3.2	<p><b>Pliable material</b></p> <p>A sub-compartment may be constructed of pliable material attached to the cylinder so that the cylinder valve, piping and connections are contained within the sub-compartment.</p> <p>The pliable material shall meet the requirements of this clause and shall be clearly marked accordingly.</p>
2.4.3.3	<p>Where the sub-compartment is removed to initiate repairs or at the periodic inspection special attention shall be given to the inspection of the material to ensure that no degradation of material has taken place.</p> <p>Any sub-compartment showing signs of degradation shall be replaced.</p>
2.4.3.4	<p>The cylinder valve actuating device position shall be clearly identified and shall have provided adequate material to allow closing of the valve without damage to the sub-compartment sealing.</p>
2.4.3.5	<p>The pliable sub-compartment shall be shielded or installed in a</p>

	<p>protected location to prevent damage, from unsecured objects and abrasion and:</p> <p>(a) The material shall be sufficiently strong to resist mechanical damage, preserve venting integrity, shall not support combustion and shall meet the following minimum criteria:</p> <p style="padding-left: 40px;">(i) Resistance to cold cracking. The material shall withstand a bend of 180° applied within 0.5 seconds around a 6 mm diameter former at temperature of –35°C without cracking.</p> <p style="padding-left: 40px;">(ii) Flammability. The material shall conform to SAE J369a class SE/NBR.</p> <p style="padding-left: 40px;">(iii) Presence of resistance to ultraviolet degradation agent shall be confirmed.</p> <p>NOTE – Item (a) shall be the basis of approval for proof of design.</p>
<b>2.5</b>	<b>Roof Strength test</b>
2.5.1	<p>Load test</p> <p>In case the cylinders are fitted on roof, the roof of the cabin shall withstand a static load corresponding to the 10 times the filled capacity of a highest weight of the cylinder.</p> <p>This load shall be distributed uniformly over all the bearing members of the roof structures where fitted by means of a suitably shaped rigid former.</p> <p>The load test shall be carried out for 90 sec with cylinders in fully mounted position on the roof. <b>Add pass-fail criteria of the test – to be added by ICAT</b></p>
2.5.1.1	For CNG cylinders
2.5.1.1.1	Cylinders shall be securely attached to the vehicle to prevent slipping, rotating and jarring loose, in accordance with the following requirements:
	(a) The method of attachment shall not cause undue stresses or wear in the cylinder shell;
	(b) The mounting method shall not significantly weaken the vehicle structure, and reinforcement shall be added where necessary to ensure compliance with (c) below. An air gap of not less than 5 mm shall be provided between the cylinder and vehicle structure;
	(c) The force necessary to separate the cylinder from the vehicle shall

	<p>not be less than 20 times the mass of the full cylinder along longitudinal and transverse axis.</p> <p>The strength of the anchorages may be established by static test (forces directed through the centre of mass of the cylinder).</p>															
2.5.1.1.1.1	<p>If the testing as per clause 2.5.1.1.1 is not feasible / impracticable ,following design requirements shall apply:</p> <p>(i) There shall be at least 4 points of attachment to the vehicle structure. The spacing between these shall be sufficient to ensure the stability of the cylinder.</p> <p>(ii) Where a cylinder is anchored to steel sheet metal the sheet metal shall be reinforced by a plate of not less than 3600 mm<sup>2</sup> and a thickness of not less than 2.5 mm or appropriate thickness supported by the calculation or test report. It is preferred that a round washer be used but where a square plate is fitted the corners shall be radiused. Any such reinforcement plate/washer shall be contoured to the shape of the sheet metal or chassis rail.</p> <p style="text-align: center;"><b>Table 1</b></p> <table><tr><th>Cylinder size (water capacity in ltrs.) Over, up to and including L</th><th>Band dimensions – Minimum nominal size (mm)</th><th>Bolt or stud diameter for strap or flange mountings minimum nominal size (mm)</th></tr><tr><td>0 -30</td><td>30 x 2</td><td>10</td></tr><tr><td>30-100</td><td>30x3</td><td>10</td></tr><tr><td>100 150</td><td>50 x 6</td><td>12</td></tr><tr><td>Above 150</td><td>Specific design required</td><td>--</td></tr></table> <p>(iii) Where anchorage bolts pass through a hollow section, provision shall be made to prevent collapse of that section under load.</p> <p>(iv) Anchorage bolts or studs shall have a diameter not less than that shown in Table 1 and shall conform to strength grade 8.8, IS: 1364 or equivalent ISO:4014 with nuts to IS:1364 or ISO:4032.</p> <p>(v) Where clamping bands are used, at least two steel bands per cylinder shall be provided, the dimensions, of which shall not be less than those in Table 1.</p> <p>To prevent possibility of external corrosion where clamping bands are used a non-moisture retaining hard rubber or equivalent material shall be provided on the inner side of the bands. Similar adequate protection to the cylinder shall also be provided wherever the cylinder rests against other metal objects such as the mounting frame.</p> <p>(vi) Where the attachment is by means of clamping bands there shall be a positive means of resisting end loads on the cylinder by means of providing suitable end stoppers (Except for transverse mounted</p>	Cylinder size (water capacity in ltrs.) Over, up to and including L	Band dimensions – Minimum nominal size (mm)	Bolt or stud diameter for strap or flange mountings minimum nominal size (mm)	0 -30	30 x 2	10	30-100	30x3	10	100 150	50 x 6	12	Above 150	Specific design required	--
Cylinder size (water capacity in ltrs.) Over, up to and including L	Band dimensions – Minimum nominal size (mm)	Bolt or stud diameter for strap or flange mountings minimum nominal size (mm)														
0 -30	30 x 2	10														
30-100	30x3	10														
100 150	50 x 6	12														
Above 150	Specific design required	--														



	<p>cylinders).</p> <p>(vii) Screwed fasteners or clamping devices shall either be inherently resistant to loosening or be locked or pinned after tightening.</p>
2.5.1.2	<p>For LNG Cylinders</p> <p>LNG Cylinder installation guidelines (ref Fig 5)</p> <p>Mounting of LNG Tank :</p>
2.5.1.2.1	<p>The manufacturer shall specify the means by which the tank(s) shall be supported for installation on vehicles. The manufacturer shall also supply installation instructions, including maximum clamping force and torque to not cause unacceptable stress in the tank or damage to the tank surface.</p> <p>Installation instructions shall be provided to ensure that the cylinders will not suffer unacceptable damage during installation and during normal operation over the intended service life.</p>
2.5.1.2.2	<p>Where the mounting is specified by the manufacturer, the instructions shall contain where relevant, details such as mounting design, the use of resilient gasket materials, the correct tightening torques and avoidance of direct exposure of the cylinder to an environment of chemical and mechanical contacts.</p>
	<p>a. Where the mounting is not specified by the manufacturer, the manufacturer shall draw the Installer's attention to possible long term impacts of the vehicle mounting system, for example: vehicle body movements and cylinder expansion/contraction in the pressure and temperature conditions of service.</p>
	<p>b. The container and/or tank shall be permanently installed in the vehicle and shall not be installed in the engine compartment</p>
	<p>c. The container and/or tank shall be installed such that there is no metal to metal contact, with the exception of the fixing points of the container(s) and/or tank(s).</p>
	<p>d. When the vehicle is ready for use the fuel container and/or tank shall not be less than 200 mm above the road surface. This shall not apply if the container and/or tank is adequately protected, at the front and the sides and no part of the container is located lower than this protective structure.</p>
	<p>e. The LNG fuel container(s) and/or tank(s) shall be mounted and fixed so that the following accelerations can be absorbed (without damage occurring) when the container(s) and/or tank(s) are full:</p> <ul style="list-style-type: none"> <li>(i) 6.6 g in the direction of travel;</li> <li>(ii) 5 g horizontally perpendicular to the direction of travel.</li> </ul>

