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PART II

Statutory Notifications (S.R.O.)

GOVERNMENT OF PAKISTAN
MINISTRY OF PETROLEUM AND NATURAL RESOURCES

NOTIFICATION

Islamabad, the 13th May, 1992

S.R.O. 714(I)/92.—In exercise of the powers conferred by section 2 of the Regulation of Mines and Oil fields and Mineral Development (Government Control) Act, 1948 (XXIV of 1948), the Federal Government is pleased to make the following rules, namely:—

PART I

1. **Short title and commencement.**—(1) These rules may be called the Compressed Natural Gas (CNG) (Production and Marketing) Rules, 1992.

(2) They shall come into force at once.

2. **Definitions.**—In these rules, unless there is anything repugnant in the subject or context,—

(a) "area of operation" means the area within which a licensee is authorised to compress natural gas for the purpose of storing, filling or distribution of CNG in automotive(s);

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(b) "Authority" means the Director General (Gas) or any officer appointed by the Federal Government to exercise the powers and perform the functions of the Authority under these rules;

(c) "consumer" means any person or corporation who is supplied with compressed natural gas in his automotive(s) by a licensee for his own use but not for storage, processing, filling, sale or distribution;

(d) "container" means any cylinder or vessel installed in an automobile or at CNG refuelling station and used for storing, transporting and distributing CNG;

(e) "corporation" includes any corporation, joint stock company, partnership association, business trust, organised group of persons, whether incorporated or not and receiver or trustee of any of them;

(f) "licensee" means a person or a corporation who holds a licence under Part II of these rules;

(g) "compressed natural gas" or "CNG" means compressed gaseous fuel composed predominantly of methane (CH_4);

(h) "meter" means all equipment used for the purpose of measuring the quantity of CNG supplied, and includes all kinds of apparatus upon whose reading or indication for the supply or sale of CNG is wholly or partly determined in a specified or unspecified time;

(i) "sale price" means the price of CNG to be charged by a licensee under an agreement from the consumer (s);

(j) "supply mains" means a pipeline used for the transportation of natural gas for the purpose of sale to a licensee; and

(k) "works" includes pipelines, machinery or equipment including civil works established or installed, owned, controlled, operated or managed in connection with the compression of natural gas for the purpose of storage, filling or distribution of CNG.

PART II

3. **Licence compulsory.**—No person or corporation shall, without first obtaining a licence from the Authority, undertake, or cause to be undertaken under any agreement, the operation or construction of works connected with compression of natural gas for the purpose of storing, filling or distribution of CNG.

4. **Application for licence.**—(1) A person or corporation ~~having experience or knowledge of handling high pressure fuels~~ may submit an application to the Authority for a licence and ~~the number of~~ refuelling station (s) at the existing petrol pumps or at separate sites.

(2) An application for licence shall be in triplicate in the form annexed to these rules and shall be accompanied by a fee of Rs. 25,000/ Provided that where the grant of the licence is refused, half of such fee shall be refunded to the applicant.

5. **Consideration of application.**—(1) The Authority shall consider the application having regard to all the circumstances which appear to it to be relevant, and in particular, but not so as to limit the generality of the foregoing, to:

(a) the public and national interest; and

(b) the financial and technical competence of the applicant.

(2) The Authority may require such changes and alteration in the plants and in the details to be made as it may deem expedient.

(3) A licensee shall be bound by the provisions contained in these rules and such other terms and conditions as may be specified in the licence.

6. **Authority may grant or refuse licence.**—(1) The Authority may grant a licence for the compression of natural gas for the purpose of storing, filling or distribution of CNG in accordance with these rules and may specify in the licence such terms and conditions as it may think fit to impose on the licensee or it may refuse to grant the licence.

Provided that any person or corporation who or which was engaged, immediately before the commencement of these rules and with the approval of the Federal Government, in the compression of natural gas for the purpose of storing, filling or distribution of CNG or, in whose favour sanction for compression of natural gas for the purpose of storage, filling or distribution of CNG was issued by the Federal Government before such commencement shall be granted a licence, if such person or corporation makes an application in the form annexed to these rules for the purpose within three months from the commencement of these rules.

(2) In case of refusal to grant a licence, an appeal shall lie from the decision of the Authority to the Federal Government.

7. **Renewal of licence.**—(1) A licence granted under these Rules shall, unless earlier revoked under rule 8, remain valid for a period of fifteen years and may be renewed from time to time for a period of fifteen years each time on payment of a fee of rupees 25,000. Where the renewal of licence is refused, half of such fee shall be refunded to the applicant.

(2) Every licensee desiring to have his licence renewed shall make an application in that behalf to the Authority not less than three months preceding the expiry of the period for which the licence is valid.

(3) No application for a renewal of a licence shall be refused unless the licensee has been given an opportunity of being heard.

(4) In case of refusal to renew a licence an appeal shall lie from the decision of the Authority to the Federal Government.

8. **Revocation or amendment of licences.**—(1) The Authority may, if in its opinion the public interest so requires, revoke a licence in any of the following cases, namely:—

(a) where the licensee, in the opinion of the Authority makes wilful and unreasonably prolonged default in doing any thing required of him under the licence granted to him or by these rules and has been informed in writing to that effect by the Authority,

(b) where the licensee violates any of the terms and conditions of his licence and is so informed in writing and does not rectify the violation within the time specified,

(c) where the licensee is, in the opinion of the Authority, unable by reason of his insolvency fully and efficiently to discharge the duties and obligations imposed on him by his licence.

(2) Where, in the opinion of the Authority, the public and national interest so require the Authority may, instead of revoking a licence under sub-rule (1), permit it to remain in force in relation to the whole or any part of the area of operation with such alteration or amendments in the terms and conditions of the licence as it thinks fit to make or upon such new terms and conditions as it may impose upon the licensee.

(3) In case of revocation of a licence or any alteration or amendment in the terms and conditions thereof, an appeal shall lie from the decision of the Authority to the Federal Government.

9. **Licensee not to sell, assign, transfer, convey or lease his licence or works.**—No licensee shall, without the previous approval in writing of the Authority,

(a) sell, assign, transfer, convey or lease his licence or his works or any interest therein in whole or in part;

(b) enter into any agreement or contract for—

(i) the amalgamation of his works with those of any other person or corporation; or

(ii) the operation of his works by any other person or corporation;

(c) mortgage or otherwise create a charge upon the works or any interest therein.

10. **Execution of works after commencement of licence.**—The licensee, after the commencement of the licence, shall execute to the satisfaction of the Authority, his works within a period of one year or, such further period as the Authority may allow under special circumstances proved by the licensee to be beyond his control.

11. **Addition to or extension of the works.**—A licensee shall not make any alteration in, addition to, or extension of, his works as given in his plan and approved by the Authority, unless such alteration, addition or extension is authorised by the Authority.

12. **Right to discontinue supply.**—A licensee may temporarily discontinue supply of CNG when such discontinuance becomes necessary for the maintenance of works.

PART III

CHARGES AND ACCOUNTS

13. **Price of CNG to be sold.**—The price for CNG sold by a licensee to consumer(s) shall be charged in accordance with an agreement to be concluded between the licensee and the consumer(s).

14. **Measurement.**—(1) the amount of natural gas suplied to a licensee and CNG supplied to a consumer shall be ascertained by means of a correct meter. A meter shall be deemed to be correct if it registers the amount of natural gas or CNG supplied within the limits of error approved by the Authority and complies with such conditions as may be prescribed by the Authority.

(2) A licensee may require a consumer to give him security deposits for the price of CNG kit and ancillary equipment for the conversion of petrol or diesel vehicles into CNG vehicle or to enter into an agreement for the hire and maintenance thereof, and where the licensee or the consumer, as the case may be, enters into such an agreement the latter shall keep CNG kit and ancillary equipment for such conversion in correct and good condition.

15. **Wilful hindrance in submitting records, etc. unlawful.**—No licensee or consumer shall wilfully hinder, delay or obstruct the making, submitting or keeping of any information, document, report, memorandum or record or account required to be made, submitted or kept under these rules.

PART IV

GENERAL

16. **Entry, inspection and enforcement of the rules.**—The Authority or any person duly authorized by the Authority in this behalf may enter, inspect and examine any place in which he has reason to believe that there is any work (s) for compressing natural gas for the purpose of storing, measuring or distribution of CNG and take

other necessary steps for the due observance of the provisions of these rules by licensees, consumers or any other person connected with the storage, filling, distribution and use of CNG.

17. **Protection for acts done in good faith.**—No suit, prosecution, or other proceeding shall be instituted against the Authority for anything done, or purporting to be done, in public interest under the provision of these Rules.

18. **Protection to public.**—A licensee shall locate, construct and operate his works connected with CNG Refueling Station, installatoin of CNG equipment in automobiles in accordance with the Code of Practice appended with these rules and to the satisfaction of Chief Inspector of Explosives so as not to endanger public health or safety.

19. **Marking of works.**—A licensee shall mark with conspicuous signs the place of his works.

20. **Penalty for breach of rules.**—Whosoever commits a breach of these rules shall without prejudice to any other action that may be taken against him, be punishable for every such breach with fine which may extend to fifty thousand rupees.

KUNWAR IDRIS,
Secretary.

APPLICATION FORM FOR THE GRANT OF LICENCE UNDER THE COMPRESSED NATURAL GAS (PRODUCTION AND MARKETING) RULES, 1992

COMPRESSION OF NATURAL GAS FOR THE PURPOSE OF STORAGE, FILLING AND DISTRIBUTION OF CNG

(To be submitted in triplicate alongwith a fee of Rs. 25,000 ~~which should be deposited in Government Treasury under the Head of Account "XLVI—Miscellaneous"—Receipts arising out of Mines, Oilfields and Mineral Development (Federal Control) Act, 1948, Other Receipts and Challan attached).~~

(1) Name(s) of applicant(s) in full .....

(2) If application is by an individual or individuals,

(a) Address.....

(b) Nationality.....

(c) Present occupation and duration .....

(3) If application is by a corporation:

(i) (a) Present business(es).....

(b) Location(s).....

(ii) If principal place of business is outside Pakistan, name and address of duly authorised agent in Pakistan with particulars as in 3(i) above.....

(4) Previous experience/knowledge of handling high pressure fuels.

(5) Location ~~and area of operation for the activity/activities applied for (existing/proposed), and number~~ of CNG refuelling stations.

(6) Project details (attach a report giving the following):

(A) Compression/storage/filling units.

(i) Nature and capacity of fixed assets

(ii) Detail of utilities and services

(iii) Details of technical and operational personnel with an organogram

(iv) If new project, the period of completion and time of commissioning

(v) Capital cost, existing or estimated under following heads (give break-down of foreign exchange and rupee cost separately):

(a) Plant cost (separately for the activities applied for)

(b) Land

(c) Building

(d) Electrical equipment

(e) Fire fighting equipment

(f) Furniture and fixture

(g) Vehicles and transport

(h) Construction and engineering (for new projects and other miscellaneous assets)

(7) For distribution licence, indicate the details on which CNG requirement in the area of operation (applied area) are based indicating market surveys, if any, carried out.....

(8) Any other relevant information which may be helpful in the evaluation of the project.

(9) Remarks:

I/We hereby solemnly declare that all the particulars given above are correct.

I/We solemnly undertake not to sell, mortgage, etc., either directly or indirectly or through association, the rights privileges and obligation granted under this licence without prior approval of the Authority.

*In the even of any violation of this undertaking by me/us the Authority shall have the right to cancel the licence, provided that any dispute between the Authority and the applicant as to whether any of my/our activities can be considered as a violation of this undertaking shall be subject to decision in accordance with the provision of sub-rule (3) of rule 8 of the Compressed Natural Gas (Production and Marketing) Rules, 1992, and the appropriate clause in the licence.

Signature(s) Applicant(s).....

Date and place of applicant.....

(If the applicant is a corporation, capacity in which form is signed).

*In case the applicant is an alien or a corporation incorporated outside Pakistan.

COMPRESSED NATURAL GAS

SAFETY RULES 1992

STANDARD CODE OF PRACTICE

PART I: CNG REFUELLING STATION

1.0 General

1.1 The object of this Code is to provide planning information, procedures, standards and guidance for the procurement of equipment for the establishment of a CNG compressor and refuelling station.

2.0 **Definitions**

2.1 For the purpose of this standard the following definitions shall apply:

Bulk Tank.—A pressure vessel or a battery of pressure vessels composed of high pressure storage cylinders.

Compressed Natural Gas (CNG).—A compressed gaseous fuel composed predominantly of methane (CH_4).

Cylinder.—A pressure vessel with a water capacity not exceeding 250 litres for the storage of CNG.

Cylinder Filling Area.—A cylinder filling area specifically allocated for the filling and storage of CNG cylinders not permanently mounted on a motor vehicle. This may include the following types of cylinder applications:

(a) Single or portable containers

(b) Multi-cylinder containers.

DIVISION 1

An area within which any flammable or explosive substance, whether gas, vapour or volatile liquid, is processed, handled or stored, and where, during normal operations, an explosive or ignitable concentration is likely to occur in sufficient quantity to produce a hazard.

DIVISION 2

An area within which any flammable or explosive substance, whether gas, vapour or volatile liquid, although processed or stored, is so well under conditions of control that the production (or release) of an explosive or ignitable concentration in sufficient quantity to constitute a hazard is only likely under abnormal conditions.

Emergency Shut off Valve.—A quick action valve which operates from full open to fully close in less than one complete turn.

Fire Resistance Rating (FRR).—The minimum period of time for which all sides of an element of structure, any of which is subjected to a standard fire, continues to perform its structural function and does not permit the spread of fire.

Where a period of time is used in conjunction with the abbreviation FRR it is required that the element of structure referred to shall have fire resistance rating of not less than the period stated.

Gas Cylinder Truck System (Trawasi System).—A multicylinder or tank fixture permanently mounted on a special truck carriage and essentially used for the transportation of CNG to other refuelling stations.

