

AIS 027 : CODE OF PRACTICE FOR USE OF LPG FUEL IN INTERNAL COMBUSTION ENGINE TO POWER 2 & 3-WHEELED VEHICLES

1. This Code of Practice may be called as “Code of Practice for Use of LPG Fuel in Internal Combustion Engine to Power 2 & 3-Wheeled Vehicles”.

2. SCOPE

This Code of Practice shall apply to design, construction, installation, operation, maintenance, inspection, testing and fueling of liquefied petroleum gas (LPG) system for motor vehicles, in which LPG is used either wholly or as bi-fuel for the internal combustion engine of 2 & 3-wheeled vehicles. In general the Standard is directed towards vehicle installations.

3. This Code of Practice does not cover the areas where major structural modifications (major structural modifications are those not defined in clause no. 4) are to be carried out in the vehicles. Before commencement of major structural modifications, guidelines from the vehicle manufacturers shall be sought for.
4. Any alteration or modification to any motor vehicle to install equipment for LPG system shall be carried out in accordance with sound engineering practices and in compliance with Central Motor Vehicles Act 1988 and Central Motor Vehicles Rule, 1989 and their superseding amendment and notification issued thereafter. The following aspects shall be taken into consideration during alteration or modification:

Where the modifications are made to:

- a) Suspension: mounting locations, geometry, ground clearance adjustment, axles and sub-axles or steering mechanism.
- b) Original fuel storage: the fuel tank assembly, fuel tank mounting, venting or filler assemblies
- c) Vehicle structures: Holes greater than 13 mm shall, not located within 40 mm from the edge of panel, welded joint or direct load bearing point (such as belt anchor). The only holes permitted greater than 13 mm diameter are for the installation of the filling valve or for venting purposes.
- d) Braking system including the hand brake and components.

In this aspect design guidelines supplied by vehicle manufacturers, vehicle safety standards of Indian or relevant standards, wherever applicable shall be referred.

Only equipment and systems approved by the relevant Statutory Authority / **Test Agency** shall be used.

5 DEFINITIONS

For the purpose of this Standard, the following definition shall apply:

- a) **APPROVAL OR APPROVED:** means Approval or Approved by Statutory Authority.
- b) **AUTHORISED PERSON:** A person, normally an automotive workshop person, authorised by the vehicle manufacturer or the conversion kit manufacturer/kit supplier, specially trained for installation, maintenance and periodic inspection of motor vehicle converted for bi-fuel or dedicated operation of internal combustion engine 2 & 3-wheeled vehicles.
- c) **AUTOMATIC FILL LIMITER:** means a provision in the filling system of the Auto LPG Tank, which automatically terminates filling when the predetermined liquid level in the Auto LPG Tank has been reached.
- d) **AUTOMATIC FUEL SHUT-OFF VALVE:** means a device such as solenoid valve for shutting off the supply unless certain essential conditions exist.
- e) **AUTO LPG TANK (ALT):** means cylinder/container/tank meant for containing LPG to be used as fuel for the 2 & 3-wheeled vehicle engine and approved/**endorsed** by Chief Controller of Explosives under Gas Cylinders Rules, 1981 and meeting the requirements as per IS: 14899 (as amended from time to time).
- f) **CONTENTS GAUGE:** means a gauge which gives a visual indication of the level or quantity of the LPG contained in Auto LPG Tank.
- g) **CONVERSION KIT:** means a complete system assembly from auto LPG tank to gas-air mixer **for converting vehicle to run on LPG. The kit needs to be** duly tested **and approved** by one of Testing Agencies mentioned in Central Motor Vehicles Rules 126 in bi-fuel mode of LPG/gasoline or dedicated mode of LPG.
- h) **EXCESS FLOW CHECK VALVE:** means a valve normally in the open position which closes automatically in the direction of flow for which it is designed, when a predetermined flow limit is exceeded as determined by the pressure drop.
- i) **FLOW-RATING PRESSURE:** means the pressure at which the relief valve is rated for flow.
- j) **GAS AIR MIXER:** means a device for introducing gaseous fuel to the induction air of the engine.
- k) **GAS CYLINDER RULES, 1981:** means The Gas Cylinder Rules, 1981 (with latest amendments) framed under Indian Explosive Act, 1884 and administered by Chief Controller of Explosives.
- l) **LIQUEFIED PETROLEUM GAS FOR AUTOMOTIVE PURPOSES,** hereinafter referred to as Auto LPG: means a mixture of certain light hydrocarbons derived from petroleum which are gaseous at normal

ambient temperature and atmospheric pressure but may be condensed to the liquid state at normal ambient temperature by the application of moderate pressure meeting the requirements of Indian Standard Specifications IS:14861 (as amended from time to time).

- m) **MULTI-FUNCTION VALVE:** means an assembly for mounting an auto LPG tank for filling and withdrawal of LPG along with safety devices including:
- i. Automatic fill limiter
 - ii. Service valve
 - iii. Excess flow check valve
 - iv. Pressure relief device
 - v. Fusible Plug
 - vi. Content Gauge
 - vii. Inlet connected to fill connector having Non-Return Valve

Multi function valve assembly shall conform to latest Indian Standard (amended from time to time) and approved/**endorsed** by Department of Explosives (DOE).

- n) **NON-RETURN VALVE:** means a valve, which permits fuel to flow in one direction only.
- o) **PRESSURE :** Refers to gauge pressure.
- p) **RELIEF VALVE:** means an automatic pressure relieving device, communicating directly with the vapour space of the tank and actuated by the static pressure upstream of the valve which opens in proportion to the increases in pressure over the opening pressure to maintain internal fluid pressure. This also includes a device discharging excessive pressure due to temperature rise between two valves / isolated sections.
- q) **SERVICE VALVE:** means a manually operated or remotely controlled shut-off valve fitted on the Auto LPG Tank which can open or shut off the LPG supply.
- r) **VAPOURISER/REGULATOR:** means a device which vapourises liquid LPG and reduces fuel pressure at a level appropriate for delivery to the gas-air mixer in case of liquid/vapour withdrawal system.