	A calculation method can be used instead of practical testing if its equivalence can be demonstrated by the applicant for approval to the satisfaction of the Testing Agency.
2.5.2	<p><b>Cylinder manifolding</b></p> <p>Where more than one cylinders is fitted to a vehicle it is preferable the cylinders be manifolded together in such a way that all can be simultaneously filled from any fill point on the vehicle. Each cylinder shall retain its required individual cylinder valve</p>
2.5.3	<p>More than one cylinder</p> <p>Specific design may be required for the mounting attachment. Refer also 1.3.</p>
2.5.4	Cylinder identification markings should be capable of being read when in the installed position.
2.6	<b>Shielding</b>
2.6.1	Cylinders shall be installed to ensure that valves and connections on cylinders shall be protected to minimize the possibility of damage due to accidental contact with stationary objects or from loose objects thrown up from the road. Valves shall be protected to minimize the possibility of damage due to collision, overturning, or other accident. Parts of the vehicle may be used to provide such protection to valves and fittings.
2.6.2	Shielding – Temperature/pressure tests
2.6.2.1	The electric wiring employed in the construction of vehicles shall not be damaged by the temperatures attained during normal operation.
2.6.2.2	<p>The test measurement shall be carried out after <b>two hours</b> of running-in as per the duty cycle as declared by the manufacturer or at 80% of the max speed.</p> <p>The maximum temperature rise over the ambient on the surface of any combustible material of electrical insulation shall not exceed 150 ° C.</p> <p>The temperature measurement shall be recorded at minimum 5 different points. Measurement points can be identified based on the electric circuit diagram submitted.</p> <p>Recommended points :</p> <ol style="list-style-type: none"> <li>1.Engine compartment</li> <li>2.Operator cabin</li> <li>3. Under body</li> <li>4. or any other exposed part</li> </ol>

	Test agency may include additional point(s) for measurement.
<b>3.0</b>	<b>GASEOUS FUEL LINE</b>
<b>3.1</b>	<b>GASEOUS fuel line - High &amp; Low pressure fuel line</b>
3.1.1	<p>For CNG/BIO-CNG: Rigid piping and connections for use with pressures exceeding 2.15 MPa shall comply with IS 15716.</p> <p>For LNG : Rigid piping which coming in contact with cryogenic gas (subjected to Tank pressure) shall meet requirements ECE R 110 or equivalent standard.</p> <p>Any LNG fuel line downstream of the heat exchanger/vaporizer is suitable of being treated as CNG fuel lines.</p> <p>LNG rigid pipeline after heat exchanger/ vaporizer shall meet requirements of IS: 15716 or equivalent standards.</p> <p>LNG rigid fuel lines shall be made of austenitic stainless steel or copper, either seamless or welded.</p> <p>LNG fuel line shall be insulated or protected in those areas where low temperature can damage other components and/or harm people. Bite-type compression joints are not permitted for LNG.</p>
3.1.2	<p>For CNG / BIO-CNG fuel line and connections for use with pressures exceeding 100 kPa but less than 2.15 MPa shall comply in accordance with IS 15722. <del>The material of the flexible hose made up of synthetic rubber or composite materials like fiberglass, PTFE (Teflon) and steel braiding shall meet the requirements of ISO 15500 or IS :15722 or equivalent standard, except testing on slab.</del> (TBD)</p> <p>For LNG flexible piping in contact with cryogenic gas shall meet requirements of ECE R110 or equivalent standard.</p> <p>Any LNG fuel line downstream of the heat exchanger/vaporizer is suitable of being treated as CNG fuel lines.</p> <p>LNG flexible pipeline after heat exchanger/vaporizer shall meet requirements of IS: 15722 <del>or equivalent standards.</del></p>
<b>3.1.3</b>	<b>Flexible hose exceeding 2.15 MPa</b>
3.1.3.1	<p>Flexible hose shall comply with IS 15718 <del>meet SAE 100R1 (except impulse loading test and testing on slab) or equivalent. Each flexible hose assembly shall be permanently and clearly marked with the manufacturer's name and trademark, type, size and design working pressure. It shall be identifiable as being suitable for CNG / BIO-CNG use either by marking it with "CNG / BIO-CNG" or with a</del></p>

	<p>specification mark.</p> <p>For LNG flexible piping hoses in contact with cryogenic gas shall meet requirements of ECE R110 or equivalent standard. It shall be identifiable as being suitable for LNG.</p> <p>Any LNG fuel lines downstream of the heat exchanger/vaporizer are suitable of being treated as CNG fuel lines.</p> <p>LNG flexible hoses after heat exchanger/ vaporizer shall meet requirements of IS: 15718.</p>
<b>3.1.3.2</b>	<b>Reserved</b>
<b>3.1.3.3</b>	<b>Installation</b>
3.1.3.3.1	The hose shall be supplied and fitted as a fully made up assembly and proof tested to not less than 27.5 MPa with fittings attached prior to installation.
3.1.3.3.2	In addition to the requirements of 3.1.5 of this part, flexible hose shall be installed in accordance with the following requirements: (The exception being the flexible hose used between the towed and towing vehicle)
	(a) The bend radius of the hose shall not be less than 35 mm or the manufacturer's recommended specifications.
	(b) Flexible hose shall be secured to the chassis frame or vehicle body by clips, secured at not more than 300 mm apart and shall be fitted prior to and after each bend.
	(c) Such clips shall be of sufficient resilience and secured to the vehicle in such a manner so as to prevent lateral movement and damage to the hose and not work loose.
	(d) The hose shall be located as far away as practicable from the exhaust system. In no case shall it be closer than 100 mm. Where the hose is situated between 100 mm and 200 mm from the exhaust, shielding shall be provided which shall take the form of one piece of sheet metal located midway between the exhaust and fuel line.
<b>3.1.3.4</b>	<b>Inspection</b>
3.1.3.4.1	At the time of periodic inspection, the hose shall be inspected for twists, kinks and damage or abrasions to the cover, which expose the wire. The hose shall be condemned on detection of any one of these defects
3.1.3.4.2	At no time shall flexible hose be placed back into service after removal

	from the vehicle, the exception being flexible hose designed for and used between the towed and towing vehicle.
<b>3.1.4</b>	<b>Joints and connections</b>
3.1.4.1	Every joint or connective fitting in rigid high pressure fuel line shall be tested for minimum test pressure of 70 MPa without leakage or failure.
3.1.4.2	The number of joints and connections shall be the minimum for the inclusion of all components.
3.1.4.3	Joints or connections in a GASEOUS fuel line shall be in accessible positions for easy inspection.
3.1.4.4	Connection means shall provide positive retention of the fuel line in the fitting (e.g. by double inverted flaring of the tube end).
<b>3.1.5</b>	<b>Securing and location</b>
3.1.5.1	High pressure piping and hoses in vehicles shall comply with the following:
	(a) No GASEOUS fuel line inside the part of any vehicle occupied by the driver or passenger shall be outside the sealed and vented enclosure (except as provided for in 2.4.3)
	(b) All CNG / BIO-CNG/ LNG fuel lines shall be positioned for protection from the possibility of damage by impact, accident or loose objects thrown by the vehicle wheels/tyres. Parts of the vehicle may be used to provide such protection.
	(c) GASEOUS fuel lines shall not be located inside box sections or in other inaccessible locations nor shall they be installed in any location, which is not adequately protected from sources of heat, abrasion, or from impact.
	(d) Use of the drive shaft tunnel for fuel line location is not desirable or recommended. If such routing is the only possible practicable method of installation, the fuel line must be positioned along the lower corner of the tunnel with the underside of the fuel line not more than 15 mm above the intersection with the floor pan. The fuel line should follow this route for the shortest distance possible. The fuel line shall have a minimum clearance of 40 mm with the drive shaft under all operating conditions. This method is not applicable to vehicles where the open axle shaft passes through a tunnel.
	(e) Use of the wheel arch for fuel line location is not desirable or recommended.