Gas Storage Unit.—A group of gas cylinders contained within a length of 5.5 m, a height of 1.6 m and width of 1.1 m in the case of vertical cylinders, or 5.5 m, 1.6 m and width of one cylinder up to 2 m in the case of horizontal cylinders. Whichever arrangement is used, they shall be linked by piping to form a single gas storage unit.

Gas Storage Unit Isolation Valve.—A quick action valve for stopping gas flow from a particular gas storage unit.

Master Shut Off Valve.—A quick action valve for stopping gas flow which operates from full open to fully close in less than one turn and is capable of being locked off.

Non-Return Valve (Check Valve).—A valve which permits fuel flow in one direction only.

Pressure.—Gauge pressure in Kg/Cm^2.

Snubber.—A component which performs the function of a gas shock absorber normally achieved by an arrangement of suitable gas restriction orifices.

Statutory Authority.—Chief Inspector of Explosives, Government of Pakistan or an agency responsible for the particular aspect. (See Appendix J).

S.T.P. Standard Temperature (25° C) and pressure (atmosphere).

Vehicle Refuelling Probe.—The standard filling system refuelling device fitted at the end of the refuelling hose suitable for insertion into the vehicle refuelling valve fitting.

Vehicle refuelling shut-off valve.—A quick action valve for stopping gas flow which operates from full open to fully close in less than one turn and has the facility for venting residual high pressure gas in the refuelling line after completion of the vehicle refuelling operation.

3.0 **Procedure**

3.1 *Choice of site*

3.1.1 Planning and approval for the site of a proposed CNG refuelling station necessitates compliance with Compressed Natural Gas Safety Rules, 1992.

3.1.2 Use of the proposed site for an establishment of CNG compressor and refuelling station shall comply with prevailing industry practice for safe use of natural gas and isolation distance must be followed as per Clause 2 of this standard. Approval of the site location shall be the responsibility of the local Town Planning Authority.

3.1.3 At this preliminary stage application should be addressed to the local Gas Company for approval in so far as gas reticulation for the proposed site is concerned, and for basic guidance on connection requirements and for the inlet gas pressures which may be expected as these could be fundamental to the type of gas compressor suitable for that site.

3.1.4 The local Gas Company is additionally responsible for approval of the gas connection, the gas equipment and piping installation as laid down in Natural Gas Rules 1960 and requires that a permit be obtained from them prior to work being carried out on any new gas installation or appliance. Application shall be made to them accordingly. A CNG operating licence shall be obtained from the Chief Inspector of Explosives before station operations commence.

3.1.5 The gas storage system may be provided by an arrangement of linked multiple gas cylinders or by bulk storage tanks. Manufactured in accordance with ASME Boiler and Pressure vessel Code Section VIII Pressure Vessel Division I and Code Case 1215-6.

3.2 **Isolation distances**

3.2.1 Tanks, cylinders, and regulating equipment used with natural gas storage and for dispensing installations shall be located outdoors unless otherwise specifically approved as set out in Clause 3.1.

3.2.2 *Cylinders.*—Each individual cylinder used for storage or dispensing natural gas shall be located with respect to the nearest building or boundary of site, compressor equipment, or other source of ignition in accordance with table 1.

3.2.2.1 Isolation distances between openings or windows in walls in any building or structure on the CNG refuelling station and cylinder or tanks shall comply with column (b) in table 1.

3.2.2.2 No storage cylinders shall be located less than 3 m from the nearest street line or pedestrian walkway or other public place or protected works unless separated therefrom by a 4 h FRR concrete or masonry wall. Bulk storage tanks shall not be located less than 5 m from walkways.

3.2.3 *Cylinder filling areas*

3.2.3.1 Where cylinder filling areas are required, they shall be specifically allocated on the site, and protected from damage or unauthorized entry by means of a rugged steel mesh fence with secured access. Cylinder filling areas may be protected from the effects of the weather by a roof or canopy. Such a roof if provided shall be designed to facilitate the dispersion of free or escaped gas and shall not permit gas to be trapped.

TABLE 1

ISOLATION DISTANCE FROM BUILDING AND BOUNDARY TO GAS UNIT

Note.—For conditions applying to electrical equipment refer to section 9

Total capacity of gas storage units in cubic metres of gas at S.T.P.	Minimum Distance	Minimum on site distance between gas storage units and a 4 h FRR concrete or masonry wall
(a)	(b)	(c)
	m	m
Up to 1100 m^3 of gas (up to 4,500 L)	2.5	1.0
1100 to 2450 m^3 of gas (4,500 L to 10,000 L)	4.0	1.0
2550 to 24,500 m^3 of gas (10,000 L to 100,000 L)	10.0	1.6

Where L = Litres water capacity of cylinder or tank and gas capacity is in cubic meters at standard temperature (25° C) and pressure (atmosphere) when stored at 248 kg/Cm^2.

FRR *See* clause 2.1

3.2.3.2 Where a cylinder filling area is located within 3 m from a gas storage unit, boundary of site, public place or protected works, a 4 h FRR

reinforced concrete or masonry wall shall be located between the cylinder filling area and the aforementioned situation. Such a wall shall have a minimum height of 2 m and a length equal to the protected elevation of the cylinder filling area plus 2 m. When located on the site boundary the wall shall have a height equal to any roof or canopy line installed over the cylinder filling area.

3.2.3.3 When a cylinder filling area is located within a building, the isolation distances shown in table 1 shall apply.

Refer to definition in clause 2.1 for cylinder filling area.

3.2.4 *CNG dispensing point*

3.2.4.1 For positioning of the CNG dispensing point adjacent to a footpath or public place or where a footpath is likely to be constructed, any CNG dispensing point placed closer to the public place than 3 m should be separated from the public place by a high wall or netting fence which will make it impossible for the vehicles standing on the public place to be served. If the CNG dispensing point is between 3 m and 4.5 m from a public place a low nib wall should be constructed alongside the public place to ensure that vehicles being served do not project on to the public place. It is desirable that the CNG dispensing point should be 4.5 m from the footpath or public place to give vehicles sufficient room to manoeuvre freely. On rural roads the CNG dispensing point should not be located closer than 6 m from the edge of the roadway.

Note: The term "Place" in these instances means footpath or public place.

3.2.4.2 The CNG dispensing point shall not be closer than 2.5 m to the nearest cylinder in the CNG cylinder storage bank and vehicles shall not be permited closer than 2 m, this being controlled preferably by the provision of a kerbing surround. The CNG dispensers point shall be closer than 2.5 m to the nearest cylinder in the CNG cylinders storage bank provided the storage bank is enclosed in a suitable container. Vehicle shall not be permitted closer than 2 m if controlled by a provision of a kerbing surround or 1 m if controlled by steel bollards and a kerbing surround.

3.2.4.3 A CNG dispensing point shall not be closer than 3 m from any source of ignition or closer than 2 m from any opening into a building.

3.2.5 *Compressor situation.*—refer to section 9 and Appendices E, F and G.

3.2.6 *Storage location.*—If the CNG storage facility is adjacent to an existing petrol or liquid fuel dispensing facility the two must be separated by a minimum distance of 5 m.

3.3 **Static gas storage system and arrangements**

3.3.1 *Cylinders.*—(See clause 2.1) For ready access and to ensure that all cylinder fittings are easily accessible, multiple cylinder units which comprise a static CNG storage facility and are stored in a vertical position shall be limited to a width of 1.1 m, a length of 5.5 m and a height of 1.6 m above floor level. Each such storage unit shall be separated from other units by a distance of 2 m.

Isolation distances, refuelling arrangements and a typical vertical cylinder CNG storage facility are shown in Appendix A.

3.3.2 In the case of static storage facilities in which cylinders are in a horizontal position, each storage unit shall be limited to a height of 1.6 m, a length of 5.5 m and a width equal to the length of one cylinder up to 2 m. To ensure ready access all cylinder fittings should be arranged to face one direction in each unit. Each such storage unit shall be separated from other units by a distance of not less than 2 m. Where horizontal storage units are sited parallel to each other, cylinder fittings should be arranged so that they do not face cylinder fittings of other units. Isolation distances, refuelling arrangements and a typical horizontal cylinder CNG storage facility are shown in Appendices B and C.

3.3.3 Cylinders installed horizontally shall be separated from one another in each storage unit by a distance of not less than 30 mm. Their cylinder valves should be on the same side opposite to the refuelling point and arranged so that any gas escapement discharges upwards and clear from cylinders above. Valves, manifolds and piping from these shall be provided with protection against damage from vehicles, maintenance gear or equipment traffic.

3.3.4 The distance between each area of storage cylinders shall be 2 m. The CNG storage unit could be sited adjacent to an existing petrol or liquid fuel dispensing facility in which case the two shall be separated by a distance of 5 m minimum. (See diagrams Appendices A, B and C).

3.3.5 Cylinders and bulk storage units shall be installed on a firm, compacted, well-drained foundation. This foundation may be in the form of a plinth with the raised edge at 2 m from the front and sides of the cylinder storage unit forming a kerb up to which vehicles would be permitted.

3.3.6 Above-ground storage shall be protected from damage or unauthorised interference by means of a rugged mesh steel fence or equivalent fitted to surround the storage area at 1m from the cylinder banks. Above-ground storage units shall be protected from impact from manoeuvring trucks, trailers and other vehicles where such impact is likely or probable, by a

with an approved pressure relieving device and an approved isolating valve which shall be readily accessible when installed in the gas storage unit. The isolating valve shall not be capable of closing off the pressure relieving device.

5.1.2 If at all practicable, relief devices should have their outlets arranged or angled such that in the emergency event of a high pressure gas escape from these there should be no direct impingement on operators or persons in the close vicinity of the gas storage unit enclosure.

5.2 **Safety relief devices for cylinder storage units**

5.2.1 Piping and gas storage systems shall be protected against over pressure by safety relief devices. Relief devices installed to protect the storage systems shall have sufficient capacity and shall be set to open at a pressure not exceeding 20 per cent above the maximum allowable working pressure of the system or the pressure which produces a hoop stress of 75 per cent of the specified minimum yield strength whichever is lower.

5.2.2 Safety relief devices may consist of ~~one of~~ the following:

(a) *Burst disc assembly.*—An overpressure device set at not exceeding 20 per cent above the maximum allowable working pressure of the cylinder. In addition to the disc the discharge is made through fixed directional orifices.

(b) *Relief valve.*—Mechanical pressure relief valve which opens at a pre-determined pressure.

5.2.3 Pressure relief devices for natural gas service shall not be fitted with lifting devices. If external the adjustment shall be provided with means for sealing to prevent tempering by unauthorised persons. If at any time it is necessary to break such a seal, the valve shall be removed from service until it has been reset and sealed. Any adjustments necessary to natural gas safety relief valves shall be made by the manufacturers or other companies having competent personnel and adequate facilities for the repair, adjustment and testing of such valves. The organization making such adjustment shall attach a permanent tag marked with the setting capacity and date. All safety relief devices shall be tested at least annually and maintained in proper operating condition.

5.2.4 If pressure regulators are used, a safety relief device shall be provided on the low-pressure side of each final stage regulator, and on the low-pressure side of all other regulators unless the piping or fittings, or both, from the low-pressure side of such regulators to the high-pressure side of the next stage regulation are suitable for full tank pressure.

suitable kerb or fences or posts and railings.

3.3.7 Gas storage facilities may be protected from the effects of the weather by a roof or cannopy. Such a roof, if provided, shall be designed to facilitate the dispersion of free or escaped gas and shall not permit gas to be trapped.

3.4 **Mobile gas storage Travasi system** (see Clause 2.1)

3.4.1 An isolated parking bay shall be provided at both the compression station where the gas cylinder truck is refilled and at the refuelling station where CNG is decanted form this truck for vehicle refuelling.

3.4.2 Isolated parking bays shall allow easy access and means of egress and shall be constructed with reinforced 4 hour FRR walls and roof. Wall height shall be a meter above the maximum height of the gas cylinder truck. The parking bay should also be oriented such that in case of cylinder failure, maximum protection is afforded to other CNG station components.

3.4.3 Parking bays for the gas cylinder truck should be isolated from the rest of the CNG station by distances in conformance with Table 1. (See Appendix K for layout).

3.4.4 Isolation distances between opening in walls of the parking bay shall comply with column (b) in Table 1. Openings in walls are not desirable.

3.4.5 The minimum isolation distance for gas cylinder parking bays from the nearest public place or protected works shall be not less than 5 m.

4. **Pressure-vessel-design**

4.1 *Cylinders*

4.1.1 *Specifications.*—specifications currently approved for cylinder design include BS 5045 Part 1 or the (US) D.O.T. 3AA. Testing and certification of these and proposals for the use of other specifications which could be acceptable shall have the prior approval of the Chief Inspector of Explosives.

4.1.2 All cylinder and valve fitting shall be rated for the full range of temperatures and pressures and the manufacturer shall stamp or otherwise permanently mark the valve body to indicate the service ratings.

5. **Pressure relief devices**

5.1 *General*

5.1.1 Each cylinder or bulk tank used for the storage of CNG shall be equipped

5.2.5 The minimum required rate of discharge of the safety relief valves for CNG, storage units shall be at least equal to any input from the system, whether stored or being compressed.

5.2.6 All safety relief devices and cylinders shall be approved by the Chief Inspector of Explosives.

5.2.7 Each safety relief device shall be plainly marked by its manufacturer with the pressure at which it is set to start to discharge and the discharge capacity in cubic meter per minute.

5.2.8 No shut-off valve shall be installed between the safety relief device and the gas storage unit without written permission from the Chief Inspector of Explosives, except that a shut-off valve may be used on multiple valve installations where the arrangement of the valves will provide full required flow through the safety relief devices at all times. The opening or connection between the gas storage unit and safety relief device or devices shall have at least the combined areas of all connected safety relief device inlets.

5.2.9 Safety relief devices shall be so arranged that they will have an unobstructed full size discharge to a safe place and shall be so arranged that escaping gas will not impinge on the vessel, valves or fittings, or vent under the eaves of buildings.