6. PROTOTYPE OF CONVERSION KIT / **OE FITMENT TO BE SUBJECTED TO TEST:**

- i. Every conversion kit manufacturer / supplier shall submit the conversion kit to be manufactured by him for test by Vehicle Research & Development Establishment of the Ministry of Defence, Govt. of India or Automotive Research Association of India, Pune or Indian Institute of Petroleum, Dehradun and such other agencies as may be specified by the Central Govt. for granting a certificate by that agency as to the compliance of provisions of the **Motor Vehicle Act, Rules made thereunder** and these Codes.

- ii. An application for approval of conversion kit shall contain the following information :
 - a. The identity of the manufacturer and the country of origin of the component;
 - b. The specification to which the component is to be manufactured and
 - c. The quality control procedures to be adopted during the course of construction of the component.
- iii. If any type approval is issued it will be made subject to the condition that the conversion kit is installed and operated in accordance with the requirements of such approval. The Ministry of **Road Transport and Highways** may impose other conditions of type approval as deem appropriate, depending on its anticipated use. However, if any problem arises with the kit or components thereof, at the discretion of testing agency concerned / MORTH, kit may be subjected to fresh type approval.
- i. The type approval of a conversion kit may be revoked or the conditions of approval may be varied by the Ministry of **Road Transport and Highways** if the kit or any component thereof is found to be unsafe in service or if the circumstances of use of the conversion kit or any component thereof alter those originally envisaged.

7. AUTO LPG TANK FITTINGS/MARKINGS

- I. Fittings- All auto LPG tanks permanently attached to the vehicles shall have fitting as per IS:14899 (as amended from time to time).

(A) PRESSURE RELIEF VALVE

- i. The pressure relief valve shall be set at a pressure of 110% of the design pressure of auto LPG tank and have adequate relieving capacity to prevent internal pressure rising about 120% of design pressure under fire condition.
- ii. The relief valve shall communicate directly with the vapours space of the ALT with no valve in between and shall be fitted internally, only the relieving outlet being outside.
- iii. The discharge from the relief valve shall not be directed into the passenger space of the vehicle.
- iv. Manufacturer's symbol/name, set pressure, discharge capacity and serial number shall be marked on the valve.

(B) FILLING CONNECTION/AUTOMATIC FILL LIMITER

- (i) Size of filling receptacle shall conform to the ECE **Regulation No. 67** or equivalent standard **adopted by DOE**. However, the vehicle manufacturer/kit installer

may seek the guidance from the Ministry of Petroleum and Natural Gas **and DOE**.

(ii) The automatic fill limiter working on a float mechanism shall cut-off the liquid inlet when the predetermined max. level of 80% water capacity of ALT is reached.

(iii) The filling connection shall be provided with a filler cap which shall be captive to the connection and shall be either capable of withstanding the design pressure of the ALT or designed so that pressure does not accumulate. If the cap is the pressure related type, the connection shall be designed so as to relieve the accumulated pressure commencing at the backing off of not more than one turn of the cap.

(C) SERVICE VALVE

Either a manually operated or remotely controlled service valve, which can open or close the auto LPG supply to the vaporizer, pressure regulator during maintenance / servicing, etc., shall be fitted downstream of excess flow check valve.

(D) EXCESS FLOW CHECK VALVE

A valve normally in open position, closes automatically in the direction of flow for which it is designed.

(E) CONTENT GAUGE

The content gauge of dial type shall be fitted to the Auto LPG Tank for indicating the level/quantity of LPG in the fuel tank, the dial to be placed into the dash board/handle bar of the vehicle. In addition, if required, a fixed liquid level gauge may be provided in the tank.

II. MARKINGS – The Auto LPG Tank shall have the markings as per IS:14899, as amended from time to time.

8. The fitment of auto LPG tank and other kit components in the motor vehicle shall be carried out as per following clauses:

(A) LOCATION AND VENTILATION OF AUTO LPG TANK

i. Auto LPG Tank, fittings, and pipe work shall be mounted in a protected location inside the perimeter of the vehicle. The tank shall not be so located that the vehicle driving characteristics are adversely affected.

ii. For externally mounted tanks in no case shall the tank valves be positioned less than 100 mm from the front and rear ends for 2-wheeler and 200 mm from the extremities of the vehicle for 3-wheeler unless they are protected to minimise the possibility of damage due to collusion, overturning or other accident.

- iii. In case of 3-wheeler, the Auto LPG Tank shall be situated and vented so that any gas escaping due to leakage from tank fittings shall not enter the vehicle passenger compartment or driver space.
- iv. The Auto LPG Tank shall not be fitted:
 - 1) On the roof or above any passenger compartment (applicable for 3-wheeler only).
 - 2) In a position behind the driver seat (seat adjusted to rearmost position), which will hinder the driver seat adjustment unless specifically approved by the testing agency.**
 - 3) In a position beneath the vehicle that decreases the effective ground clearance.

Note: The attachment of the auto LPG tank to the roof of the vehicle, and particularly to the gutters, is generally considered to be of inadequate strength, and unsatisfactory for a number of other reasons. Such installations require specific approval, which is usually given only for special vehicles, and takes into account such aspects as vehicle speed, cylinder protection and strength of mountings.