	(f) Fuel lines shall follow the shortest practical route taking into account the requirements of 3.3.2.
	(g) Rigid fuel lines shall be effectively secured to the chassis frame or vehicle body by clips spaced not more than 300 mm apart for 2 and 3 wheeler and 600 mm apart for other vehicles. In order to prevent the possibility of fretting corrosion or erosion of the fuel line cushioning must be provided to protect the fuel line from both the chassis/body and the clips themselves. Suitable grommets must be provided where the fuel line passes through any body panel.
	(h) Manifolds used in multi-cylinder applications shall be installed in a protected location. Manifold branch pipelines shall be sufficiently flexible to prevent damage to the lines, valves and fittings due to vibration, expansion or contraction.
	(i) In no case shall the clearance between the exhaust system and the fuel line be less than 75 mm.
	(j) Fuel lines shall not be installed where any part will be permanently hidden from sight or cannot be inspected or easily replaced (except as provided for in 2.4.3). High pressure piping and hoses in vehicles shall comply with the following:
	(k) No GASEOUS fuel line inside the part of any vehicle occupied by the driver or passenger shall be outside the sealed and vented enclosure (except as provided for in 2.4.3)
	(l) All GASEOUS fuel lines shall be positioned for protection from the possibility of damage by impact, accident or loose objects thrown by the vehicle wheels/tyres. Parts of the vehicle may be used to provide such protection.
	m) GASEOUS fuel lines shall not be located inside box sections or in other inaccessible locations nor shall they be installed in any location, which is not adequately protected from sources of heat, abrasion, or from impact.
	(n) Use of the drive shaft tunnel for fuel line location is not desirable or recommended. If such routing is the only possible practicable method of installation, the fuel line must be positioned along the lower corner of the tunnel with the underside of the fuel line not more than 15 mm above the intersection with the floor pan. The fuel line should follow this route for the shortest distance possible. The fuel line shall have a minimum clearance of 40 mm with the drive shaft under all

	operating conditions. This method is not applicable to vehicles where the open axle shaft passes through a tunnel.
	(o) Use of the wheel arch for fuel line location is not desirable or recommended.
<b>3.2</b>	<b>GASEOUS fuel line - pressure not exceeding 100 kPa (low pressure fuel line)</b>
<b>3.2.1</b>	All CNG / BIO-CNG fuel lines for use for service pressure not exceeding 100 kPa (low pressure hose) shall comply with the following:
	<p>(a) Such low pressure fuel line shall be of flexible material complying with IS: 15722 or ISO 15500 or equivalent. Low pressure fuel line shall withstand test pressure as per IS 15722 the maximum pressure likely to be encountered in service and shall comply with 3.1.5.1(a) to (f) inclusive and (j). In case of LNG flexible piping which coming in contact with cryogenic gas shall meet requirements of ECE R110 or equivalent standard. It shall be identifiable as being suitable for LNG.</p> <p>LNG flexible hoses after heat exchanger/vaporizer shall meet requirements of IS: 15722 or equivalent standards.</p> <p>Any LNG fuel lines downstream of the heat exchanger/vaporizer is suitable of being treated as CNG fuel lines</p>
	(b) Joints and connections for low pressure fuel lines shall be suitable for use with CNG / BIO-CNG /LNG and capable of sustaining 5 times the maximum pressure likely to be encountered in service, and shall comply with 3.1.4.2 and 3.1.4.3.
<b>3.3</b>	<b>Flexibility</b>
<b>3.3.1</b>	Low pressure hose shall be of sufficient length to accommodate engine movement.
<b>3.3.2</b>	High pressure fuel line shall be installed so as to accommodate any relative movement between chassis/body and fuel system components or temperature variations in the fuel line.
<b>3.3.3</b>	All runs of rigid fuel line piping between any two components shall be installed with a 'pigtail' or U bend to provide this essential flexibility (Refer 3.3.2).
<b>4</b>	<b>GASEOUS CONTROL EQUIPMENT</b>
<b>4.1</b>	<b>Definition</b>
<b>4.1.1</b>	The GASEOUS fuel control equipment includes all the equipment

	<p>necessary to convert GASEOUS at high pressure at the cylinder to GASEOUS air mixer/injector for supply to the engine.</p> <p>In case of heavy motor vehicle, engine control equipment includes all the equipment used to convert a compression ignition engine to run on a Gaseous fuel. This includes devices such as fuel provision and control device, the ignition system (if one is used), the speed and/or load governing device (if any), and any engine protection devices such as temperature and pressure alarms, and knock detection systems.</p>
4.2	<b>Control Equipment</b>
4.2.1	<p>Filter</p> <p>At the termination of every CNG / BIO-CNG / LNG service fuel line immediately prior to any regulator component there shall be fitted a properly designed filter capable of removing all particulate matter from the fuel that could cause malfunction of such regulator components.</p>
4.2.2	GASEOUS shut-off valve
4.2.2.1	<p>This valve shall shut-off fuel supply to the engine when activated by the fuel change over control on dual fuel/ bi-fuel fuel operation and by the ignition switch on single fuel operation. Normally this is a regulator component but in any case it shall be located downstream of the filter.</p> <p>In case of LNG it shall meet the requirements of ECR R110 or equivalent standard. An automatic valve shall be installed either directly on the tank or as close as practicable after the vaporizer in the LNG system.</p> <p>This valve shall automatically shut-off the fuel supply to the engine unless the following conditions are satisfied:</p> <ul style="list-style-type: none"> <li>(a) The ignition is on;</li> <li>(b) The engine is turning;</li> </ul>
4.2.2.2	<p>Service shut-off valve</p> <p>A service shut-off valve shall be installed in the high pressure line between the cylinder valve and any other valve or component within the engine compartment and as close as practicable to the Regulator, however it is acceptable to install the valve at the refueling point. It shall be possible to readily operate the valve in the installed position at all times in particular during the refueling operation. A permanent label shall be provided 'CNG /BIO-CNG /LNG service shut-off valve' or similar wording to positively indicate its purpose and a positive indication of "Closed" and "Open" positions of the valve shall be clearly marked.</p>