5.2.10 Except for safety valves that are integral with service valves, safety relief devices on tanks and cylinders shall be installed in a vertical position and shall be fitted with suitable raincaps.

5.2.11 All natural gas devices not otherwise specifically provided for shall be constructed and installed to provide a safety equivalent to that required for other parts of the system.

5.3 Unattended filling stations shall have a gas detector operated cut-out switch fitted to the electrical system of the compressor to automatically switch off the unit in the event of a major gas leak.

6.0 **Corrosion Protection**

6.1 Pressure vessels which are made of materials that are subject to corrosion by atmospheric conditions, and which are not provided with an allowance for external corrosion by a suitable increase in design thickness, shall be protected by painting or other equivalent means necessary to prevent corrosion.

6.2 The user's attention is drawn to the importance of avoiding corrosion which can otherwise limit the working life of the cylinders and affect the fatigue characteristics in serious cases. The implementation of good periodic preventative maintenance in anti-corrosion procedures is strongly recommended.

7 CNG Transfer

7.1 *Equipment.*—All devices which are used in natural gas installations shall be of a type and construction suitable for their intended use. The Statutory Authority (refer Appendix J, Clause 3) may approve or accept devices or package units upon satisfactory evidence that they are designed and constructed for safe operation in natural gas service.

7.2 *Valves*

7.2.1 A minimum of four shut-off valves shall be fitted between the gas storage unit and the vehicle refuelling filling nozzle except in those cases quoted in Clause 7.2.3.

7.2.2 *Gas storage unit isolation valve.*—Each gas storage unit shall have an approved quick action gas storage isolation valve installed in the steel supply pipe immediately adjacent to its gas storage unit to enable individual shut-off and isolation of each such unit. These valves will be within the security fence enclosure.

7.2.3 *Master shut-off valve.*—A master shut-off valve shall be installed in the steel outlet pipe outside, but immediately adjacent to, the gas storage unit. This valve shall be capable of being locked off but not capable of being locked on. The valve shall be an approved quick action valve. This valve shall be outside by the security fence that surrounds the gas storage unit. The function of this valve is to isolate all downstream equipment from the gas storage unit.

Note.— In those refuelling stations where vehicle CNG refuelling is carried out only immediately adjacent to the gas storage unit the master shut-off valve is acceptable as the emergency shut-off valve (*See* Clause 7.2.4).

7.2.4 *Emergency and isolation shut-off valve.*—A quick action emergency shut-off valve shall be installed on the steel outlet pipe and shall be in a readily accessible position to the vehicle refueller. This valve should be shut-off when the refuelling point is unused. (Refer to Appendix H).

7.2.5 *Vehicle refuelling shut-off valve.*—A vehicle refuelling shut-off valve shall be installed for each flexible vehicle refuelling hose. This vehicle refuelling

shut-off valve will control the refuelling of vehicles with CNG and shall have facilities for venting to allow for the bleeding of residual high pressure gas in the refuelling line after vehicle refuelling (Refer to Appendix H).

7.2.6 All valves shall be suitable for the full range of pressure and temperature to which they may be subjected. The manufacturer shall stamp or otherwise permanently mark the valve body to indicate the service ratings. Other piping components such as strainers, snubbers and expansion joints shall also be similarly marked. The master shut-off valve and emergency shut-off valve shall be clearly labelled by a label affixed there to, with letters of not less than 20 mm height on a yellow or white background. The valves or valve labels should clearly indicate the direction of closing.

7.2.7 For a typical arrangement of these valves, See Appendix H.

7.2.8 It is recommended that bleed connections are designed into transfer systems to permit depressurizing any CNG supply line before dismantling for servicing.

7.3 *Rigid Piping*

7.3.1 All rigid pipe, tubing, fittings and other piping components between the gas storage unit and the emergency and isolating shut-off valve shall be designed of the full range of pressures, temperatures and loadings to which they may be subjected with a factor of safety of at least 8 based on the minimum specific tensile strength at 20° C. Any material used, including gaskets and packing, shall be compatible with natural gas and its service conditions.

7.3.2 All piping and tubing shall be run as directly as practicable with adequate provisions for expansion, contraction, jarring, vibration and settling. Exterior piping may be either buried or installed above ground and shall be well supported and protected against mechanical and corrosive damage. Where overhead piping crosses the vehicle access way it shall be at least 4.4 m above ground. In the case of buried pipes on site the minimum burial depth is to be 450 mm, but consideration must be given to local conditions and traffic patterns over these including settlement effects and physical damage from fill materials.

7.3.3 All welded piping shall be fabricated and tested in accordance with BS 5351.

7.3.4 All welds in high pressure pipelines throughout the storage and compressor system shall be carried out only by an appropriately qualified welder.

Alternative methods of jointing may be approved by the appropriate Authority.

7.3.5 All piping and tubing shall be tested after assembly to a pressure equal to that of the safety relief device setting and proved to be free of leaks. It is recommended that this test could initially be carried out with kerosene or an inert gas. it is imperative that safety precautions appropriate to the pressurizing agent being used should be rigidly applied.

7.3.6 Rigid pipelines shall be continuous between their respective components and free of connections except welded joints. Any concession from this requirement shall be subject to the approval of the Statutory Authority.

7.4 *Flexible hose*

7.4.1 Flexible hose shall only be used downstream of the emergency and isolation shut-off valve.

7.4.2 The flexible hose shall be of or lined with material that are resistant to corrosion and to the actions of natural gas and shall be approved by the Statutory Authority.

7.4.3 The flexible hose shall be suitable for the most severe pressure, temperature and service conditions expected with a burst pressure of at least four times the maximum working pressure. (*See* Clause 10.1.3).

7.4.4 Connections for flexible hose shall be designed with a burst pressure of at least four times the most severe pressure and temperature conditions expected.

7.4.5 The components of the flexible hose shall be tested after assembly and prior to use to at least two times the working pressure, and also tested to a pneumatic pressure of at least 40 Kg/cm^2 under water. After the original installation, all hoses shall be examined visually at such intervals as are necessary by the owner to the requirements of the Statutory Authority to assure that they are safe for use. In no case shall such examination interval exceed one year. Hose shall be tested for leaks with soap suds or equivalent at least annually and any leakage shall be reason for rejection. The test shall be recorded.

7.4.6 Flexible hose shall be distinctly marked either by the manufacturers permanently attached tag or by distinct markings indicating the manufeturer's name or trade mark working pressure and suitability for use with CNG.

8.0 **Pressure Gauges**

8.1 Every CNG storage unit including manifolded group of cylinders or bulk storage tank shall be provided with a suitable pressure gauge. The pressure gauge shall communicate directly with the tank of storage unit system and shall have an opening not to exceed 1.4 mm diameter at the connection. The pressure gauge shall have a dial graduated to read approximately double the operating pressure, but in no case less than 1.2 times the pressure at which the pressure relief valve is set to function. Pressure gauges shall be check calibrated every three years.

9.0 **Electrical Equipment and Wiring**

9.1 All electrical wiring and equipment shall be in accordance with the requirements of KESC/WAPDA except that electrical equipment located within the hazardous areas Divisions 1 and 2 (*see* definitions, Clause 2.1) shall comply with the requirements of:

BS 4683	Electrical appuratus for explosive atmospheres
BS 229	Flameproof enclosure of electrical apparatus
BS 4137	A guide to the selection of electrical equipment for use in Division 2 areas.

(*See* Appendices E, F and G for hazardous area delineations, Division 1 and 2).

9.2 Any building encroaching on the hazardous area containing non-flameproof or non-intrinsically safe electrical apparatus, shall be constructed of impervious materials and located such that the gas path to any opening is equal to or greater than that specified for hazardous area delineation.

10.0 **Operation**

10.1 At public refuelling stations, vehicle refuelling should be from an overhead hose assembly. When not in use the refuelling hose shall be supported by wide clips, to ensure against abrasion or kinks, and to facilitate the easy withdrawal for use without contact with the ground. A vented metal cabinet shall be provided for overnight security for the vehicle refuelling shut-off valve which is fitted on the refuelling hose.

10.1.1 No natural gas shall be vented to the atmosphere unless the vent is led to a safe point of discharge. Nothing in this code shall prohibit the use of

gauging devices which vent to the atmosphere through an opening not exceeding 1.4 mm diameter.

10.1.2 A sign shall be erected adjacent to the filling point which shall indicate that no smoking or open flame is permitted within 6 m of the refuelling operation. This sign shall be easily read from a distance of 30 m.

10.1.3 The maximum allowable filling pressure for vehicle CNG cylinders is 200 kg/cm² at 15° C, or its equivalent at another temperature. There shall be a pressure controlling device fitted to achieve this.

10.1.4 All refuelling connections used for vehicle refuelling shall be of a common type. The approved refuelling connection is the vehicle refuelling probe type, as shown in Appendix M.

10.1.5 Except for control and indicating devices that are also designed for natural gas and which have an orifice not larger than 1.4 mm drill size, natural gas shall not be used to operate any device or equipment designed to be operated with compressed air which exhausts to the atmosphere. Natural gas vapour shall not be released into the air except as referenced in this code.

10.1.6 Designers and operators of CNG filling stations should seek the advice of the local Area Fire Service with respect to suitable fixed fire protection services including extinguishers and alarm systems.

10.1.7 It is in the interests of refuelling station operators to establish a contact with their nearest Fire Service authority and to offer them inspection facilities so that in the event of emergencies arising the Fire Service will know the layout of equipment, whereabouts of keys, and access arrangements applicable to the station.

10.1.8 Refer to Appendix L for refuelling procedure.

Appendix 1.

REFUELLING PROCEDURE

L1 **Filling Instructions**

L1.1 Filling instructions should be posted in a conspicuous place adjacent to the dispensing hose:

Ensure that:

(a) The identification labels are approved and in position.

(b) There is no smoking within 6 m of the vehicle.

(c) The vehicle hand-brake is firmly applied and automatic transmission vehicles parked in the gear of "P".

(d) All vehicle ignition, electrical system and radio (including shortwave communication equipment) are switched off.

(e) The cylinder is within the periodic test life and the system complies with this standard and any statutory requirements, including inspection certification.

(f) There are no obvious leaks in the vehicle's CNG equipment.

(g) The fuel connection is in good condition and matches the dispenser filler nozzle.

L.2 FILLING PROCEDURE

(a) Remove dust plug from vehicle refuelling connection.

(b) Attach refuelling hose to fill point.

(c) It is desirable not to leave the vehicle during filling operations except in the case of trickle fill.

(d) Open refuelling valve slowly allowing the CNG to transfer from storage cylinders to vehicle cylinder. CNG should be slowly introduced into the vehicle to avoid shock loading and a rapid increase in gas temperature.

(e) Close the refuelling valve on completion of fill.

(f) Carefully disconnect filling hose allowing a small escape of gas from filling nozzle.

(g) Return hose to correct position on dispenser.

L2.1 Before any vehicle is driven away from any dispensing point it is imperative that there are no gas leaks either:

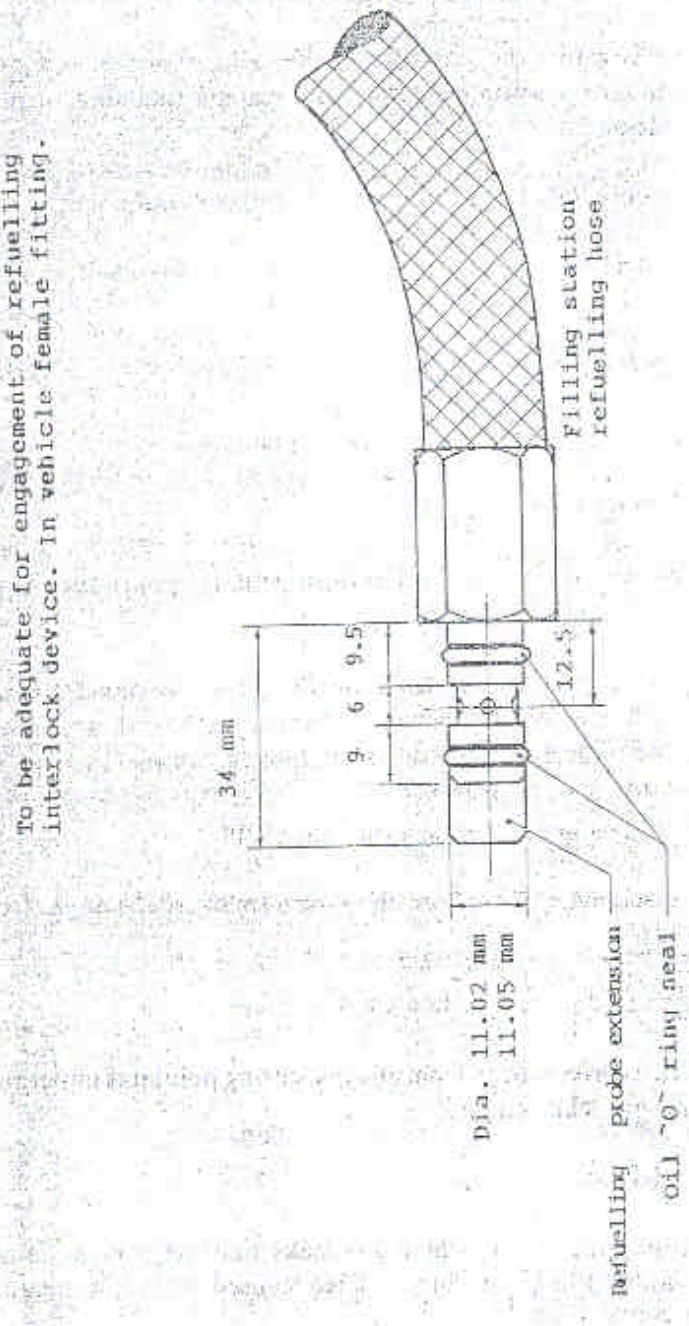
(a) On the vehicle, or

(b) On the dispensing point, where gas leaks may have been caused through faulty filling or any leakage caused by replacing and removing connections.