- i. Cylinder shall be secured firmly to the body of vehicle to prevent it from working loose when vehicle runs on a rough terrain or accidentally overturns or falls down to prevent it from being thrown not as projectile in the event of an impact.

(B) Auto LPG Tank location ground clearance

Auto LPG Tank shall be located in accordance with the following requirements:

- i. The vehicle mass for determining ground clearance shall be the laden mass, including permanent non-standard attachments to the vehicle with all fuel, water and oil container full.
- ii. The tank installed between and behind axles shall not be lower than the lowest of the following points and surfaces forward of the tank.
 - 1) The lowest structural component of the body.
 - 2) The lowest structural component of the frame or sub-frame, if any.
 - 3) The lowest point of the engine.
 - 4) The lowest point of the transmission (including the clutch housing or torque converter housing as applicable) but excluding differential housings.

- iii. All clearances shall be measured to the bottom of the Auto LPG Tank, or to the lowest fitting support or attachment on the Auto LPG Tank housing whichever is the lowest.
- (C) Internal Auto LPG Tank: Where an Auto LPG Tank is located within the body shell of a vehicle, either
- i. The whole body of the Auto LPG Tank together with its attached components and fittings shall be enclosed in a compartment; or
 - ii. The valves, fittings and pipe connections associated with or attached to the Auto LPG Tank shall be enclosed in a localised sub-compartment, which is attached to the Auto LPG Tank and vented to the atmosphere.

Provision shall be made for ready access to the service valve in all installation arrangements.

- (D) Construction of compartments and sub-compartments:

An Auto LPG Tank compartment or sub-compartment shall comply with the following requirements:

- i. Construction shall be such that any gas which might leak from any fittings, component or piping, can not pass to any other enclosed compartment, passenger space or luggage space of the vehicle.
- ii. When a compartment or sub-compartment has been subjected to a hydrostatic internal pressure of 30 kpa for a period of 5 minutes, sealing materials or gaskets shall not be displaced or otherwise lose integrity.
- iii. 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 designed to prevent the dislodgment of the hatch or cover when in the closed and locked position.
- iv. The construction shall be such that if 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 (ii) above. The pushing force shall be applied by a measuring instrument having a flat circular face of 20 mm diameter.
- v. A compartment or sub-compartment shall not contain an ignition source or electrical equipment or wiring unless it is intrinsically safe.

NOTE – Items (ii), (iii) and (iv) are intended to be the basis of approval for proof of design.

(E) Ventilation: One or more vents to the outside of the vehicle shall be provided, the aggregate area of which is not less than 250 mm² and which can not be blocked. The vents shall be so located as to drain any vapour, which may accumulate in the bottom of the compartment or sub-compartment, and shall exit not less than 250 mm from an exhaust pipe or other heat source. (Ref also F (iii) below). Holes for venting shall be positioned not less than 40 mm from the edge of a panel or welded joint or direct load bearing point.

(F) Ducting: All piping or hoses that pass through an enclosed area of the vehicle shall be within conduit gas-tight from the vehicle interior, vented unobstructed to outside atmosphere and protected from external damage and shall comply with the following requirements:

- i. The ducting shall be as short as practicable.
- ii. All 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 conduit by the clamping device.

NOTE: To ensure a gas tight seal between the vent and ducting material, it may be necessary to use a suitable sealant or gasket when connecting the ducting to the vent.

iii. 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:

(a) The conduit shall withstand an internal test pressure of **30 kpa**.

(b) The conduit shall not suffer sufficient damage to permit leakage when tested by applying 60 kgf static force applied through 20 mm diameter, in the following manner:

1) Applied to a free end of conduit (minimum length of 500 mm).

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.

3) Flammability: The material shall conform to SAE J369a class SE/NBR.

4) Presence of resistance to ultraviolet degradation agent shall be confirmed.

NOTE – Item (iii) shall be the basis of approval for proof of design of the conduit.

(G) Auto LPG Tank (s) installation

Attachment to vehicle: Auto LPG Tank(s) shall be securely attached to the vehicle to prevent slipping, rotating and jarring loose, in accordance with the following requirements:

- i. The method of attachment shall not cause undue stresses or wear in the Auto LPG Tank shell.
- ii. Fixing lugs, brackets and the like if welded to the Auto LPG Tank shall be attached during manufacture and specifically shall not be attached by field welding or brazing.
- iii. The mounting method shall not significantly weaken the vehicle structure, and reinforcement shall be added where necessary to ensure compliance with (iv) below. An air gap of not less than 5 mm shall be provided between the Auto LPG Tank and vehicle structure.
- iv. The force necessary to separate the Auto LPG Tank from the vehicle shall not be less than 20 times the mass of the full Auto LPG Tank applied in any direction on external surface of Auto LPG tank.

The strength of the anchorages may be established by static test (forces directed through the centre of mass of the Auto LPG Tank).

- v. In the absence of testing or where calculations are impracticable, the following requirements shall apply:
 - a) 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 Auto LPG Tank.
 - b) Where a Auto LPG Tank is anchored to sheet metal, the sheet metal shall be reinforced by a plate of not less than 3600 mm² and a thickness of not less than 2.5 mm or appropriate thickness supported by calculations or test report. It is preferred that 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.
 - c) Where anchorage bolts pass through a hollow section, provision shall be made to prevent collapse of that section under load.
 - d) Anchorage bolts or studs shall have diameter not less than that shown in table 1 and shall conform to property class 8.8 as per IS 1364 or equivalent ISO 4014 with nuts to IS 1364 or ISO 4032.