4.2.3	Regulator system and LNG vaporizer/Heat Exchanger
4.2.3.1	The regulator system shall not permit gas to pass after the engine has stopped turning, irrespective of whether the ignition is on or off. The regulator shall be installed so that:
	(a) It is securely mounted as far as practical from the extremities of the vehicle
	(b) It is mounted securely and as close to the engine carburetor position as convenient.
	(c) It is easily accessible for routine maintenance, adjustment and inspection.
	(d) It is situated as far from the exhaust system as practical. Where this distance is less than 150 mm it shall be shielded from radiant heat and any impingement from exhaust gases due to exhaust system failure.
	(e) It is reasonably protected from impact in a collision.
	(f) It allows sufficient free movement of all hoses.
	(g) The water circulating system (where required) is connected in accordance with the manufacturer's instructions, and no flow control valve in the system can shut-off original equipment water flow.
	<p>(h) Where possible, the regulator should be at lower level than top of the radiator, as insufficient water may cause freezing. (Refer also Appendix E for precautions against freezing).</p> <p>(i) LNG Heat exchanger – vaporizer The LNG heat exchanger – vaporizer is the device used for vaporizing the cryogenic liquid fuel and to deliver gas to the engine with gas temperature in between -40 °C and +105 °C.</p> <p>The material constituting the LNG heat exchanger - vaporizer which is in contact with the CNG/LNG when operating shall be compatible with the test CNG/LNG. In order to verify this compatibility, the procedure in Annex 5D of ECE R110 shall be used.</p> <p>The LNG heat exchanger – vaporizer has to comply with the water jacket freezing test. Fill the part of the heat exchanger-vaporizer which normally contains an antifreeze solution, with water to normal capacity and expose it at -40 °C for 24 hours. Attach 1 m sections of coolant hose to the coolant inlet and outlet of the heat exchanger – vaporizer. Following the freezing conditioning, conduct an external</p>

	leakage test according to Annex 5B of ECE R 110 at room temperature. A separate sample may be used for this test.
4.2.3.2	The regulator assembly shall not be attached to the engine assembly unless otherwise specified by the manufacturer and then shall be fitted only in accordance with the manufacturer's recommended instructions.
4.2.4	The gas air mixer
4.2.4.1	<p>A backfire deflector to arrest back-fire shall be installed in the air intake immediately prior to the mixer. The backfire deflector shall meet the requirements of Appendix G of this standard.</p> <p>In case of heavy motor vehicle, there shall be installed in the air intake prior to the mixer a backfire deflector (original air filter acceptable). In turbo charged applications where rigid piping is fitted from the turbo charger to the intake manifold a pressure relief valve shall be fitted as close as practicable to the intake manifold. Where a volume of gas/air mixer, due to turbo charging or inter/after coolers is contained downstream of the mixer, special precautions will need to be applied to avoid damage to components downstream of the mixer due to backfire.</p> <p>Vehicle manufacturer / kit manufacturer / kit supplier shall submit test report or certificate complying with the above requirement. It is not necessary to carry out the test if declaration is submitted.</p>
4.2.4.2	The mixer shall be securely mounted and when remotely fitted shall be suitably bracketed to support its own weight and applied working forces.
4.2.4.3	There shall be no air filter element fitted downstream of the gas air mixer.
4.2.5	Dual fuel/ Bi- fuel /Dedicated Dual fuel system
4.2.5.1	<p>(a) Dual fuel type. Dual fuel engine operation shall mean a two – fuel system having diesel as a primary combustion fuel and CNG or Bio CNG or LNG as supplementary fuel, A Dual fuel engine operation means a two fuel system having diesel as a primary combustion fuel and GASEOUS as supplementary fuel. Such dual fuel engine may be operated on diesel stand-alone mode.</p> <p>For in-use diesel engine conversion to dual fuel, the rated power output &amp; max torque of the engine in dual fuel mode should be within +/- 5% of the base engine</p> <p>(b) Bi- fuel type. A bi-fuel system is defined as a system equipped to operate with either on GASEOUS or some other fuel e.g. petrol.</p>

	(c) Dedicated fuel type. A dedicated system is defined as a system equipped to operate wholly on GASEOUS .
4.2.5.2	For Bi-fuel type
4.2.5.2.1	A shut-off device shall be installed in the bi-fuel fuel system. This device shall shut-off the optional fuel supply to the engine when this fuel is not required.
4.2.5.2.2	If the shut-off device is in the form of a solenoid operated shut-off valve it must be fitted between the fuel pump and the carburettor. The valve shall be mounted securely so that its weight is not taken on any part of the carburetor or fuel lines.
4.2.5.2.3	Where the shut-off device is mounted remotely after the regulator, flexible hose shall be used of sufficient length to accommodate engine movement. In all cases the device shall be mounted in a position reasonably protected from damage in a collision and shall be as far as practicable from high tension electrical equipment
4.2.5.2.4	<p>Bypass relief device</p> <p>A bypass relief device shall be installed in the fuel pump or between the fuel pump and the automatic shut-off valve in the liquid fuel line to the carburetor on vehicles equipped with bi- fuel systems for the use of petrol and Gaseous fuel. The relief device need not be installed on fuel pumps containing a bypass relief device as original equipment.</p>
4.2.5.2.5	<p>Fuel selection control</p> <p>A fuel selection control shall be provided which shall have at least three positions, clearly marked for the selection of each of the two fuels. The selection control shall be placed within easy reach of the driver or operator. For vehicles fitted with electronic fuel injection, a two- position switch is acceptable.</p>
4.2.5.3	For Dual fuel/Dedicated dual fuel
4.2.5.3.1	A shut-off device shall be installed in the Dual fuel system. This device shall shut-off the GASEOUS fuel supply to the engine when this is not required.
4.2.5.3.2	If the shut-off device is in the form of a solenoid operated shut-off valve it must be fitted between the tank valve and the carburetor/Injector. The valve shall be mounted securely so that its weight is not taken on any part of the carburetor/Injector or fuel lines.
4.2.5.3.3	Where the shut-off device is mounted remotely after the regulator, flexible hose shall be used of sufficient length to accommodate engine movement. In all cases the device shall be mounted in a position

	reasonably protected from damage in a collision and shall be as far as practicable from high tension electrical equipment.
4.2.5.3.4	<p>Fuel selection control, applicable for dual fuel.</p> <p>A fuel selection control shall be provided which shall have at least two modes (Diesel and Dual fuel CNG / BIO-CNG / LNG mode), clearly marked for the selection of each of the two fuels. The selection control shall be placed within easy reach of the driver or operator.</p>
4.2.6	<p>Fuel Level Indicator</p> <p>A fuel level indicator shall be provided which indicates the level of GASEOUS fuel in the tank. The level indicator shall be placed within visible range of the driver or operator.</p>
4.2.6.7	Installation
4.2.7.1	<p>The CNG / BIO-CNG / LNG control equipment shall be:</p> <p>(a) Installed in positions that are accessible for routine inspection, maintenance and adjustment.</p> <p>(b) Mounted securely and reasonably protected from damage in a collision.</p> <p>(c) Remote from the vehicle engine exhaust system or protected there from by a metal shield.</p> <p>(d) No closer than is avoidable and practicable to any electrical equipment capable of sparking</p>
<b>4.3</b>	<b>Electrical wiring</b>
4.3.1	All wiring shall be properly installed, taped, clipped or contained in a loom along its length.
4.3.2	Wiring cables shall comply with the requirements of JIS C 3406 or equivalent standard, for only conductor resistance test; spark and immersion test to withstand voltage. The kit supplier / kit manufacturer or vehicle manufacturer shall submit test certificate / test report complying with above requirements.
4.3.3	<p>The electrical circuit shall be provided with a current limiting device. This equipment or fuse shall be dedicated to the CNG / BIO-CNG / LNG fuel system.</p> <p>NOTE – Where fuses are used they should be sized to conform such that 110% of rated current of the circuit – shall not fuse within 60 minutes and at 135% of the rated current of the circuit, it shall fuse</p>