APPENDIX - M
(Part - 1)

CNG REFUELLING PROBE

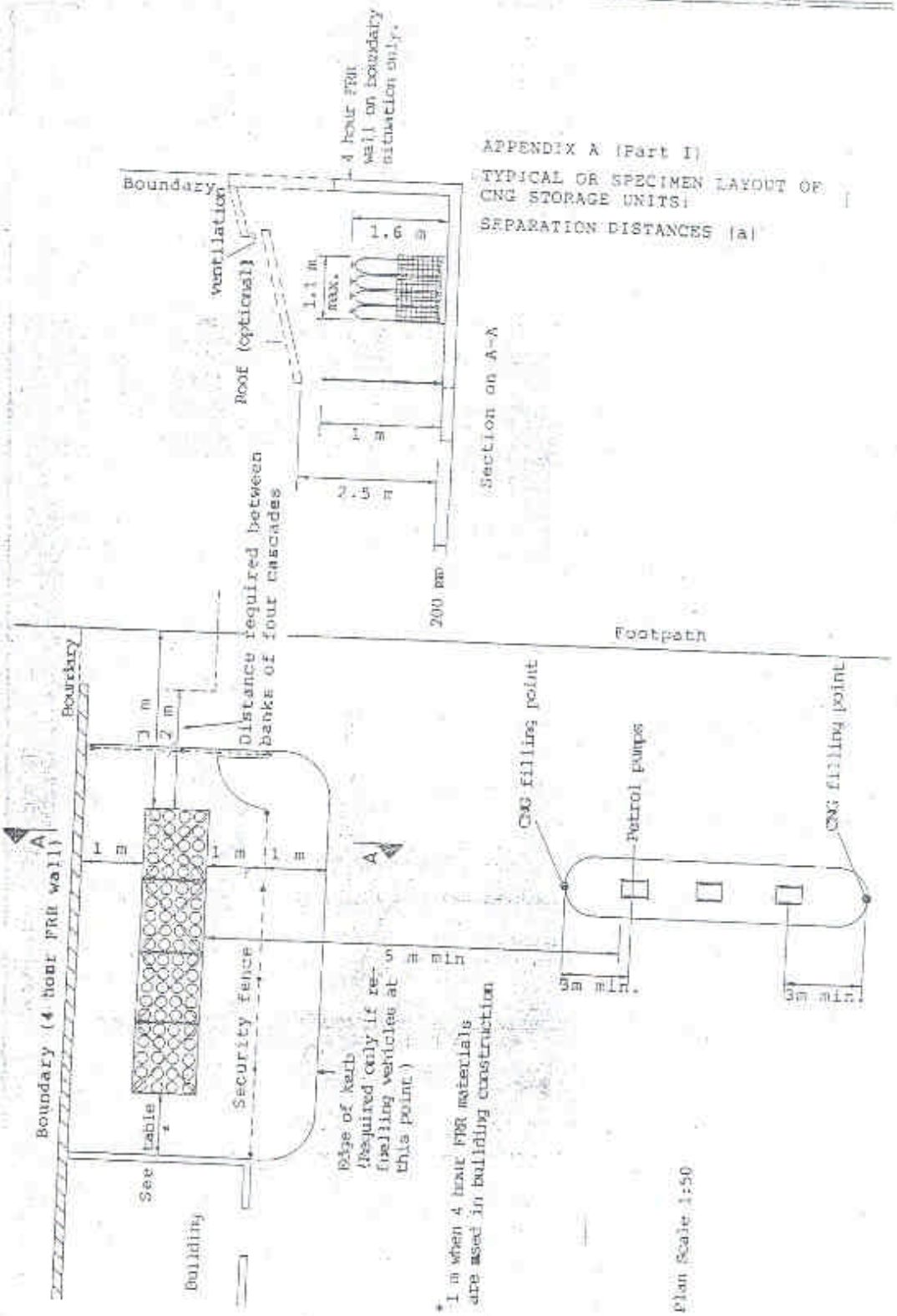
Dimensions in mm

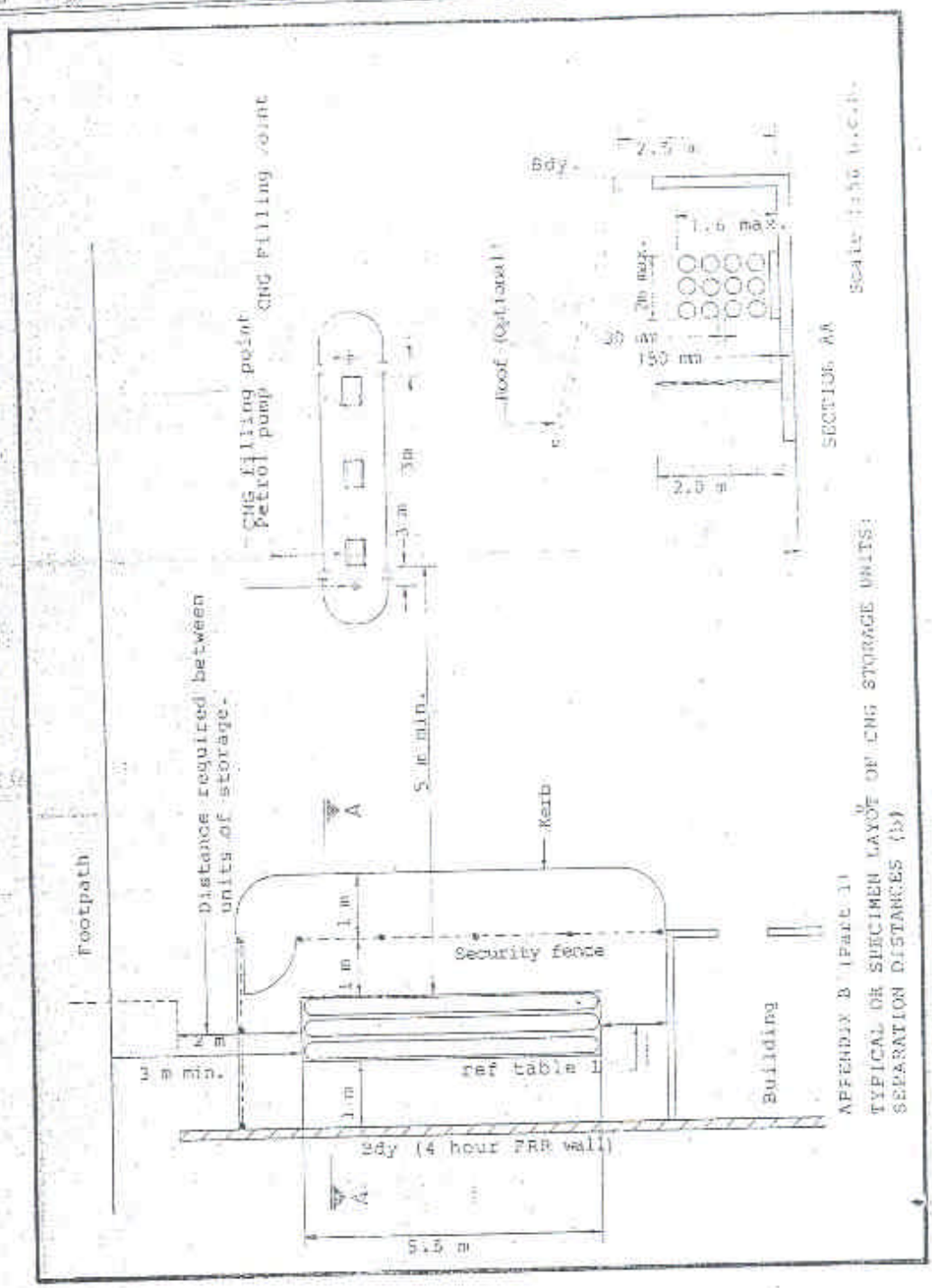


APPENDIX A (Part I)

TYPICAL OR SPECIMEN LAYOUT OF CNG STORAGE UNITS:

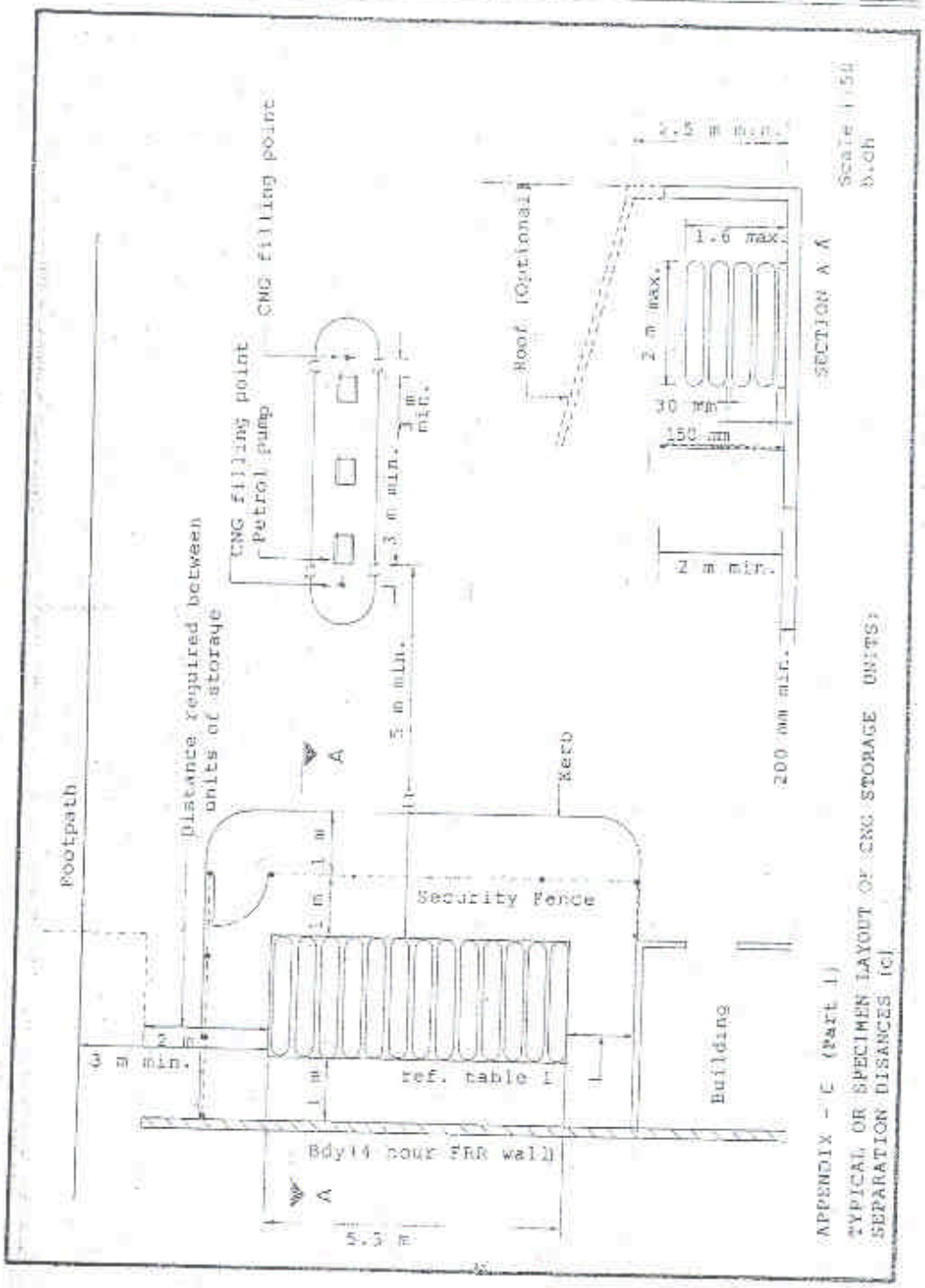
SEPARATION DISTANCES (a)





APPENDIX B (Part 1)

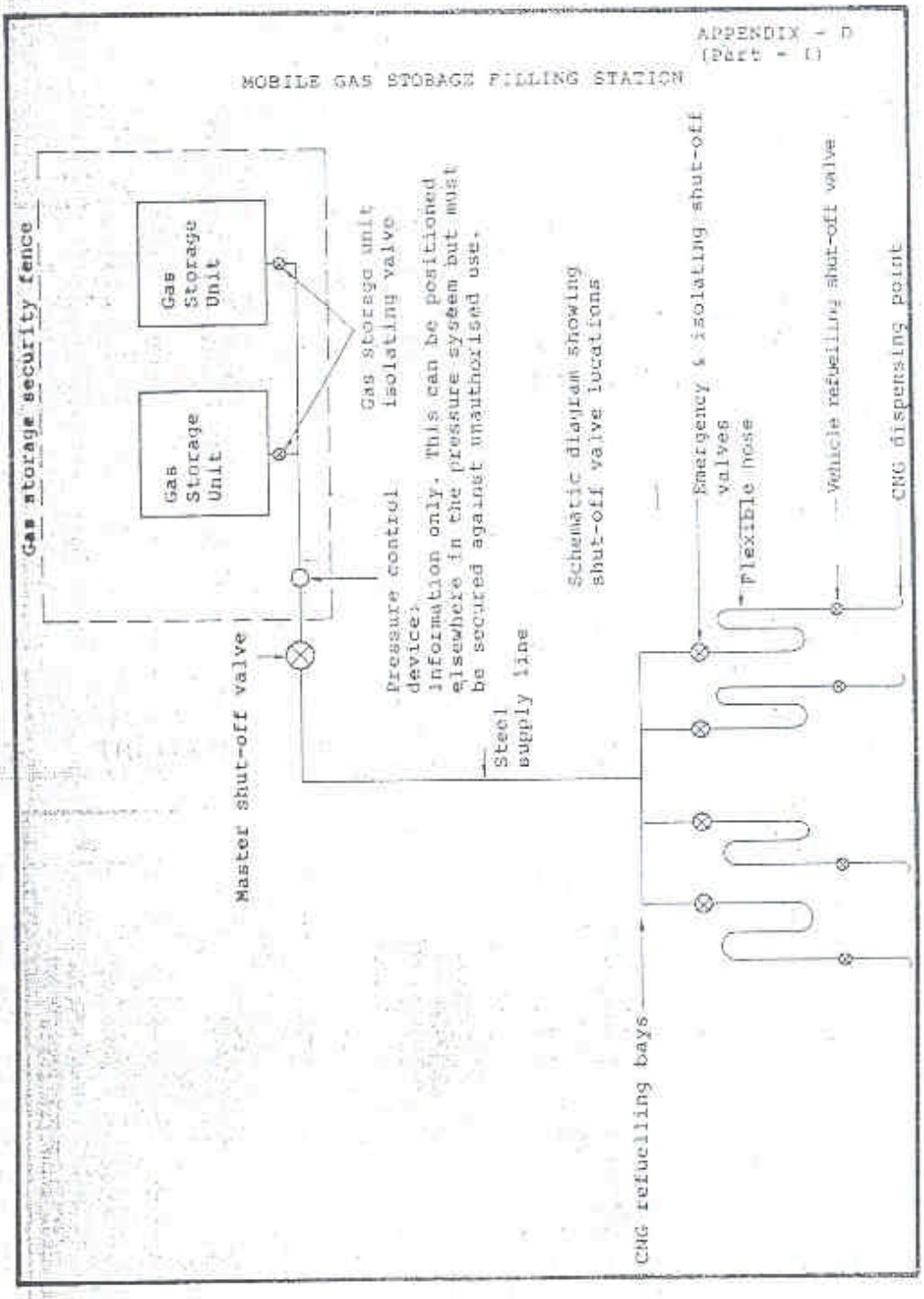
TYPICAL OR SPECIMEN LAYOUT OF CNG STORAGE UNITS: SEPARATION DISTANCES (1)