Table 1

Cylinder size (water capacity in ltrs) Over, up to and including	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	

- e) Where clamping bands are used, at least two steel bands per auto LPG tank shall be provided, dimensions of which shall not be less than those in Table 1. 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.
 - f) Where the attachment is by means of clamping bands there shall be a positive means of resisting end loads on the Auto LPG Tank by means of providing suitable end stoppers.
 - g) Screwed fasteners or clamping devices shall either be inherently resistant to loosening or be locked or pinned after tightening.
- vi. Auto LPG Tank orientation: The Auto LPG Tank shall be mounted in a level position correctly oriented in relation to vapour and liquid connections and for the effective operation of level gauges.
- vii. The chassis of 3-wheeled vehicles can be subjected to considerable torsion and bending deflections even under normal operating conditions. Mounting of cylinders to chassis must take these deflections into account and the cylinder mounting method chosen must not unduly prevent these deflections occurring.

In addition, many chassis manufacturers specifically prohibit the welding of attachment points to their chassis members and in some cases also prohibit the drilling of additional mounting holes in the chassis members. For any proposed chassis modification due consideration must be given to the particular chassis manufacturer's restrictions with respect to welding, drilling and sealing of existing

holes. Advice on these matters can be obtained from the chassis manufacturer.

- viii. More than one Auto LPG Tank
Specific design may be required for mounting.
- ix. The Auto LPG Tank data plate shall be easily read when in the installed position.
- x. Heating: Heating shall not be applied to fuel Auto LPG Tanks for purposes of increasing the internal pressure or the supply of fuel.
- xi. Heat Shielding: Auto LPG Tank shall be situated as far from the exhaust system as practicable and in no case shall the distance be less than 75 mm. If the clearance between Auto LPG Tank and exhaust system is less than 100 mm shielding against radiation shall be provided. Where practical the shielding shall be positioned halfway between the exhaust and Auto LPG Tank but in any case the air gap shall not be less than 15 mm.

NOTE: Exhaust systems shall not be positioned below the Auto LPG Tank unless there is no practical alternative route.

- xii. Shielding: Valves and connections on Auto LPG Tank 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.

9. **LPG Fuel Line Pressure Exceeding 4.5 kg/cm² (g)**

LPG fuel line for pressure exceeding 4.5 kg/cm² (g) used in the liquid or vapour phase high pressure piping shall be either

- a) steel, copper or copper alloy (9(i))
- b) Flexible (9(ii)(a))
 - i. Rigid piping : High pressure piping of steel , copper or copper alloy shall be suitable for use with Auto LPG. The pipeline shall be designed for a minimum pressure of 32 kg /cm² (g) with a factor of safety of 4 and shall be tested at a pressure of not less than 48 kg/cm² (g).
 - ii. Fuel line size: Piping for liquid/vapour LPG shall be as small as possible consistent with the needs to supply the maximum requirements of the engine and to permit the excess flow valve to function in the event of rupture or disconnection.

- (a) Flexible hose: Flexible high pressure hose shall be suitably fiber braided hose conforming to IS: 9573 with latest amendment, **except testing on slab (the bursting pressure shall be tested for five times of working pressure encountered in service).**
- iii. Inspection: 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. At no time shall flexible hose be placed back into service after removal from the vehicle.
- iv. Joints and connections:
 - a) Every joint or connective fitting in rigid high-pressure fuel line shall be tested for 48 kg/cm² without leakage or failure.
 - b) The number of joints and connections shall be the minimum for the inclusion of all components.
 - c) Joints or connections in LPG fuel lines shall be in accessible positions **for easy inspection.**
 - d) Connection means shall provide positive retention of the fuel line in the fitting (e.g. by double inverted flaring of the tube end).

v. Securing and location:

High pressure piping and hoses in vehicles shall comply with the following:

- a) No LPG fuel line inside the part of any vehicle occupied by the driver or passengers shall be outside the sealed and vented enclosure, (except as provided for in clause 8(F)).
- b) All LPG 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 protections.
- c) LPG 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 plan. 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 clause 10 (B) (ii).
- g) Fuel lines shall be effectively secured to the chassis frame or vehicle body by clips spaced not more than 300 mm apart in case of 2-wheeler and 500 mm in case of 3-wheeler. In order to prevent the possibility of fretting corrosion or erosion of the fuel line cushioning must be provided to protect the pipe from the chassis/body and the clips themselves. Suitable grommets must be provided where the pipe passes through any body panel.
- h) Manifolds used in multi Auto LPG Tank 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) LPG fuel line subjected to Auto LPG Tank pressure shall be protected from heat radiated from any exhaust component within 150 mm of it by a radiation shield. In the event of clearance being less than 100 mm the shielding shall consist of 2 mm thickness of sheet metal separated from each other by an air gap of 15 mm and positioned halfway between the exhaust and fuel line. In no case shall the clearance be less than 75 mm.
- j) Fuel lines shall not be installed where any part will be permanently hidden from sight or can not be inspected or easily replaced (except as provided for in clause 8(F)).

10. LPG fuel line pressure not exceeding 4.5 kg/cm² (g)

- (A) All LPG fuel line for use at service pressure not exceeding 4.5 kg/cm² (g) .
 - i. Such a low pressure fuel line shall be of flexible material complying with IS:9573 as amended, **except testing on slab (the bursting pressure shall be tested for five times of working pressure encountered in service or it shall be tested for 10 bar whichever is higher).** Such low pressure fuel line shall be capable of sustaining 5 times the maximum pressure likely to be encountered in service and shall comply with clause 9 (v) ((a) to (f) and (j)).
 - ii. Joints and connections for low pressure fuel lines shall be suitable for use with LPG and capable of sustaining 5 times the maximum pressure likely to be encountered in service and shall comply with clause 9 (iv) (b and c).