	<p>within 60 seconds. A circuit breaker meeting this criteria is acceptable.</p>
4.3.4	Connectors and terminals
4.3.4.1	Connectors and terminals shall be insulated to prevent accidental earthing during operations or routine servicing.
4.4	<b>Pressure indicator/ Contents gauge</b>
4.4.1	<p>A pressure indicator to indicate pressure in the CNG / BIO-CNG gas cylinder shall be fitted in an easily visible position to service personnel at the regulator or fill point preferably within the engine compartment.</p> <p>For LNG, (differential) pressure gauge shall meet the requirements of ECE R110 or equivalent standard</p>
4.4.2	A supplementary gauge or electronic gauge may be placed in the driver's compartment provided any gauge shall be gas isolated from the cylinder or piping to prevent gas leaking into the compartment.
<b>5.0</b>	<b>COMPLIANCE PLATE</b>
5.1	<p><b>Compliance plate</b></p> <p>There shall be installed near the filling connection and be clearly visible to the re-fueler a compliance plate displaying the following information:</p>
	<div style="border: 1px solid black; padding: 10px;"> <p style="text-align: center;"><b>COMPLIANCE PLATE</b></p> <ul style="list-style-type: none"> <li>➤ Gaseous Fuel Cylinder Identification Number(s)</li> <li>➤ Date of Installation</li> <li>➤ Water Capacity (litre) of the Total Installation</li> <li>➤ Date of the Last Retest</li> <li>➤ Vehicle Registration/Product Identification No</li> <li>➤ The gaseous fuel installation complies with the safety requirements of this part.</li> <li>➤ Installed by</li> </ul> </div>
<b>6.0</b>	<b>LABELS</b>
6.1	<b>Identification labels</b>
6.1.1	<p>Vehicles using a Gaseous Fuel system shall be labeled as follows (Dedicated/Bi-fuel):</p> <p>Labels conforming with the specification given in 6.1.1.1 and 6.1.1.2</p>

	of this Standard shall be affixed in a vertical position as close to the vehicle number plate as practical or on the left side of the front and rear safety glass and shall ensure visibility from the front and rear sides.
6.1.1.1	The label shall be in position at all times, shall be in good condition, and the shape, colouring and lettering shall be easily identifiable.
6.1.1.2	<p>Label shall be colored white and sized 80 mm x 80 mm square. Label shall have on them the text “CNG / BIO CNG /LNG)” in a central position not less than 20 mm high, colored black.</p> <p>The label shall have a black border 1 mm wide, 5 mm inside the outer edge and running parallel to it. The 80 mm dimension is measured from the outer edge. (Refer Appendix C-1 for drawing).</p>
6.1.2	Vehicles using a Dual Fuel GASEOUS system shall be labeled as follows:
6.1.2.1	Labels conforming with the specification given in 6.1.2.2 and 6.1.2.3 of this Standard shall be affixed in a vertical position as close to the vehicle number plate as practical or on the left side of the front and rear safety glass and shall ensure visibility from the front and rear sides.
6.1.2.2	The label shall be in position at all times, shall be in good condition, and the shape, coloring and lettering shall be easily identifiable
6.1.2.3	Label shall be colored orange and sized 80 mm x 80 mm square. Label shall have on them the text “Diesel + GASEOUS Fuel ” in a central position not less than 15 mm high, colored black. The label shall have a black border 1 mm wide, 5 mm inside the outer edge and running parallel to it. The 80 mm dimension is measured from the outer edge. (Refer Appendix C-2 for drawing).
<b>7.0</b>	<b>INSPECTION, TESTING AND COMMISSIONING (FOR INSTALLER)</b>
7.1	<p><b>Commissioning</b></p> <p>Prior to initial use, an inspection of the GASEOUS system and components shall be carried out by, or under the supervision of an Authorized Person/Installer, who shall also carry out a complete examination to ensure the system complies with all relevant sections of this Standard and any other statutory requirements as specified by the Central Government.</p>
7.1.1	<p>Initial inspection and installation certificate</p> <p>The system shall be leak tested as detailed in 7.2 of this Part of this Standard. The installation shall be inspected for compliance with this</p>

	<p>Standard and all components shall be checked for operational performance. In the case of dual fuel/bi-fuel fuel installations, the ability for the vehicle to operate on the optional fuel shall also be tested.</p> <p>When the system conforms to this standard, an installation certificate, as per Annexure VI of AIS-024( Rev 1), signed by authorized person / installer shall be issued to the owner of the vehicle.</p>
<b>7.1.2</b>	<b>Periodic Inspection /preventive maintenance</b>
7.1.2.1	<p>The cylinder, piping and all components of the system shall be examined by an installer for corrosion, deterioration and for any modification affecting compliance with this Standard, at least once in a year or in case of malfunction or accident. The inspection shall include leak testing under 7.2 of this Part of this Standard.</p> <p>Every CNG / BIO-CNG bus manufacturer / installer shall incorporate periodic inspection schedules in the operation and owner's manuals.</p>
7.1.2.2	When the system has been inspected and any defects remedied and the system conforms to this Standard to the satisfaction of the installer, a checklist as per Appendix A of this Standard shall be issued to the owner of the vehicle.
<b>7.2</b>	<b>Leak testing</b>
7.2.1	<p>Initial test</p> <p>At the time of commissioning, the complete pressure system shall be subjected to a pressure test of <math>20 \pm 1</math> MPa by using GASEOUS or a gas inert to GASEOUS such as nitrogen.</p>
7.2.2	<p>Procedure</p> <p>Gas tightness of compartments and sub-compartments</p>
7.2.2.1	The compartment and sub-compartment shall be tested at the time of commissioning and subsequently at each periodic inspection to ensure that it is gas tight to the vehicle interior by blowing tracer gas into the compartment or sub-compartment and testing the surrounding atmosphere for gas leakage with a gas detector. Passages between the compartment and outside air, e.g. ventilation provisions, or an access hatch or door in the case of a permanently in-built compartment, should be sealed during testing. Any leakage should be rectified, and testing repeated.
7.2.2.2	Should the compartment or sub-compartment fail the above tests, corrective action shall be taken and the tests repeated until they comply with the test requirements.

	NOTE – It may be permissible to check such a compartment or sub-compartment before installation of the fuel system, provided that nothing in the subsequent installation procedure will negate the validity of the test.
7.2.2.3	Where CNG / BIO-CNG is used for testing the following precautions shall be observed: (a) Testing shall be carried out under adequately vented conditions. (b) Testing shall be carried out at least 5 m from any open flame or other source of ignition.
7.2.4	The operation of the equipment and controls shall also be tested with CNG / BIO-CNG under normal working conditions to prove satisfactory performance of the entire system and a further leak test shall be carried out using a non-corrosive foaming agent.
7.2.5	A BCF fire extinguisher and dry powder fire extinguisher to meet IS: 2171 and each of 2 kg shall be kept ready within a safe distance. If ignition occurs the service valve should be closed and the extinguisher(s) used to quell any fire, which may continue.
<b>8.0</b>	<b>GARAGING AND REPAIR (FOR INSTALLER)</b>
<b>8.1</b>	<b>Garaging and repairing of GASEOUS fueled vehicles</b>
8.1.1	Vehicles fueled with GASEOUS may be stored or serviced and repaired inside garages provided that the following conditions are observed:  (a) There shall be no leaks in the fuel system.  (b) Such vehicles shall not be parked within 3 m of any sources of ignition.  (c) GASEOUS fueled vehicles being repaired in garages, unless the fuel is required for engine operation, shall have the cylinder shut-off valve closed and the GASEOUS fuel in the service line exhausted by running the engine or depressurizing the line in a well-ventilated area.  (d) Vehicles undergoing repairs involving welding or the application of heat, to any part within 1 m of the cylinder, shall have the cylinder removed or shielded from the source of heat.
<b>8.2</b>	<b>Repair Operation</b>
8.2.1	Repair operation involving heat shall be carried out with due regard to fire safety.
8.2.2	Damaged fuel lines shall not be repaired; in all cases they shall be



	replaced.
8.2.3	Welding, brazing and the application of heat shall not be carried out on any part of the cylinder subsequent to manufacture.
8.2.4	When a vehicle is involved in an accident causing damage to part of all of the GASEOUS fuel system or where any part of the system necessitates removal to allow for the repair of the vehicle the system shall, after re-assembly or repair, be tested in accordance with 7.2 and a checklist as per Appendix A of this standard be issued. If applicable the requirements of 8.3.2 shall also be met.
8.3	<b>Scrapping</b>
8.3.1	A vehicle, which is about to be scrapped, shall have its cylinder removed prior to disposal.
8.3.2	Where the cylinder has been subjected to impact or fire damage the cylinder shall be inspected and re-tested by the owner of the vehicle as per Gas Cylinder Rules, 2016, as amended from time to time NOTE – There will always be combustible gas in the cylinder until it has been cleared of all traces of flammable vapour or gas.