APPENDIX - C (Part I)
TYPICAL OR SPECIMEN LAYOUT OF CNG STORAGE UNITS: SEPARATION DISANCES (C)

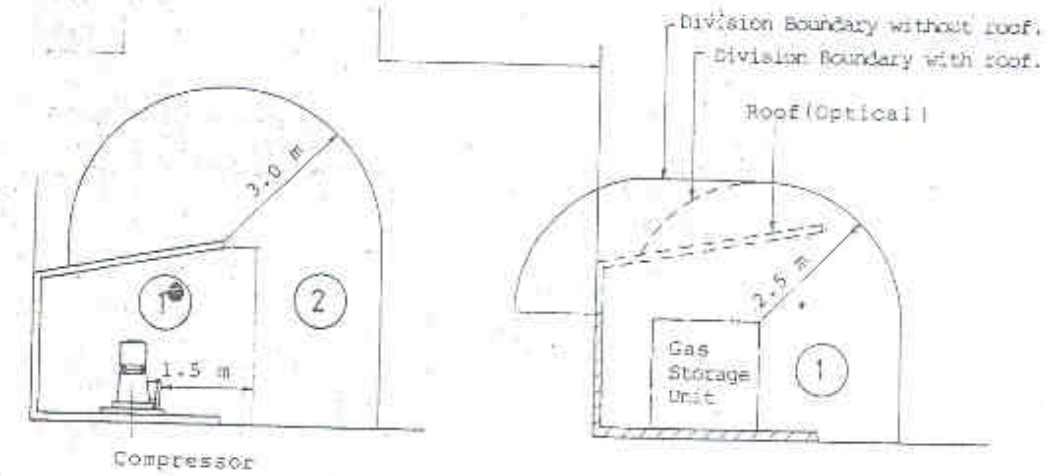
APPENDIX - D
(Part - I)

MOBILE GAS STORAGE FILLING STATION



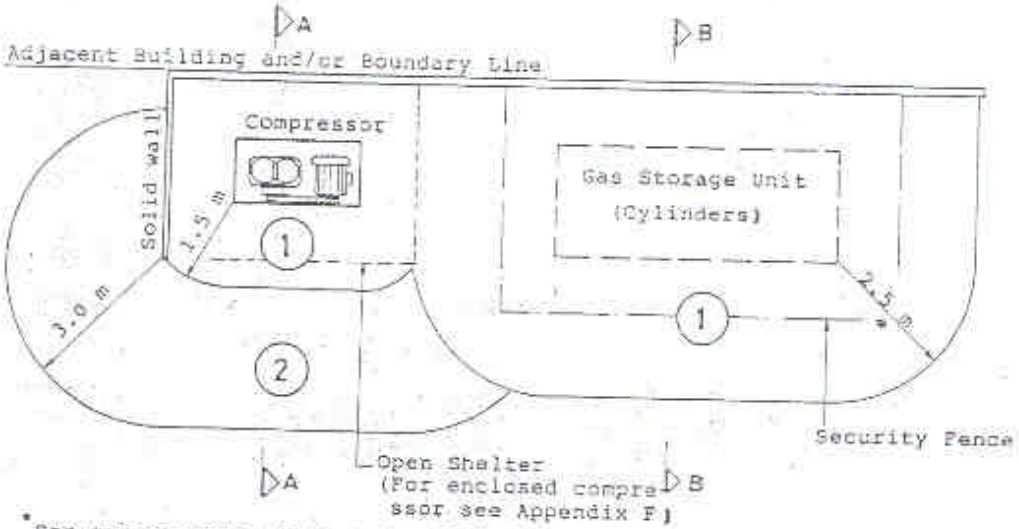
HAZARDOUS AREA DELINEATION (ADJACENT BUILDING) APPENDIX - E (Part - I)

djacent Building and/or
oundary line



Sect. on A-A

Sect. on B-B

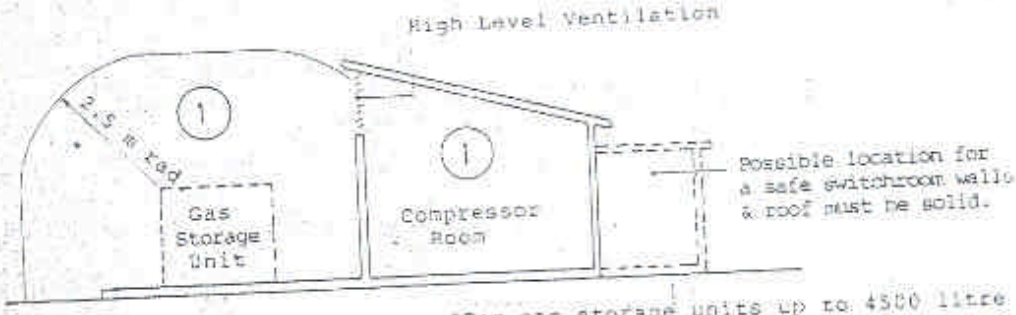


* For gas storage units up to 4500 litre capacity
For gas storages greater than this see table 1

1 Hazardous Area - Division 1

2 Hazardous Area - Division 2

HAZARDOUS AREA DELINEATION (ENCLOSED COMPRESSOR) APPENDIX - F
(Part - I)

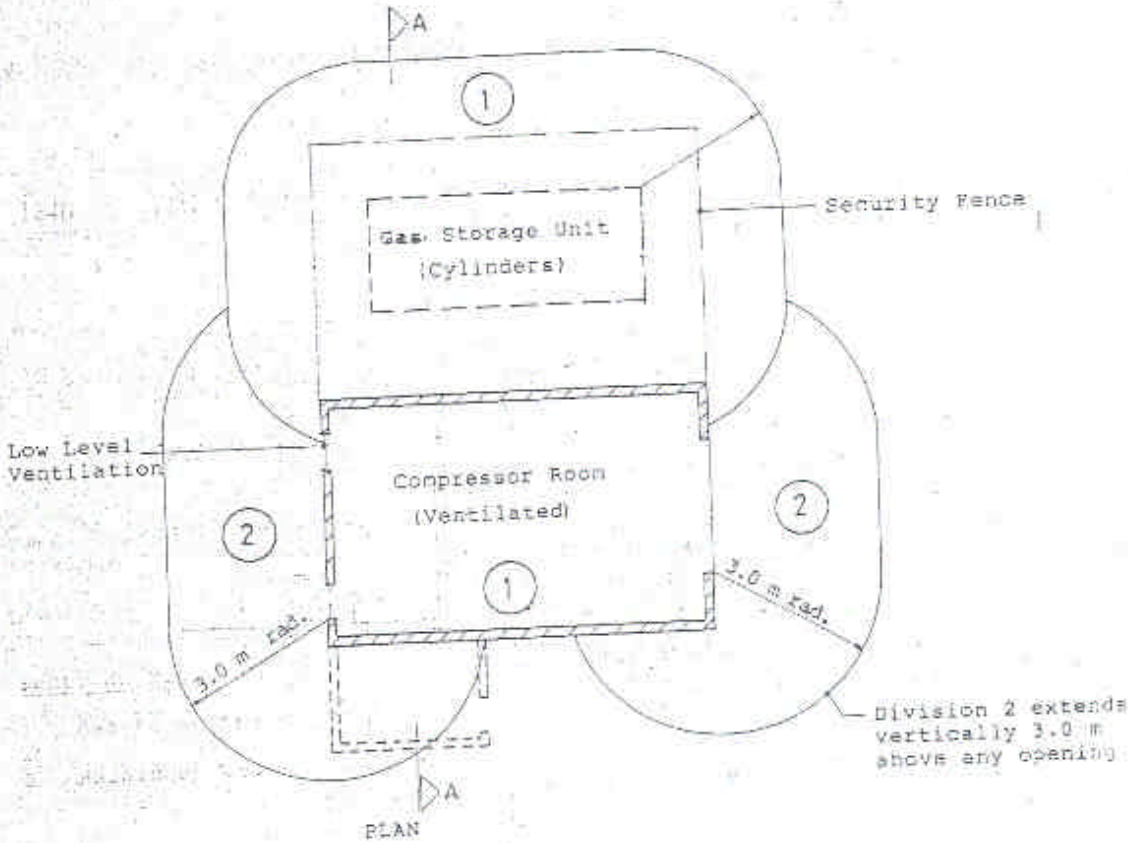


*For gas storage units up to 4500 litre capacity.
For gas storages greater than this see table 1.

Sect. on A.A

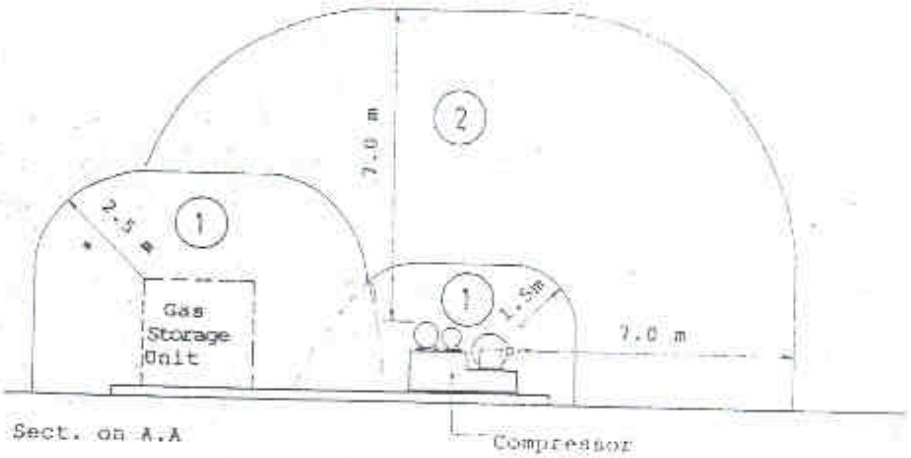
1 Hazardous Area - Division 1

2 Hazardous Area - Division 2



APPENDIX - C

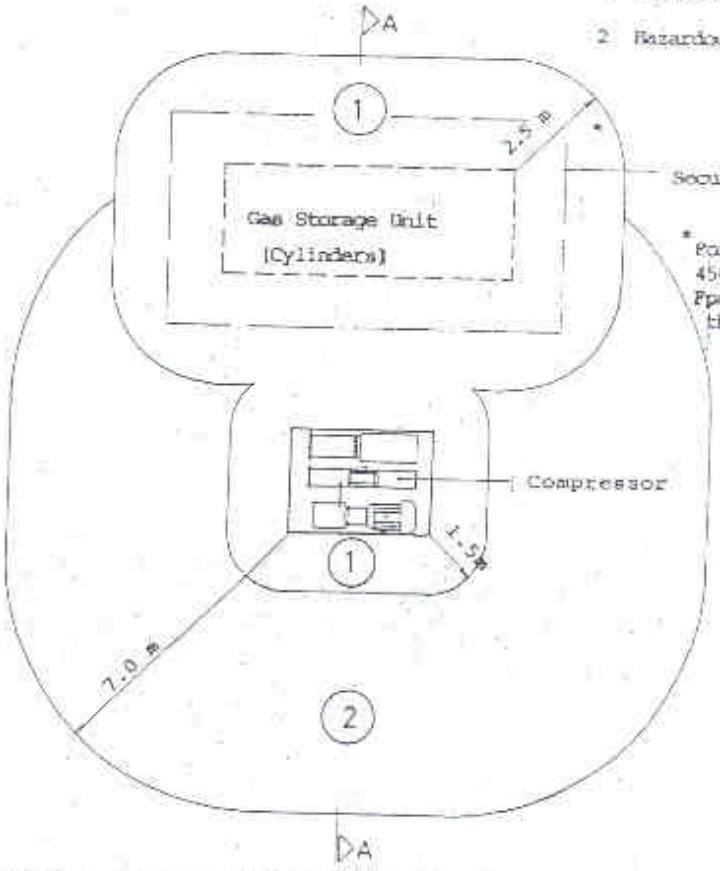
HAZARDOUS AREA DELINEATION (OUTDOOR INSTALLATION) (Part -I)



Sect. on A.A

1 Hazardous Area - Division 1

2 Hazardous Area - Division 2



* For gas storage unit upto 4500 litre capacity. For gas storage greater than this see table 1.

Note: A shelter over equipment having not more than three walls may be classified as an outdoors location, provided that all walls and roof apex have ventilation openings.