- (B) Flexibility
- i. Low pressure hose shall be of sufficient length and flexible to accommodate engine movement.
 - ii. 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.
 - iii. All runs or rigid fuel line piping between any two components shall be installed with a 'pigtail' or U bend to provide this essential flexibility (Ref. 10(B) (ii)).

11. LPG CONTROL EQUIPMENT:

The LPG fuel control equipment includes all the equipment necessary to convert LPG at high pressure at the cylinder to LPG air mixer for supply to the engine.

The control equipment shall consist of following namely

- a. Filter: At the termination of every LPG service fuel line immediately before entry to the LPG shut off valve shall be fitted a properly designed filter capable of removing all particulate matter from the fuel that could cause malfunction of shut-off valve or pressure regulator.
- b. Automatic fuel shut-off device: This device shall be fitted between the filter and the inlet of the vaporizer / regulator. The device shall automatically act to prevent the flow of liquid into the vaporizer in case of liquid withdrawal or regulator in case of vapour withdrawal unless both the following conditions are satisfied.
 - (i) The ignition is on
 - (ii) The engine is turning
- c. Vaporizer and regulator or regulator system: The system shall not permit gas to pass after the engine has stopped turning, irrespective of whether the ignition is on or off. This system shall be installed so that:
 - i. It is securely mounted as far as practical from the extremities of the vehicle.
 - ii. It is mounted securely and as close to the engine carburettor position as convenient.
 - iii. It is easily accessible for routine maintenance, adjustment and inspection.

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.

- iv. It is reasonably protected from impact in a collision.
- v. It is adjacent to or connects directly with the LPG shut-off valve, any fuel line connection to which shall be kept as short as possible.

For liquid withdrawal system: 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.

Where possible, the vaporizer should not be at a level higher than the top of the radiator, as insufficient water may cause freezing.(refer Appendix E)

- vi. It allows sufficient free movement of all hoses.
- d. 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.
- e. Backfire Deflector: Immediately prior to the mixer, a backfire deflector to arrest flash back, shall be installed in the air intake, which shall meet the requirements of Appendix F of this Standard.

Vehicle manufacturer/kit manufacturer/kit supplier shall submit the test report or certificate complying with the **requirements mentioned in Appendix F of this standard. It is not necessary to carry out the test if declaration is submitted.**

- f. The mixer shall be securely mounted and when remotely fitted shall be suitably bracketed to support its own weight and applied working forces.
- g. There shall be no air filter element fitted downstream of the gas air mixer.
- h. Bi-fuel/Dedicated fuel system:
 - (i) Bi-fuel type: A bi-fuel system is defined as a system equipped to operate with either on LPG or some other fuel e.g. petrol.
 - (ii) Dedicated fuel type: A dedicated fuel system is defined as the system equipped to operate wholly on LPG.
- i. For bi-fuel type:
 - (a) A shut-off device shall be installed in the bi-fuel system. This device shall shut-off the optional fuel supply to the engine when this fuel is not required.
 - (b) 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 carburettor or fuel lines.

- (c) Where the shut-off device is mounted remotely from the engine, flexible hose of sufficient length shall be used 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.
- (d) Where flexible hose is used as part of the installation, the hose shall be a reinforced hose for the LPG fuel (as per clause 9 (ii)(a)).
- j. Bypass relief device (if applicable): 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 carburettor on vehicles equipped with bi-fuel systems for the use of gasoline and gaseous fuel. The relief device need not be installed on fuel pumps containing a bypass relief device as original equipment.
- k. Fuel selection control: 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.
- l. Installation: The LPG control equipment shall be:
 - i. Installed in positions that are accessible for routine inspection, maintenance and adjustment.
 - ii. Mounted securely and reasonably protected from damage in a collision.
 - iii. Remote from the vehicle engine exhaust system or protected therefrom by a metal shield.
 - iv. No closer than is avoidable and practicable to any electrical equipment capable of sparking.

12. ELECTRICAL WIRING

- a. All wiring shall be properly installed, taped clipped or contained in a loom along its length.
- b. 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/manufacturer or vehicle manufacturer shall submit the test certificate/test report complying with above requirements.

- c. The electrical circuit shall be provided with a current limiting device. This equipment or fuse shall be dedicated to the LPG fuel system.

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 **within 60 seconds**.

A circuit breaker meeting these requirements is acceptable.

- d. Connectors and terminals shall be insulated to prevent accidental earthing during operations or routine servicing.

13. COMPLIANCE PLATE

There shall be installed near the filling connection and be clearly visible to the refueller a Compliance plate displaying the following information:

COMPLIANCE PLATE	
➤	Auto LPG Tank Identification Number(s)
➤	Date of Installation
➤	Water Capacity (litre) of the Total Installation
➤	Date of the Last Retest
➤	Vehicle Registration/Identification No
	The LPG installation complies with the safety requirements of AIS 027
➤	Installed by

Identification labels

- i. Vehicles using a LPG system shall be labeled as follows:

Labels conforming with the specification given in clause 13(ii) of this Standard shall be affixed in a vertical position as close to the vehicle number plate as practical or on left side of the front and rear safety glass and shall ensure visibility from the front and rear sides.

- ii. The label shall be in position at all times, shall be in good condition, and the shape, colouring and lettering shall be easily identifiable.
- iii. Label shall be coloured green, sized 80 mm x 80 mm square. Label shall have on them the text “LPG” in a central position not be less than 20 mm high, coloured white. The label shall have a white 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 D for drawing).