<b>APPENDIX A CHECKLIST FOR INSTALLATION (DEDICATED/BIFUEL/DUAL FUEL)</b>	
A1	This checklist is a guide for the installer when carrying out the inspection prior to issuing installation Certificate. Reference to relevant clauses in this Standard and guidelines issued by Central Government from time to time should be made where appropriate.
(a)	<p>Cylinder:</p> <p>Approved by PESO</p> <p>Validity of Certificate</p> <p>Free from corrosion</p> <p>Mounted securely and inside vehicle parameter</p> <p>Mounting points free from corrosion and fractures</p> <p>Shielded and valves protected where necessary</p> <p>5 mm clearance between cylinder to vehicle components provided</p> <p>Ground clearance correct</p>
(b)	<p>Valves:</p> <p>Cylinder valve operating correctly</p> <p>Burst disc fitted` (NA for LNG valves)</p>
(c)	<p>Filling connection:</p> <p>Refueling connection made external to vehicle interior</p> <p>Captive dust plug fitted</p> <p>Meets proof loading of 50 kgf</p>

(d)	Refueling interlock (NA for LNG): Operation correct
(e)	Non-return valve: Operation correct free from bypass leakage
(f)	Leak test: All valves and fittings leak free
(g)	Vapour sealing: Gas tight
(h)	Ducting: Free from damage and secure to outlets
(i)	Pliable sub-compartment: Ease of operation of cylinder valve satisfactory Position identified
	(j)Fuel line: Free from damage and corrosion Secured to vehicle Protected and shielded where necessary
	(k)Joints and connections: Leak free
	(l)GASEOUS shut off valve/solenoid valve: Mounting secure Operation correct Leak free
	(m)Service shut off valve: Operation satisfactory Mounted securely Leak free Identified and operation clearly marked
	(n)Regulator(CNG/Bio CNG): Mounting secure No gas bypass after engine has stopped turning Shielded where necessary Leak free Vaporizer / Heat Exchanger (LNG): Mounting secure No gas bypass after engine has stopped turning Shielded where necessary Leak free
	(o)Control equipment: Approved type

	<p>(p)Gas air mixer: Securely mounted Backfire deflector where applicable</p> <p>(q)Bi-fuel shut-off device: Operation correct Petrol lock off where fitted is mounted securely Petrol hose secure joints leak free and free from cracks Sufficient flexibility for engine movement Bypass device fitted where applicable</p> <p>(r)Electrical wiring: Current limiting device fitted Connections secure Terminals insulated to prevent shorting Wiring taped and clipped securely</p> <p>(s)Compliance Plate: Installed and carries correct markings</p> <p>(t)Identification labels: Located front and rear of vehicle</p>
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<b>APPENDIX B STATUTORY AUTHORITY APPROVAL</b>	
<b>B1</b>	The type of component in question and its use determine the Statutory Authority Approval in respect of GASEOUS (Dedicated/Bi-fuel/Dual fuel)/LNG(Dedicated vehicles above 3.5 Ton GVW) fuel system components. The Statutory areas of responsibility are:

<b>Government Agency</b>	<b>Statutory powers</b>	<b>Scope of application</b>
B 1.1 Ministry of Road Transport and Highways, Government of India.	Central Motor Vehicle Act, 1988 (CMVA) Central Motor Vehicle Rules, 1989 (CMVR) as amended by government of India from time to time	All GASEOUS kit components (excluding CNG / BIO-CNG /LNG cylinder & its valve(s)) and systems used for the purpose of propelling a motor vehicle on road.
B 1.2	Gas Cylinder Rules, 2016	CNG / BIO-CNG / LNG cylinder with

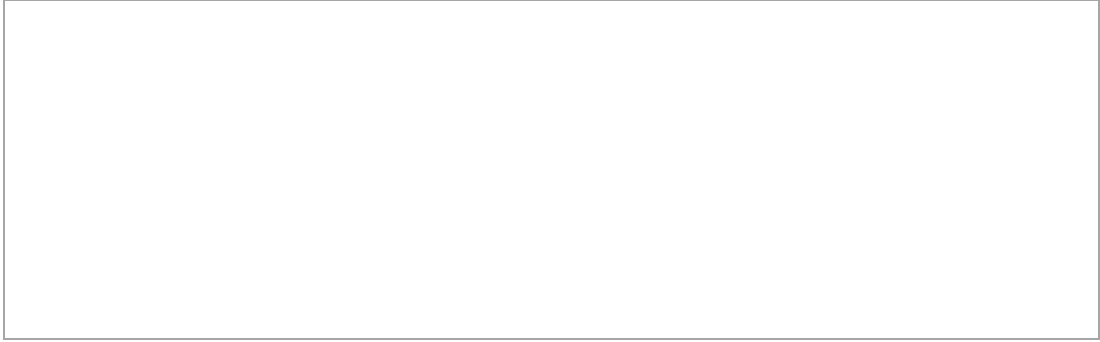
PESO, Nagpur, Government of India	as amended by government of India from time to time	valves and their accessories.	
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**APPENDIX C-1**