Appendix H

CALCULATIONS OF THE TOTAL GAS STORAGE REQUIRED

H1 The figures given in this appendix are for guidance only and merely indicate the fundamentals involved in making an elementary calculation for a first approximation of the gas storage requirements. They are not to be taken as specific.

H2 Estimate number of vehicles per day (x) that the station is likely to refuel with CNG.

H2.1 Estimate the average number of cubic meters of CNG (y) that is to be required for each vehicle refuelled (average uplift per vehicle).

(1) From the product of (x) times (y) calculate the total of cubic meters of gas required by the station per day to meet the estimated demand.

(2) Divide answer (1) by the number of hours per day that the station is to be operated.

(3) From (2) obtain the cubic meters of gas required per hour. This will be the average only.

(4) Estimate the peak demand (5) assuming that each vehicle will require 6 min. for a refuel.

(5) From (4) knowing that 10 vehicles per hour maximum can be refuelled from each separate refuelling point calculate the number of CNG refuelling points required on the station.

(6) Multiply answer (3) by 1.5 which will then give 1.5 times the average cubic meter demand per hour for the station.

(7) Take answer (6) and compare this with the peak demand answer (4).

(8) Decide from (7) the cubic meters of CNG gas that the station will economically require per hour and then calculate gas storage cylinders required assuming that 40 per cent of the CNG only can be recovered from the cascade.

(9) If a booster compressor is fitted between the cylinder storage unit and the fill point then the 40 per cent recoverable from the unit can be

disregarded and the calculation for storage can be made assuming the whole (100 per cent) can be recovered.

H3 NOTE ON METHODS OF STORAGE USAGE

H3.1 As the filling pressure of gas to vehicles will be approximately 200 Kg/Cm² and the maximum pressure in the storage system 248 Kg/Cm², it follows that the minimum storage pressure of 200 Kg/Cm² must be available at any refuelling time. Any drop below this figure in the delivery bottle would be unacceptable for satisfactory service unless a booster pump is fitted between this and the dispensing point.

H3.2 To make the most efficient use of the gas storage, depending on the size and peak demand of the system, it may be necessary to arrange for a number of bottles to be held at high pressure (well above 200 Kg/Cm²) while allowing other groups of cylinders to fall below vehicle maximum delivery pressure. By manifolding these groups, gas pressure from the lowest pressure group manifold is fed first to the refuelling point until the vehicle cylinder is filled to match, the operator will then switch to the next group manifold with medium pressure and thirdly to the high pressure for topping off at the 200 Kg/Cm².

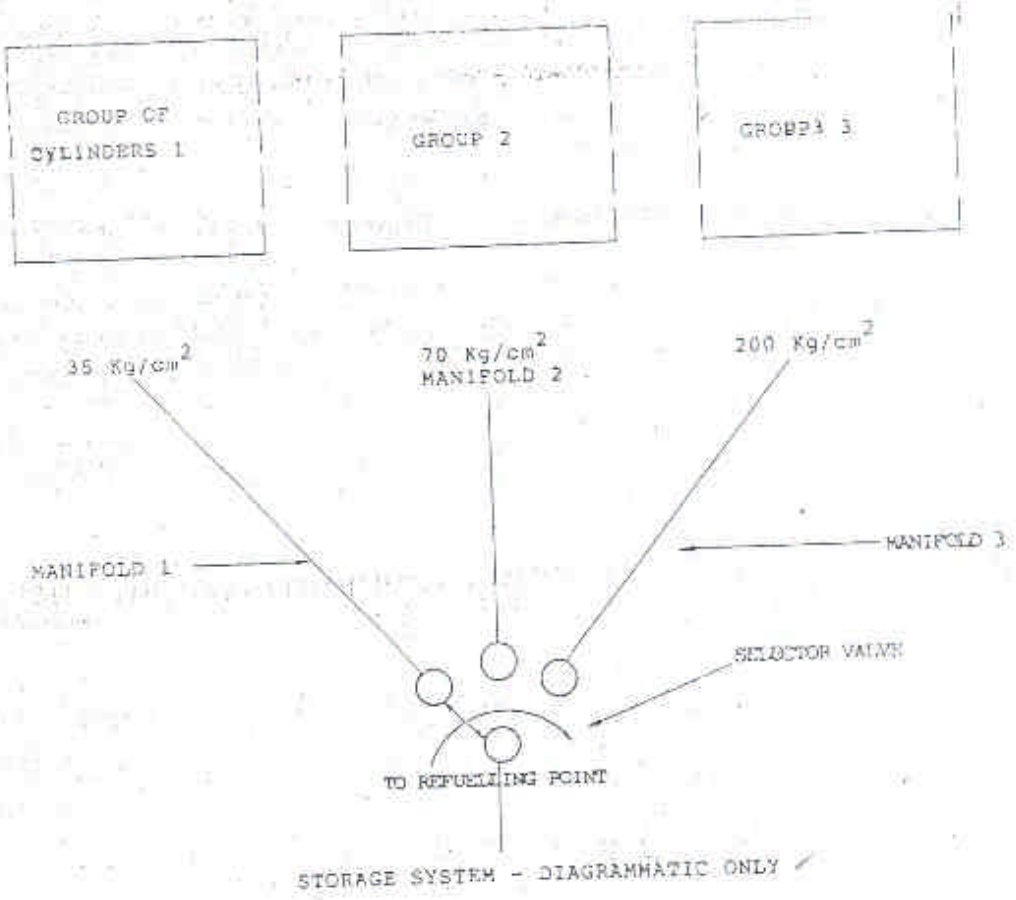
H3.2.1 Such a system might have three or more pressure stages but will involve the operator in an increase of refuelling time required unless an automatic switching device is fitted.

The figures given are for explanation of a system only and may be a typical situation in a gas storage unit during the course of an operation. They are not to be taken as requirements.

It is possible to arrange for a small compressor and large gas storage unit or a larger compressor and smaller gas storage. The decision will rest with the pattern of refuelling demand expected and with timing and frequency of peak conditions.

The compressor must be capable of meeting the estimated total uplift per day with some reserve and its output arranged to cover peak conditions through storage flexibility.

It is essential to request the compressor specification delivery volumes per hour at the requirement pressure for compressed natural gas at its specific compressibility factor before making a decision on size requirements.


GROUP OF CYLINDERS 1
GROUP 2
GROUP 3
35 Kg/cm2
70 Kg/cm2
MANIFOLD 2
200 Kg/cm2
MANIFOLD 1
MANIFOLD 3
SELECTOR VALVE
TO REFUELLING POINT
STORAGE SYSTEM - DIAGRAMMATIC ONLY

Appendix J

STATUTORY AUTHORITIES

1. Director General (Gas) Ministry of Petroleum & Natural Resources:

   - CNG Station installation approval in compliance with CNG Rules 1992.

2. Chief Inspector of Explosives, Ministry of Industries, in compliance with CNG Rules, 1992:

   Design, inspections and approval of bulk tanks and their fittings.

3. The local Gas Company:

   Low pressure area inspection.

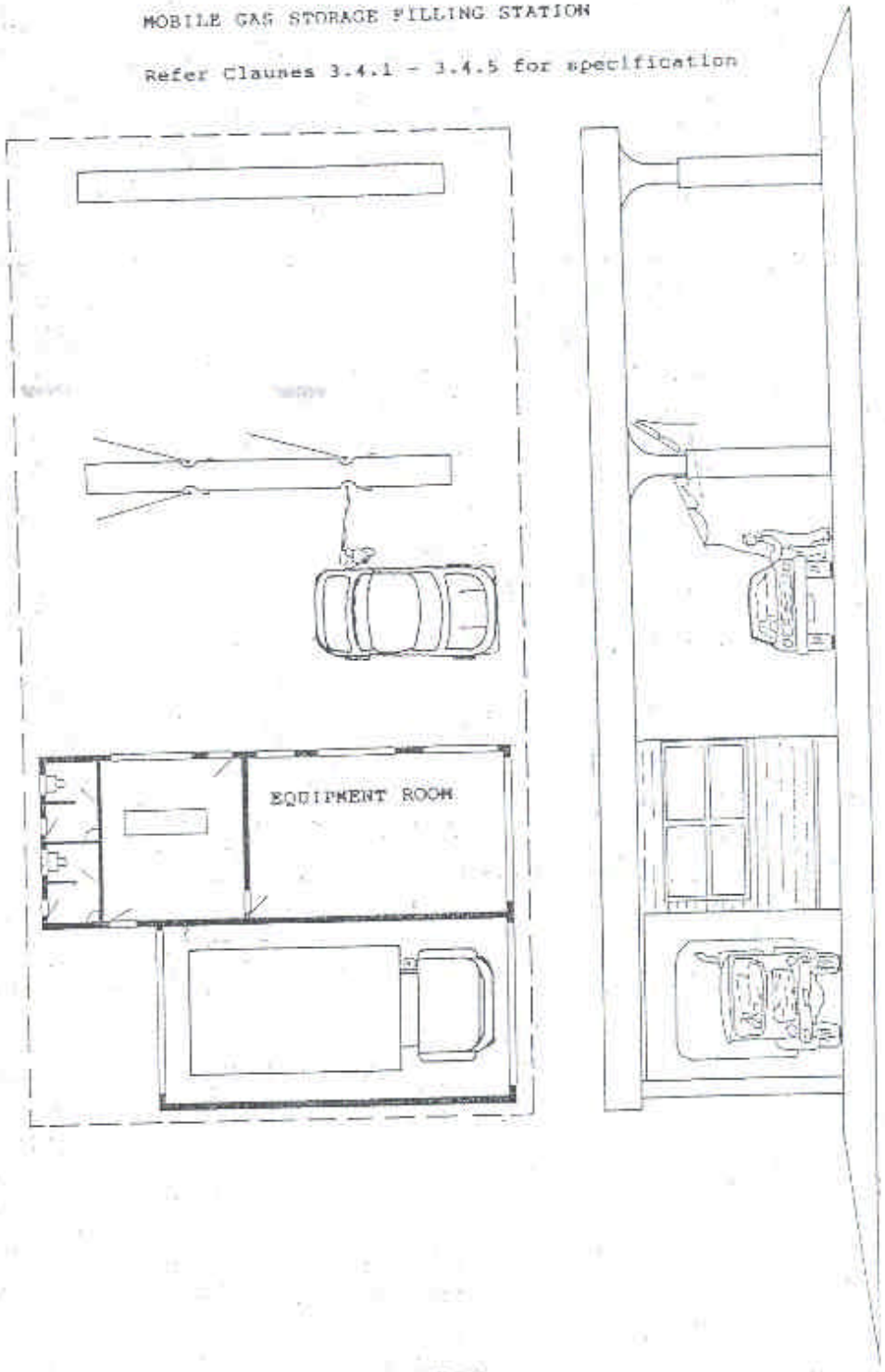
4. Hydrocarbon Development Institute of Pakistan (HDIP) or CNG Station operator.

   Hydrostatic testing of storage cylinder after 5 years of operation. (Primary responsibility of testing shall be of user's of high pressure cylinder and owner responsible for filling of these cylinders).

APPENDIX K
(Part - I)

MOBILE GAS STORAGE FILLING STATION

Refer Claunes 3.4.1 - 3.4.5 for specification



COMPRESSED NATURAL GAS
SAFETY RULES, 1992
STANDARD CODE OF PRACTICE
PART II : CNG COMPRESSOR EQUIPMENT

1.0 General

1.1 The object of this code is to provide planning information procedures, standards and guidance in the procurement of equipment for the establishment of a CNG compressor and refuelling station.

1.2 *Scope*

1.2.1 This Part concerns in particular compressors using natural gas supplied by pipeline by gas companies.

2.0 Approval Requirements

2.1 A CNG compressor should fulfil the Approval requirement of Appendix A.

3.0 Gas Supply Requirements

3.1 Prior to the selection and specification of CNG compressor for a particular site the local Gas Company must be contacted for:

(a) The gas reticulation and connection requirements.

(b) Gas inlet pressure that is to be available at the specified connection.

(c) The equipment to be provided to safeguard the reticulation system and the meter/regulator equipment. (*See* section 6).

3.2 *Characteristics of the gas*

3.2.1 In considering a decision on a suitable compressor it is essential that the answer to clause 3.1 is known before laying down a specification of the unit.

3.2.2. It is necessary to apply for a permission from the local Gas Company before any installation work commences.

3.2.3 Most compressors will be sited outdoors and will be provided with a simple roof over them for minimum protection and cover for maintenance

operations. In those cases where a compressor is to be sited inside a building, ventilation shall be designed to facilitate the dispersion of free or escaped gas and shall not permit gas to be trapped.

4.0 **Switchboard Electrical Control Equipment**

4.1 In the process of the selection of a suitable compressor for the station its electrical power requirements must be considered and discussed with the Electricity Supply Authorities at an early stage of the station planning. The capacity of existing power mains will be a consideration and in some instances and conditions the authorities may find it necessary to undertake special measure to bring adequate power on site.

4.2 All electrical wiring, electrical equipment located within the hazardous areas Divisions 1 and 2 (*see* definitions, section 9 of Part 1 of this Standard) shall comply with the requirements of BS 4683, BS 229 and BS 4137.

4.3 For the zoning application of electrical switch gear refer to Appendices E, F and G of Part 1 of this standard.

4.4 Further reference is made in Section 9 of Part 1 of this Code to electrical equipment and wiring requirements for the refuelling station.

4.5 In positioning the compressor it is necessary to plan the layout to permit adequate space and accessibility for the electrical switchgear, the meter, the regulator components and to ensure that the area requirements are made for proper maintenance and inspection.

4.6 If the switchgear is remote from the compressor or positioned in a separate room an isolation switch shall be fitted adjacent to the compressor.

4.7 The lighting installation shall comply with the requirement of the Electrical Wiring Regulations of the electricity supply authority.

5.0 **Foundations**

5.1 It is important to ensure that foundations suitable to the site for the compressor are provided according to the specifications and drawings of the manufacturer of the compressor where applicable. By this means the vibration, dynamic balance, noise and damping characteristics will have been taken into account at the working rpm under load.