14. INSPECTION, TESTING AND COMMISSIONING (FOR INSTALLER)

i. Commissioning

Prior to initial use, inspection of the LPG system and components shall be carried out by, or under the supervision of, an Authorised Person/Installer, who shall also carry out a complete examination to ensure that the system complies with all relevant sections of this Standard and any statutory requirements as specified by the Government. of India.

ii. Initial inspection

The system shall be leak tested as detailed in Clause (14)(v) of this Standard. The installation shall be inspected for compliance with this Standard and all components shall be checked for desired operational performance. In the case of bi-fuel installations, the ability of the vehicle to operate on the optional fuel shall also be tested.

iii. Installation Certificate:

When the system conforms to this Standard an Installation Certificate (**as per Annexure VI of AIS 025**) signed by the Authorised Person/Installer shall be issued to owner of the vehicle.

iv. **Periodic** Inspection:

1) The Auto LPG Tank, piping and all components of the system shall be closely examined by an Installer for corrosion, deterioration and for any modification affecting compliance with this Standard at least once in a year or incase of malfunction or accident. The inspection shall include leak testing under clause (v) below.

2) When the system has been inspected and any defects remedied and the system conforms to this Standard to the satisfaction of Installer, **checklist as per Appendix A of this Standard**, shall be issued to the owner of the vehicle.

v. Leak testing

Initial test: At the time of commissioning, the complete system shall be subjected to a pressure test using LPG or a gas inert to LPG such as nitrogen in accordance with the following procedure:

1) Pressurize the system to a minimum pressure of 2.0 kg/cm² (g).

2) Check all joints, components and drain plugs for leaks.

3) Where a leak is indicated, the fault shall be rectified and system shall be re-tested for leaks.

WARNING: Ensure Auto LPG Tank and valve assembly approved by the Dept. of Explosives prior to use.

- vi. Subsequent testing: At the time of periodic inspection or after repairs to the system components downstream from the Auto LPG Tank, LPG or an inert gas like Nitrogen may be used for testing provided the following precautions are observed.

- 1) Testing shall be carried out under adequately vented conditions.
- 2) The test shall be at least 15 m from any open flame or other source of ignition.

At the time of commissioning of an installation for the first time or after any repairs, Auto LPG Tank(s) must be purged prior to filling with LPG.

- vii. Operational Performance: The operation of the equipment and controls shall also be tested under LPG at normal working pressure to prove satisfactory performance of the entire system and a further leak test shall be carried out using a non-corrosive foaming agent.
- viii. Testing of excess flow valve: The excess flow check valve shall be tested to ensure that it closes and re-opens by rapidly opening and then closing the service valve while the Auto LPG Tank remains under the pressure after the preceding test. This test should be performed at initial inspection and subsequent periodic inspections or after any servicing of the valve itself or following Auto LPG Tank removal/installment in the vehicle.

Procedure for test: The excess flow check valve shall be tested for correct functioning as follows:

- a. Close the service valve on the fuel Auto LPG Tank.
- b. Run the engine until all fuel in the service line is consumed.
- c. Disconnect the battery leads and stow safely. The battery shall be suitably covered and protected against electrical shorting.
- d. Check that the engine has no potential sources of ignition, for example, hot spots.
- e. Disconnect the service fuel line where it meets the automatic fuel shut-off device or where it meets the vaporizer/regulator whichever is first.
- f. Open the service valve on the fuel Auto LPG Tank rapidly and fully, then close it immediately.

The excess – flow check valve should function before or as soon as the service valve is fully open. Functioning of the excess-flow valve is confirmed when the initial escape of gas suddenly drops to the small flow permitted by the bypass in the closing disc of the excess-flow check valve.

- g. Reconnect the service fuel line. Slowly open the service valve and retest for leaks at the connection.

Where appropriate and acceptable alternative to the above test may be performed as follows:

Shut off the service valve and run the engine until the service line is empty. Open the service valve and listen for the sound of the excess-flow check valve operating. If it has not closed, close the service valve, run the engine until the service line is empty, and carry out the test as detailed above.

WARANING – Since large volumes of gas may escape during this test, it should only be done in the open air at a location which is at least 15 m from the open flame or any other source of ignition and as approved by Dept. of Explosives.

ix. Fire Extinguisher : A 10 kg of extinguisher conforming to IS:2171 of dry chemical powder type shall be kept ready at a safe distance at the time of performing the test. If ignition occurs the service valve should be immediately closed and the extinguisher be used to quell any fire.

x. Additional Auto LPG Tank : For more than 1 Auto LPG Tank the following shall apply:

a. Each excess flow valve shall be tested separately by disconnecting the fuel line prior to the non-return valve and the test carried out as per clause (viii) above.

b. The function of each non-return valve shall be tested by pressurizing the valve and testing for leaks.

c. When (a) and (b) are satisfactory the total system shall be tested according to clause (viii) with all Auto LPG Tank service valves opened simultaneously.

xi. Test of automatic fill limiter: **Only** functionality of the automatic fill limiter shall be checked **as per following procedure:**

Initially LPG tank shall be fully emptied of LPG (in liquid form) and then filled with LPG. Automatic fill limiter should cut-off the entry of LPG (in liquid form) to the LPG tank, when pre-determined maximum level of 80% of water capacity of LPG tank fitted on vehicle is reached.

xii. Gas tightness of compartments and sub-compartments

The compartment or sub-compartment shall be tested by the test agency for gas tightness as outlined in Clause 8(D).

At each periodic inspection the compartment or sub-compartment shall be tested by the installer using the following procedure:

a. A thorough inspection shall be made of all seals and gaskets to ensure that they are fitted correctly and no degradation of the material has taken place. Any seal or gasket showing signs of degradation shall be replaced.

- b. All mating faces of the hatch shall be inspected to ensure that full surface contacts being maintained when the hatch is in the locked position.
- c. Ducting shall be thoroughly inspected for any signs of damage or degradation. Where damage or degradation is noted the ducting shall be replaced.
- d. The ducting connections to the compartment, sub-compartment and the vent shall be checked for gas tightness.