**LABEL**

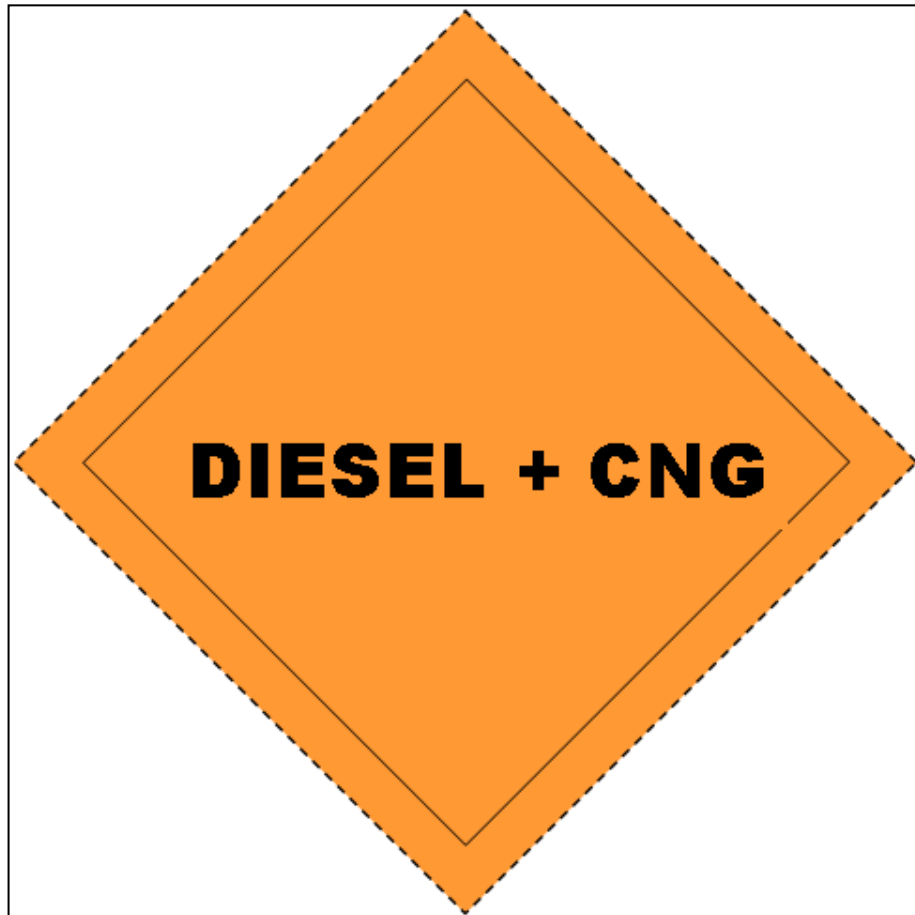


**CNG**



**APPENDIX C-2**

**LABEL**



**APPENDIX C-3**

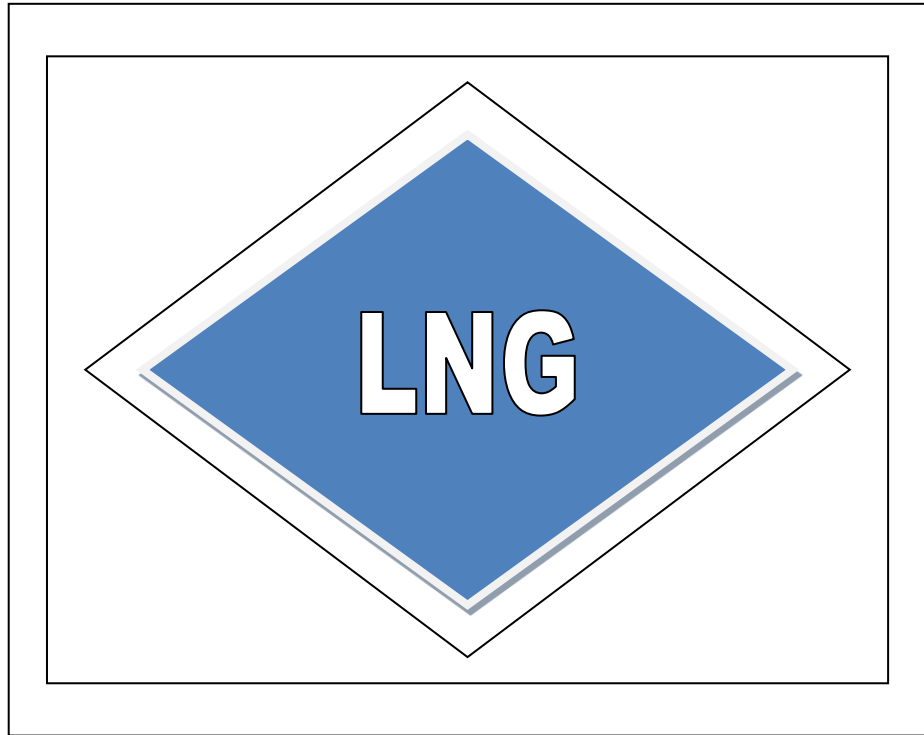
**LABEL**



**BIO  
CNG**

APPENDIX C-4

**Provisions on LNG identification mark for LNG vehicles**



The colour and dimensions of the sticker shall fulfil the following requirements:

A label shall be placed adjacent to the LNG fill receptacle stating the fuelling requirements. The fuelling requirements shall be as recommended in this standard.

**Colours:**

Background:	Blue
Border:	white or white reflecting
Letters:	white or white reflecting

**Dimensions:**

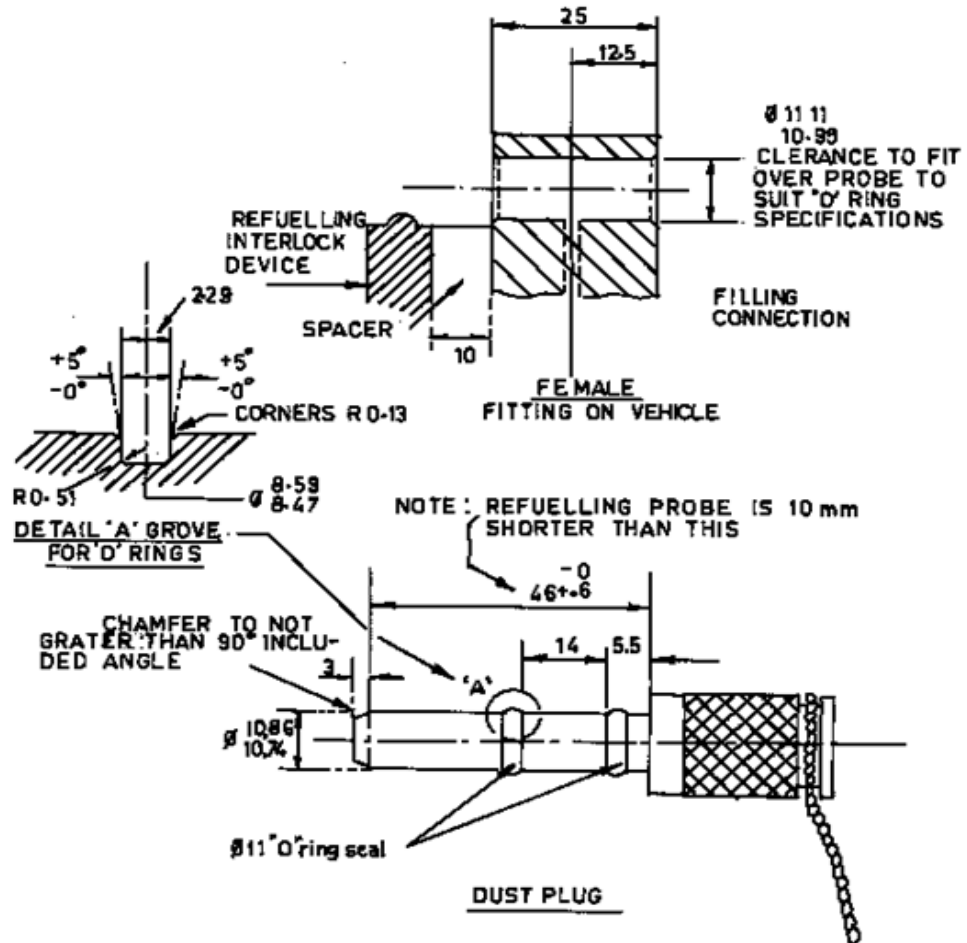
Border width:	4 - 6 mm
Character height:	$\geq 25$ mm
Character thickness:	$\geq 4$ mm
Sticker width:	110 - 150 mm
Sticker height:	80 - 110 mm

The word "LNG" shall be centred in the middle of the sticker.