5.1.1 Overseas specifications may not, in all cases, be fully appropriate to local conditions and in these circumstances a check should be made for the additional requirements that are to apply.

5.1.2 Existing floor slabs are likely to be inadequate and if these are part of an existing building it is essential to seek qualified advice before proceeding.

5.2 It should be noted that inadequate mounting and foundation arrangements can lead to high subsequent maintenance costs not only in the compressor but additionally in the associated gas system and pipework.

6.0 **Gas Connections**

6.1 The following equipment must be provided on the inlet gas line to a CNG compressor downstream of the local Gas Company metering assembly :

(a) A non-return valve to prevent back flow in the event of compressor malfunction.

(b) A low pressure cut-off valve with manual reset to shut-off the supply in the event of low reticulation system pressure. The manual reset is required to prevent the machine restarting until the fault causing the low pressure is rectified.

(c) A surge chamber to dampen flow pulsations at the meter.

(d) A flexible connection to prevent mechanical vibration being transmitted back on to the metering equipment. This will not normally be required on the slow speed hydraulic ram type of compressors.

7.0 Noise

7.1 Noise from certain types of compressor shall receive the close attention of the installation planner as in some cases this could seriously affect the economics of the station by restriction of the hours of operation permitted on a particular site or by requiring sound attenuation equipment.

8.0 **Testing and commissioning**

8.1 Testing procedure for the compressor must be carried out in accordance with the procedures laid down by the manufacturers of the unit. It is important to ensure strict compliance with the manufacturer's specifications for the lubricants to be used.

Note :—Certain lubricants, by virtue of their origins, may not be suitable for use in gas compressors.

8.2 At the first start-up of the compressor it is essential for the operator to ensure that the full conditions of the manufacturer's warranty have been observed and met.

8.3 Confirmation is required that Completion Certificates from the local power supply authority and from the local gas authority have been appropriately signed.

9.0 Safety

9.1 As the use of dry and sweet gas has an important impact on the safe operation of CNG, particularly in reducing the risk of internal corrosion of cylinders, and under certain conditions build-up of hydrate accretions, it is recommended that CNG used in Pakistan shold be dried and purified to a level that will not adversely affect the safe operation of CNG equipment. This may be achieved by using an effective drying system in conjunction with refuelling station compression equipment to ensure that moisture is absorbed from the gas prior to compression.

9.1.1 To avoid the build-up of hydrate accretions at low temperatures when the gas is used to fuel engine sytems, a methanol injection method can be used in conjunction with the refuelling station equipment. Information on the required amount of methanol to treat the gas for this purpose is given in Appendix B. The quantities of methanol required to be effective in this procedure are very small.

Attention is drawn to additional information which can be obtained from the American Gas Engineers Handbook.

9.2 Safety Notices

9.2.1 A "NO SMOKING" sign shall be positioned adjacent to the compressor room and shall be directly seen at normal eye level height by any one approaching the area.

9.2.2 In cases where compressors are subject to automatic starting a notice in letters approximately 75 mm high shall be provided at eye level and at the front of the compressor to read:

CAUTION NOTICE
THIS MACHINE MAY AUTOMATICALLY START
AT ANY TIME

Appendix A

APPROVAL REQUIREMENTS FOR CNG COMPRESSORS

PART I—GENERAL

QUALITATIVE REQUIREMENTS

1.1 *Scope*. These requirements apply to compressors designed as suitable for

continuous full load duty, mechanically, electrically or hydraulically powered and intended for CNG cylinder refuelling applications.

Such compressors are usually, but not necessarily, multistage reciprocating compressors with cooled, lubricated cylinders of either trunk type or crosshead design.

1.2 All electrical wiring and equipment shall be in accordance with the Electrical Wiring Regulations, except that electrical equipment located within the hazardous areas Divisions 1 and 2 shall comply with the requirements of :

BS 4683 Electrical apparatus for explosive atmospheres

BS 229 Flame proof enclosure of electrical apparatus

BS 4137 A guide to the selection of electrical equipment for use in Division 2 areas

1.3 **Features specially required**

1.3.1 The compressor shall be provided with adequate means of support or mounting.

1.3.2 Gas manifolds shall be firmly fixed to prevent displacement.

1.3.3 Construction of the compressor shall be such that continuity of satisfactory operation can be expected during normal usage.

1.3.4 Materials and finishes, including dressings and lubricants used in the construction of a compressor shall be suitable for the conditions of use, (*e.g.* corrosion, temperature, etc.).

1.3.5 Compressors intended for outdoor installation shall have all controls and electrical wiring adequately protected from climatic conditions to ensure safe and reliable operation.

1.3.6 The gas inlet connection shall be firmly fixed and anchored to prevent rotation while making the connection.

1.3.7 The gas inlet connection shall have a B.S.P. threads to BS 21. Male thread shall be taper threads, and all female threads for use at pressure above 0.07 Kg./cm^2 should be taper threads. An adaptor to achieve the standard gas connection is acceptable.

1.3.8 The gas inlet connection shall be so located that sufficient free space is available for the union connection to be made or disconnected, using normal tools, without the necessity for unduly difficult or time-consuming dismantling.

1.3.9 Components and integral parts which may require adjustment shall be accessible for such adjustment.

1.3.10 Components which require to be removed for service shall be so made and attached to the compressor that they can be removed and replaced.

1.3.11 Controls shall be accessible and easily operated by the user.

1.3.12 Compressors shall be provided with clear and permanent markings readily accessible and easy to read when the compressor is in the installed position. Such markings shall include the following:

1. Manufacturer's trade name.
2. Model designation
3. Serial number or month and year of manufacture.
4. Certificate of Approval number.
5. Rated capacity (cubic meters per hour).
6. Operating speed (rpm).
7. Required driving power (if motor not provided as integral unit)
8. Maximum and minimum supply pressure.
9. Maximum outlet pressure.
10. Electrical markings as required.

1.3.13 Each compressor shall be supplied with installation instructions.

1.3.14 Servicing instructions shall be available at least in draft form prior to the issue of a Certificate of Approval.

1.3.15 Operating instructions and maintenance schedule shall be supplied with each compressor. These instructions shall include maximum and normal working pressures and temperatures, horsepower requirements and other relevant design data.

PART 2 : SPECIFIC REQUIREMENTS

2.1 **Basic design**

2.1.1 Recommended design data.

Design pressure: min. 20% above the operation discharge pressure of the stage concerned, at least 6 Kg/cm², suction side at least 2 Kg/cm². Hydraulic test pressure: 1.5 times the design pressure, suction side at least 3.75 Kg/cm². Design temperature: inlet side of each stage 50°C — discharge side 200°C. Speed: mean piston speed limit 4m/sec.

2.2 **Construction**

2.2.1 Construction may be of either crosshead design incorporating a sealed and vented distance piece between cylinders and crankcase or of direct trunk type design. If the cylinders are not separated from the crankcase, the crankcase must be gastight and connected to the suction line, and cocks provided for purging and venting.

2.2.2 *Lubrication :* Splash or pressure lubrication system and materials are to be the choice of the supplier but shall be of proven design. In sealed crankcase designs oil refilling shall be possible without air ingress into the crankcase. In crosshead designs incorporating a vented distance piece between cylinders and crankcase the cylinder lubrication system shall be of the pressure type and separate from that of the crankcase, or designed so that it is impossible for gas to pass through the lubrication system to the crankcase.

2.2.3 Cylinders shall be cooled, either by direct air cooling or by jacketing and connection to the cooling system of the unit.

2.2.4 Cylinder valves shall constitute a unit so as to be easy to remove or replace. The design shall prevent the inadvertent fitting of an inlet valve in place of a discharge valve. The design should also prevent the valve stop or the valve bolt from falling into the cylinder in the event of failure or slackening of the bolt. Valves should not be held down by the valve centre bolt.

2.2.5 *Transmission :* For direct drive a maintenance free coupling to allow for misalignment shall be incorporated. For belt drive a device for tensioning shall be provided. Belts shall be oil resistant and anti-static. A transmission guard shall be provided.

2.2.6 *Coolers :* Unless specifically designed otherwise all stages shall be fitted with a cooler. Either direct air cooling or a liquid circulation system may be

used. In all cases the complete cooling system shall be an integral part of the unit. Cooler tubes shall be corrosion resistant and accessible on the air or coolant side for cleaning.

2.2.7 *Separators.*—A separator shall be fitted after the final cooler to collect oil, water and condensate from the gas. Separators should also be fitted after each intercooler.

2.2.8 *Drainage system.*—Provision shall be made for the removal and collection of liquid condensate from each separator. Gas escaping with the drained liquid shall be separated and piped to the suction line or vented. Compressors with an unloading system should be fitted with an automatic drainage system which may be combined with the unloading system.

2.2.9 *Unloading system.*—If the compressor has an unloading system the escaping gas may either be vented to atmosphere or returned to compressor section in such a manner that no part of the suction of system is over pressurised. The unloading system may be combined with condensate drainage system.

2.2.10 *Relief valve.*—Each stage shall be fitted with an approved spring loaded relief valve dimensioned for the compressor capacity and with a free piped outlet. The set pressure shall be at least 15% above the operational discharge pressure of the associated stage but shall not exceed the design pressure, except that the final stage safety valve may be set 10% above the maximum operational discharge pressure.

2.2.11 *Non-return valves.*—In addition to the normal cylinder valves gastight non-return valves of suitable pressure rating are to be fitted to compressor suction and compressor discharge. The suction valve must withstand a backpressure equivalent to first stage discharge pressure. The discharge check valve must withstand a back pressure equivalent to the maximum compressor discharge pressure. Any gas piped to compressor suction must enter the compressor downstream of the inlet non-return valve.

2.2.12 *Piping.*—The unit shall be ready piped in the supplier's works. All connections on the installation site should be made with aproved flexible hoses. The internal piping of the unit shall be removable for maintenance without unscrewing of sealed threads.

2.2.13 *Control of hydrate formation.*—A system for the controlled injection of methanol or other effective alternative gas drying methods to prevent hydrate formation may be provided.

2.3 **Instrumentation**

2.3.1 Each stage shall be fitted with a pressure indicator. On the inlet and outlet

of each stage (outlet of intercooler) provision shall also be made for a temperature indicator to be used. Each pressure lubrication system shall have an oil pressure gauge and means of checking oil level. Means shall also be provided for checking oil level in the crankcase and hydraulic oil reservoir. An hour meter shall be provided.

2.3.2 Pressure gauges shall be of the safety back type and shall have plastic faces. Each gauge shall be fitted with a pulsation suppression device or shall be of the liquid filled type. Normal operating pressure shall not exceed 75% of full scale reading.

2.3.3 The compressor shall be equipped with safety shutdown switches which will operate under the following conditions:

1. Low inlet pressure
2. High inlet pressure
3. High outlet pressure
4. High outlet temperature (final stage)
5. Low oil pressure
6. High hydraulic oil temperature
7. Low hydraulic oil level

Indicators shall be provided to indicate which fault has initiated shutdown. Indicators shall also be provided to warn the operator when power is connected to the compressor and if it is in the recycle mode.

2.3.4 Design and operation of the compressor controls shall be such that the compressor shall shutdown safely in the event of electrical power or loss of hydraulic oil pressure.

2.4 *Performance.*—It is not intended that compressor performance should be checked as part of the Approval requirements. Where performance tests are requested, inlet volume capacity and electrical power consumption should be within ± 5% of manufacturer's stated performance.

Appendix B

NATURAL GAS HYDRATE CONTROL BY METHANOL ADDITION

B1 Background

B1.1 *Formation of natural gas hydrates.*—Natural gas hydrates are formed by the freezing out of water from the gas stream as the gas cools (usually from

expansion through a regulator, control orifice, or filling nozzle). As described in the AGA Gas Engineers' Handbook, the water will freeze at higher temperatures than is usually considered possible for ice formation, provided that hydrocarbon gases at high pressure are present to help the bonding of the ice crystals.

B1.2 *Use of methanol*.—Methanol is added, not to dehydrate the gas stream, but to act as an antifreeze. The natural gas at high pressures serves to elevate the freezing point of the liquid water present. The condensation of methanol together with liquid water produces a solution with a depressed freezing point. Hence methanol reduces the temperature at which water condensing out of the gas will freeze.

B1.3 *Development of tables for addition of methanol*.—By functionalizing the limited data available and extrapolating as necessary, to estimate the water content of natural gas above which condensation of water may take place a minimum methanol addition to prevent freezing has been calculated. A set of tables has been produced to facilitate calculation of the quantity of methanol which must be added to prevent hydrate formation.

B2 **Use of the tables**

B2.1 The tables are used as follows:

(a) First establish the water content of natural gas in g/Nm³. If this is above the saturation level subtract from this the saturation value at the temperature and pressure required, as given in table 1.

(b) Obtain the methanol content, required in the gas after condensation of water and methanol has occurred, from table 2, for the particular temperature and pressure conditions.

(c) Add to (b) the product of the condensed water in g/Nm³ and the multiplying factor in table 3. This gives the minimum methanol addition required to prevent hydrate formation.

The following example is for a gas which is known to have 0.200 g water content per m³ at STP. The amount of liquid methanol to be added to prevent freezing when the gas is cooled to 4°C and compressed to 180 Kg/Cm² may be calculated as follows:—

(a) From table 1, read the column for 4°C and the line for 180 kg/Cm² and obtain the figure of 0.087 g/m³ at the gas/water saturation point.

(b) Take the normal water content per m³ of 0.200 g/m³ and subtract the figure in step (a), that is 0.087 g/m³ from this figure:

0.200 — 0.087 = 0.113 g/m³

The figure obtained will represent the amount of water which will condense from the gas.

(c) From table 2 read the column for 4°C and the line for 180 Kg/Cm² to obtain the figure 0.358 which shows the amount of methanol which must remain in the gas phase at water saturation if the condensing liquid is to contain the requisite methanol content to prevent freezing.