Note - It may be permissible to check a compartment or a sub-compartment before installation of the fuel system, provided that nothing in the subsequent installation procedure will negate the validity of the test.

15. GARAGING AND REPAIR (FOR INSTALLER)

- i. Garaging and repairing of LPG fueled vehicles.

Vehicles fueled with LPG may be stationed or serviced and repaired inside garages provided that the following safety recommendations are observed:

- a. There shall be no leaks in the fuel system and the Auto LPG Tank is not to be filled beyond the maximum filling level as prescribed by the Dept. of Explosives.
- b. Vehicles shall not be parked within 3 m of any sources of ignition.
- c. Unless the fuel is required for engine operation, LPG fueled vehicles being repaired in garages shall have the Auto LPG Tank shut off valve closed and the LPG fuel in the service line exhausted by running the engine and disconnecting the line in the ventilated area.
- d. Vehicles undergoing repairs involving welding or the application of the heat to any part within 1 m of the Auto LPG Tank shall have the Auto LPG Tank removed or shielded from the source of heat.
- e. If the vehicle is repaired within 5 m of an open pit, the pit shall be adequately ventilated.

- ii. Repair operation

- a. Any repair operation involving heat shall be carried out with due regard to fire safety.
- b. Damaged fuel lines shall not be repaired; in all cases they shall be replaced.
- c. Welding, brazing and the application of heat shall not be carried out on any part of the Auto LPG Tank subsequent to manufacture.

- d. When a vehicle is involved in an accident causing damage to part or all of the LPG Fuel systems 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 clause 14(v) of this Standard and **checklist as per Appendix A of this standard** be issued. The requirements of sub-clause 15 (iii) (b) of this Standard shall also be met.
- iii. Scrapping
 - a. A vehicle, which is about to be scrapped, shall have its Auto LPG Tank removed prior to disposal.
 - b. Where the Auto LPG Tank has been subjected to impact or fire damage the Auto LPG Tank shall be inspected and re-tested as prescribed under Gas Cylinders Rules.

Note – There will always be combustible gas in the Auto LPG Tank until it has been cleared of all traces of flammable vapour or gas.

APPENDIX A

CHECKLIST FOR INSTALLATION

A1

This checklist is a guide for Installer when carrying out the inspection prior to issuing a Installation Certificate. Reference to relevant clauses in this Standard and requirements of Government of India should be made where appropriate.

- a) Auto LPG Tank
 - Approved by DOE
 - Validity of Certificate**
 - Free from corrosion
 - Mounted securely and inside vehicle perimeter
 - Mounting points free from corrosion and fractures
 - Shielded and valves protected where necessary
 - 5 mm clearance between auto LPG tank to vehicle components provided.**
 - Ground clearance correct
- b) Valves/Multi-function valves
 - Valves/Multi-function valves operating correctly and identified.
 - Safety valves protected against ingress of water and foreign material
 - Excess flow valve to be tested.
- c) Content gauge:
 - Locked off when external to vehicle.
- d) Filling connection
 - Refueling connection made external to vehicle
 - Cap captive to connection
 - Meets proof loading of 50 kgf in forward and reverse direction of vehicle
- e) Automatic fill limiter (AFL)
 - Notice “AFL” displayed at fill point
- f) Leak test:
 - All valves and fittings leak free
- g) Vapour sealing:
 - Gas-tight
- h) Ducting:
 - Free from damage and secure to outlets
- i) Sub-compartment:
 - Hatch cover access operating correctly
 - Carries correct markings

- j) Fuel line and filler hose:
 - Free from damage and corrosion
 - Secured to vehicle
 - Protected and shielded where necessary

- k) Joints and connections:
 - Leak free

- l) Filter:
 - Mounting secure
 - Leak free

- m) LPG shut off valve:
 - Mounting secure
 - No gas bypass after engine has stopped turning
 - Shielded where necessary
 - Leak free

- n) Gas air mixer:
 - Securely mounted
 - Backfire deflector where applicable

- o) 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) Electrical wiring:
 - Current limiting device fitted
 - Connections secure
 - Terminals insulated to prevent shorting
 - Wiring taped and clipped securely

- q) Compliance plate:
 - Installed and carries correct markings

- r) Identification labels
 - Located front and rear of vehicle

Note: The installer shall issue the installation certificate based on checks carried out as per the check list duly authenticated.

APPENDIX B

STATUTORY AUTHORITY APPROVAL

B1

The type of component in question and its use determine the Statutory Authority Approval in respect of **LPG** fuel system components. The Statutory areas of responsibility are:

Government Agency	Statutory powers	Scope of application
B 1.1 Ministry of Road Transport and Highways, Government of India.	Central Motor Vehicle Act, 1988 (CMVA) Central Motor Vehicle Rules, 1989 (CMVR)	All LPG kit components (excluding auto LPG tank & its valve(s)) and systems used for the purpose of propelling a motor vehicle on road.
B 1.2 Department of Explosives, Government of India	Gas Cylinder Rules,1981	Auto LPG tank with valves and their accessories.

APPENDIX C

LPG CHARACTERISTICS AND SAFETY ASPECTS

C1

The specification of LPG shall conform to IS:14861.

C2

LPG is stored, normally, as a liquid under pressure, is colorless and its weight as a liquid is approximately half that of an equivalent volume of water.

C3

In changing from a liquid state to gas LPG expands approximately 260 times its original volume at normal atmospheric conditions.

C4

A mixture of LPG vapour in air of between 2% and 10% by volume is flammable. Outside this range any mixture is either too weak or too rich to propagate flame. However, over-rich mixtures can become hazardous when diluted with air.