## APPENDIX D1

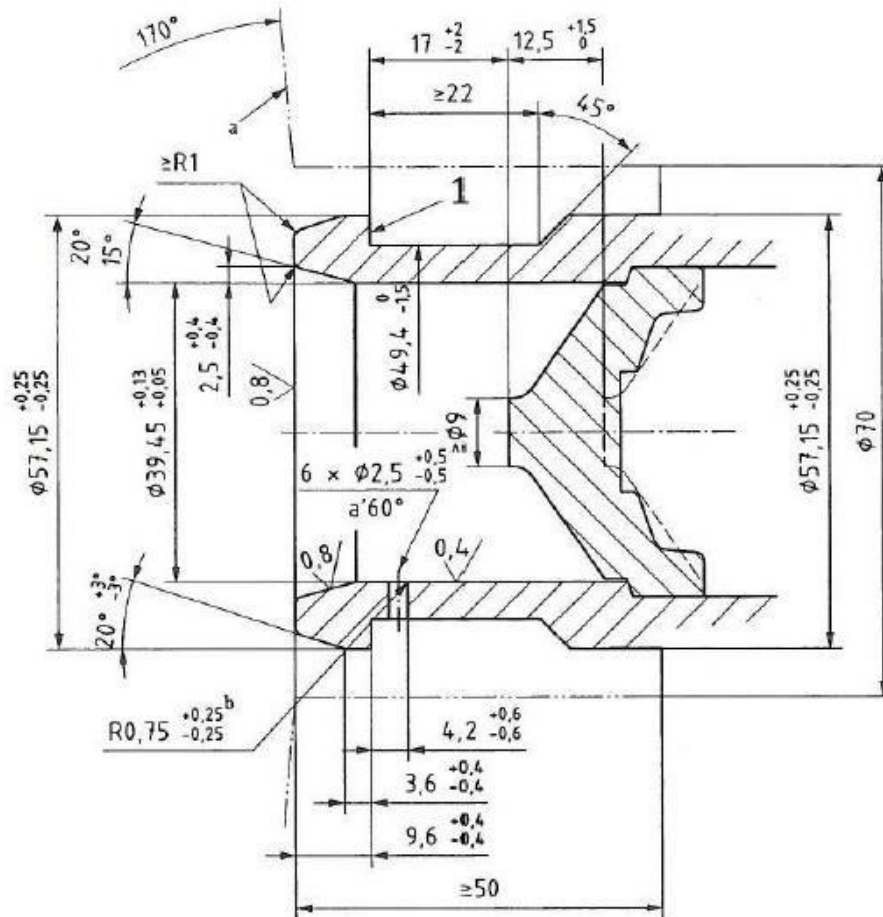
### FILLING CONNECTION AND DUST PLUG



DUST PLUG CNG VEHICLE FILLING SYSTEM

## APPENDIX D2

### Filling receptacle for LNG



<b>APPENDIX E</b>	
<b>FREEZING CONDITIONS AND CORROSIVE CONDITIONS</b>	
E1	Where Regulator heat is drawn from the engine cooling water, care should be taken to ensure that the water PESOs not freeze in the Regulator during cold weather. Expansion of the water on freezing can cause serious damage to the pressure regulator assembly.
E2	Most CNG / <b>BIO-CNG</b> Regulators are made from non-ferrous alloys, which can suffer pinhole corrosion under certain conditions. If this is allowed to take place CNG / <b>BIO-CNG</b> can be admitted to the cooling water system where it will pressurize the radiator and cause a potential hazard. It is important, therefore, to have an effective anticorrosion additive present in the cooling water
E3	It is important to ensure that the coolant additive and the dilutant ratio comply fully with the engine manufacturer's requirements.

<b>APPENDIX G BACKFIRE – DEFLECTOR TESTS</b>	
1)	A backfire deflector under backfire conditions shall contain a visible flame front within its confines and shall not be displaced, physically damaged or distorted, or show evidence of burning or smoldering of internal parts. If the deflector is of the oil-bath type, it shall be free of any overflow or discharge permitting accumulation of oil on electrical, hot-engine or exhaust system parts.
2)	A complete industrial truck / vehicle is to be used for this test. Tests are not required on backfire deflectors employed diesel engines.
3)	The backfire deflector (air cleaner, oil-bath or dry element type) and connecting hose are to be removed from the engine. The spark timing is to be advanced (approximately 8 degrees) and the spark plug leads are to be interchanged to obtain sharp backfires under the following conditions. The engine is to be alternately raced and idled and the ignition switch is to be operated to alternately energize and de-energize the ignition system. During the test, the intensity of the backfire and the issuance and extent of the accompanying flame are to be noted.
4)	The backfire deflector (air cleaner) is then to be installed on the truck in the intended location. An oil-bath type deflector (air cleaner) is to be filled to the marked “full level-line” of the bowl. Paper is to be placed beneath the intake orifices of an oil-bath type and over adjacent surfaces of parts likely to be affected by accumulations of oil.
5)	The engine is then to be operated in the several manners determined in the preliminary test to provide for the most severe backfire conditions. At least ten and not more than twenty backfires are to be produced.
6)	Observations for containment of flame are to be made under semi-darkened conditions by at least two observers. No visible flame is to be in evidence at any time during the tests. In the tests of an oil-bath type, paper is not to show evidence of oil deposits in the form of droplets.
7)	A dry-type filter element is to be tested in the above manner, then removed and then subjected to five consecutive washing and drying cycles. Washing is to consist of immersion in plain water together

	with sufficient agitation to remove bulk material adhering to the outside surface. The test element is then to be remounted as intended in operation, and the backfire test is to be repeated.
8)	The side of the filter media normally exposed to backfire is then to be subjected to a flame source of sufficient intensity to cause the media to burn or glow. The flame source is then to be removed and an acceptable filter media is not to continue to burn or smolder.

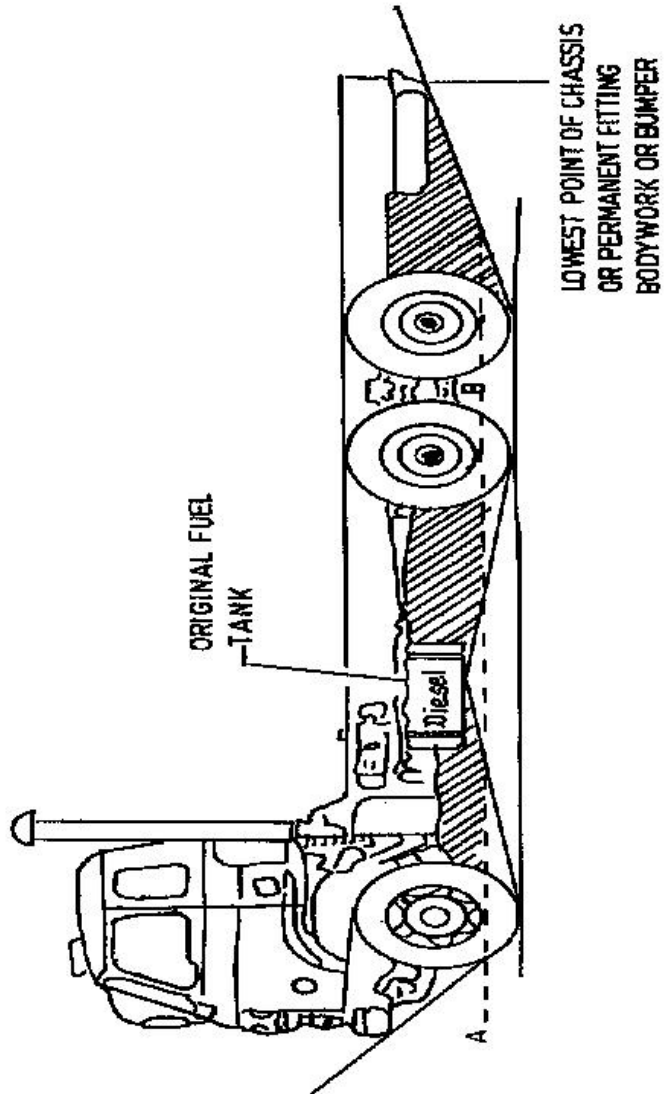


FIG: 2 TYPICAL POSITION OF ORIGINAL FUEL STORAGE TANK GROUND CLEARANCE

Typical Schematic diagram of LNG fuel system