C5

LPG vapour is approximately 1.5 times denser than air.

C6

LPG vapour in common with most light hydrocarbon vapours, is slightly anaesthetic and also cause suffocation if present in sufficiently high concentrations.

C7

LPG is odorised (by adding ethyl mercaptan) at source to be detectable by smell at a concentration in air of about 20% of lower flammability limit, i.e. a vapour/air mixture of 0.5% by volume.

C8

LPG may also be detected through condensation of water vapour from the air in the vicinity of a leak or because of a visible shimmering effect caused under certain incident light conditions.

C9

Owing to its rapid vaporization and consequent lowering of temperature, LPG, particularly liquid, can cause severe frost burns if brought into contact with the skin. Protective clothing such as gloves and goggles should be worn if exposure to this hazard is likely to occur.

C10

Action in the event of a serious leak.

C10.1

On no account should a naked flame be used to detect a leak. Shut off all engines and any electrical equipment in the immediate vicinity and leave off until the gas hazard is removed.

C10.2

Smoking or naked lights must not be allowed. Extinguish all heaters, lights, gas rings, stoves and boilers in the immediate vicinity.

C10.3

Move all people to a safe distance from the leak in an upwind or crosswind direction.

C10.4

Unless the leakage is of a minor nature or the leak can be quickly controlled by those present on site, the Fire Service and Police Department should be notified, advising them of the location, material and volume involved.

C11

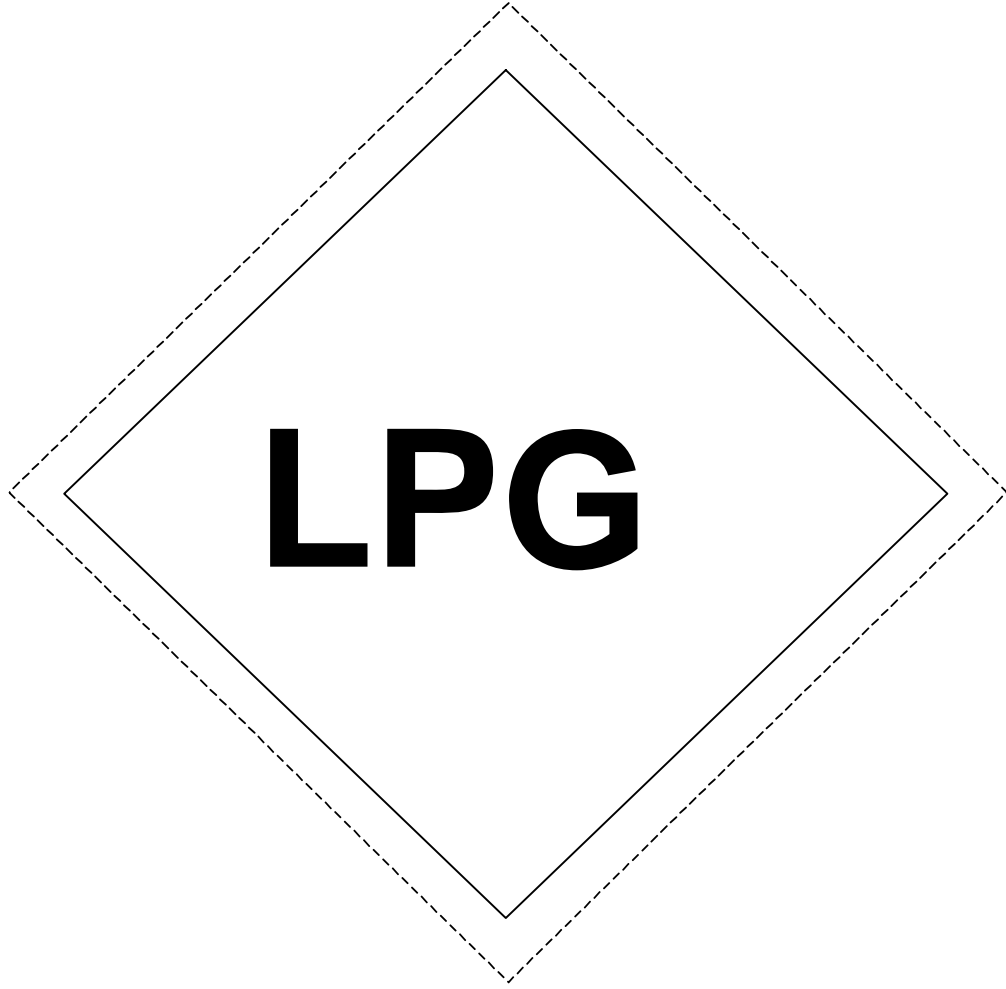
Action in the event of fire.

C11.1

In the event of fire, expert help from the Fire Service must be sought immediately and the Police Department notified. Advise them of the location. Carry out the same precautions as under "Serious Leak".

C11.2

Do not attempt to extinguish flames other than by cutting off the flow of LPG resulting fires with dry powder type extinguisher.



APPENDIX E

FREEZING CONDITIONS AND CORROSIVE CONDITIONS (*not applicable to vapour withdrawal system*)

E1

Where vaporizer heat is drawn from the engine cooling water, care should be taken to ensure that the water does not freeze in the vaporizer during cold weather. Expansion of the water on freezing can cause serious damage to the pressure regulator assembly.

E2

Most LPG vaporizer/regulators are made **from** non-ferrous alloys, which can suffer pin hole corrosion under certain conditions. If this is allowed to take place LPG 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 anti-corrosion additive 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.

APPENDIX F

BACKFIRE – DEFLECTOR TESTS

- 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.