(d) The water content above the saturation point, that is, step (b), 0.113 g/m³, then requires additional liquid methanol treatment which is obtained by reading from table 3, the column for 4° and the line for 180 kg/Cm² from which a figure of 0.660 ml per extra g/m³ of water is obtained.

Thus 0.113 × 0.660 = 0.075 ml/m³ of additional methanol will be required.

(e) The amount of total methanol per m³ of the gas to be added is reached by adding step (c) and step (d) as follows:

0.358 + 0.75 + 0.433 ml/m³

(f) The figure obtained from step (e) is then multiplied by the number of m³ of the particular gas which is to be treated.

TABLE I

WATER CONTENT OF GAS IN g/Nm³ AT SATURATION

MPa	Temperature °C										
	0	2	4	6	8	10	12	14	16	18	20
2	0.276	0.316	0.362	0.414	0.471	0.536	0.609	0.691	0.783	0.887	1.003
4	0.159	0.182	0.207	0.236	0.268	0.303	0.343	0.388	0.439	0.495	0.558
6	0.120	0.137	0.156	0.176	0.200	0.226	0.255	0.287	0.324	0.364	0.410
8	0.101	0.115	0.130	0.147	0.166	0.187	0.210	0.237	0.266	0.299	0.335
10	0.089	0.101	0.114	0.129	0.145	0.164	0.184	0.206	0.233	0.260	0.291
12	0.081	0.092	0.104	0.117	0.132	0.148	0.166	0.186	0.209	0.234	0.261
14	0.076	0.086	0.097	0.109	0.122	0.137	0.153	0.172	0.192	0.215	0.240
16	0.072	0.081	0.091	0.102	0.115	0.129	0.144	0.161	0.180	0.210	0.224
18	0.069	0.077	0.087	0.097	0.109	0.122	0.137	0.153	0.170	0.190	0.212
20	0.066	0.074	0.083	0.093	0.105	0.117	0.131	0.146	0.163	0.183	0.202
22	0.064	0.072	0.081	0.090	0.101	0.113	0.126	0.140	0.156	0.174	0.194
24	0.062	0.070	0.078	0.088	0.098	0.109	0.122	0.136	0.151	0.168	0.187
24.9	0.061	0.069	0.077	0.086	0.097	0.108	0.120	0.134	0.149	0.166	0.184
26	0.061	0.068	0.076	0.085	0.095	0.106	0.118	0.132	0.147	0.163	0.181

TABLE 2

METHANOL REQUIREMENT AT SATURATION, ml/Nm³

MPa	Temperature °C										
	0	2	4	6	8	10	12	14	16	18	20
2	0.606	0.560	0.480	0.352	0.157						
4	0.557	0.562	0.555	0.531	0.481	0.397	0.264	0.062			
6	0.493	0.510	0.520	0.520	0.507	0.473	0.412	0.312	0.157		
8	0.445	0.465	0.482	0.492	0.492	0.480	0.448	0.391	0.297	0.151	
10	0.407	0.429	0.448	0.463	0.471	0.469	0.454	0.419	0.357	0.257	0.103
12	0.377	0.400	0.420	0.437	0.449	0.454	0.448	0.427	0.385	0.312	0.198
14	0.353	0.375	0.396	0.415	0.429	0.438	0.438	0.426	0.397	0.343	0.255
16	0.332	0.354	0.376	0.395	0.411	0.423	0.427	0.421	0.401	0.360	0.294
18	0.315	0.337	0.358	0.378	0.395	0.408	0.415	0.414	0.400	0.369	0.315
20	0.300	0.321	0.342	0.362	0.380	0.395	0.404	0.406	0.397	0.373	0.328
22	0.287	0.308	0.329	0.348	0.367	0.382	0.393	0.398	0.393	0.375	0.338
24	0.275	0.296	0.316	0.336	0.355	0.371	0.383	0.390	0.388	0.374	0.344
24.9	0.271	0.291	0.311	0.331	0.349	0.366	0.379	0.386	0.385	0.373	0.345
26	0.265	0.285	0.305	0.325	0.344	0.360	0.373	0.382	0.382	0.372	0.347

TABLE 3

METHANOL IN mL/Nm³ FOR ADDITIONAL WATER IN g/Nm³

MPa	Temperature °C										
	0	2	4	6	8	10	12	14	16	18	20
2	0.290	0.228	0.166	0.103	0.039						
4	0.455	0.392	0.330	0.268	0.206	0.144	0.081	0.016			
6	0.548	0.485	0.422	0.359	0.297	0.235	0.173	0.111	0.047		
8	0.613	0.549	0.486	0.423	0.360	0.297	0.236	0.174	0.111	0.048	
10	0.663	0.598	0.534	0.471	0.408	0.346	0.284	0.222	0.160	0.097	0.033
12	0.704	0.638	0.574	0.510	0.447	0.384	0.322	0.260	0.198	0.136	0.073
14	0.737	0.672	0.607	0.543	0.479	0.416	0.354	0.292	0.230	0.168	0.105
16	0.767	0.700	0.635	0.571	0.507	0.444	0.381	0.319	0.257	0.195	0.133
18	0.792	0.726	0.660	0.595	0.531	0.468	0.405	0.343	0.281	0.219	0.157
20	0.815	0.748	0.682	0.617	0.553	0.490	0.427	0.364	0.302	0.240	0.178
22	0.836	0.769	0.702	0.637	0.573	0.509	0.446	0.383	0.321	0.259	0.197
24	0.854	0.787	0.721	0.655	0.590	0.526	0.463	0.400	0.338	0.276	0.214
24.9	0.862	0.795	0.728	0.663	0.598	0.534	0.471	0.408	0.345	0.283	0.221
26	0.871	0.804	0.737	0.672	0.607	0.543	0.479	0.416	0.354	0.292	0.230

COMPRESSED NATURAL GAS SAFETY RULES 1992 STANDARD CODE OF PRACTICE PART-III USE OF CNG FUEL INTERNAL COMBUSTION ENGINES

1. CNG FUEL.

GENERAL

1.1 **Scope**

1.1.1 This part of this standard applies to the design, construction, installation, operation, maintenance and fuelling of compressed natural gas (CNG) systems where CNG is used either wholly or in part as a fuel for internal combustion engines.

1.2 **Definitions**

1.2.1 For the purpose of this standard the following definitions shall apply:

Approved or approval.—Approved by or approval of the Statutory Authority.

Authorised person.—A person, normally a technician (Engineers, Diploma Holders) who is trained for CNG conversion by the Statutory Authority.

Compressed natural gas (CNG).—A compressed gaseous fuel composed pre-dominantly of methane (CH_4).

Cylinder.—A pressure vessel or the storage of CNG for use as fuel for an internal combustion.

Non-return valve (Check Valve).—A valve which permits fuel flow in one direction only.

Pressure.—Guage pressure.

Excess pressure device.—An automatic pressure relieving device.

Shut-off valve.— A valve for stopping gas flow.

Statutory Authority.—The government department or agency responsible for the particular aspect. (*See* Appendix C).

Special requirements

1. Only equipment and systems approved by the relevant Statutory Authority (*See* Appendix C) shall be used.

2. CNG shall have an odour which is distinctive, unpleasant, and non-persistent.

3. The fitment of a CNG fuel system shall be prohibited in any vehicle with a passenger compartment heating system which draws air from the engine compartment.

2.0 **Cylinder Design**

2.1.1 Cylinder shall be of a design approved by the Statutory Authority.

2.1.2 The weight of the CNG Cylinders will affect the tare weight of the vehicle and consideration of the effect on the legal and manufacturers rating on axle loadings should be considered.

2.1.3 In no circumstances shall the vehicles critical load distribution affecting safety consideration be compromised.

2.1.4 Cylinders shall be retested in accordance with the requirements of the Statutory Authority.

2.1.5 Prior to installation steel cylinders, other than stainless steel shall be protected against external corrosion by the application of white corrosion inhibiting paint. Prior to application, the cylinder surface shall be adequately prepared.

2.1.6 For all cylinders an alkyd zinc chromate primer or one of equivalent performance shall be used as a primer coat.

2.1.7 For all cylinders a white alkyd finish coat compatible with the primer coat shall be applied prior to installation in the vehicle.

2.1.8 For externally mounted cylinders where the operation of the vehicle is such that the cylinders will be subject to impact damage from loose metal or other objects being thrown up from the road effective shielding from these shall be provided in the form of a rubberised cover be fitted in front of the cylinders.

2.1.9 Each cylinder shall have a 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 equipment approved as in Appendix C, with a minimum working pressure of 200 Kg/Cm² at 35°C.

2.2 **Cylinder installation**

2.2.1 Cylinder attachment. Every cylinder shall be securely attached. This attachment may take the form of cradles and metal straps or bands. Cylinders shall not be welded after manufacture. No undue stress shall be imposed on the cylinder during its mounting or securing. No piping, valves, manifolds or other connections shall support the cylinders, apart from the designed mounting structure.

2.2.1.1 Motor vehicles. Cylinders in motor vehicles shall be attached to the vehicle in such a manner that they do not constitute a structural member within the vehicle and shall not be subject to undue alternating stresses.

2.2.1.2 The attachments shall be designed and constructed to withstand static forces of at least twenty times the weight of the full cylinders in the direction of the vehicles longitudinal axis and eight times the weight of the full cylinders in any other direction. The vehicle structure shall not be significantly weakened by the mounting of the cylinders and shall be reinforced where necessary to withstand these forces.

2.2.1.3 If a physical test or a calculation of strength is not practicable, transversely mounted container attachment will be deemed to comply with this part of this standard if the dimension of the attaching components are not less than the following, as relevant:

(a) Where the attachment is by means of clamping bands around the container, the bands shall be not less than two in number, shall be steel, and not less than the equivalent of 28mm × 3mm each in section. Any attaching screw threads shall be not less than 10mm diameter. For containers larger than 100 L, the minimum dimensions shall be 50mm × 6 mm straps and 12mm diameter bolting.

(b) Where the attachment is by means of bolts, not less than four bolts of 10mm diameter shall be used, except that where the container is larger than 100 L, not less than four bolts of 12mm diameter shall be used.

(c) Anchorage bolts shall conform to strength 8.8 ISO 40.4 and nuts to ISO 4032.

2.2.1.4 For longitudinally mounted cylinders the end thrusts, front and rear, shall be absorbed by suitable bracketry to form an abutment to absorb the forces

and convey these to the vehicle structure. Unless the design of clamping bands and hard rubber inner linning material has been shown capable of achieving the required restraining force without the need for abutments.

2.2.1.5 Manifolded cylinders should be supported and held together as a unit by structurally adequate means. Manifolded branch pipelines shall be sufficiently flexible to prevent damage to the lines valves and fittings due to vibration, expansion or contraction.

2.2.2 **Location**

2.2.2.1 Cylinders shall be mounted in a protected location to minimize damage from collision.

2.2.2.2 Motor vehicles. Cylinders shall be mounted inside the perimeter of the vehicle, in a protected location. Cylinders shall not be located so that the vehicle driving characteristics are adversely affected.

2.2.2.2.1 No vehicle shall have its cylinder or cylinders mounted on the roof.

2.2.2.2.3 Preferred mounting locations of cylinders in motor vehicles.

2.2.2.3.1 Sedans. The preferred mounting location of a cylinder in a sedan is in the boot, transversely, and as far as practical from the vehicle extermities. (Appendices H & J)

2.2.2.3.2 Other motor vehicle. For motor vehicles other than sedan the preferred mounting location for a cylinder is transversely, behind the rear seats or beneath the vehicle. Cylinder mounting beneath the vehicle shall not decrease the effective ground clearance.

2.3 **Shielding**

2.3.1 Cylinders and fittings shall be adequately shielded, either by location or separate guards, from damage from objects thrown up from the road and from damage due to drive shaft failure or from other damage. Cylinders located less than 200 mm from an engine or exhaust system shall be adequately shielded against heat.

2.4 Ventilation

2.4.1 Where a CNG cylinder is located inside a vehicle compartment venting to the atmosphere shall be provided unless all piping and connections are exterior to the vehicle compartment. Where venting is required, the cylinder neck and connections shall be contained in a gas-sealed bag and vented to the atmosphere to prevent leakage into the vehicle compartment.

Gas-sealed bags or containers shall not contain sources of ignition such as unshielded switches. Material of the gas-seal bags shall be sufficiently strong to resist mechanical damage.

2.4.2 The vents shall provide a cross-sectional area totalling not less than 2000 mm².

2.5 **Testing**

2.5.1 Cylinder shall be hydrostatically tested by the Statutory Authority in accordance with Appendix C:

(a) At five-yearly intervals.

(b) In the event of abnormal thermal stress, mechanical stress or abrasion, cylinders must be tested as above before they are use again.

2.5.2 Each time the cylinder is tested the identification information as in clause 6.7 of this Standard shall be updated.

3. **Piping**

3.1 CNG piping pressure exceeding 1 Kg/Cm²

3.1.1 CNG piping for pressure exceeding 1 Kg/Cm² (high pressure piping) shall be steel piping approved for use with CNG. Piping shall be effectively protected against external corrosion.

3.1.1.1 The high pressure piping shall have a minimum working pressure rating of not less than 275 Kg/CM² and a test pressure of 700 Kg/CM². Tubing to AS 1835 or AS 1836, or equivalent standards is acceptable.

3.1.2 *Piping size.*—High pressure piping shall not exceed 10mm in internal diameter. Piping size shall be adequate to ensure unrestricted gas flow to the engine. For light automotive vehicles piping of upto 8 mm external diamter is considered adequate.

3.1.3 Joint and connections. Exceeding 1 Kg/CM²

(a) Every joint or connective fitting shall be of a type approved for service with CNG at a working pressure of 275 Kg/CM² and a test pressure of 700 Kg/CM².

(b) The number of joints and connections shall be the minimum for the inclusion of all components.

(c) Joints or connections in CNG pipelines shall be in accessible positions.

(d) The connection means shall be of an approved type and shall provide positive retention of the pipe in the fitting. This should be by means of double inverted flaring of the tube end or by a steel compression type fitting which deforms the tube.

3.1.4 Securing and location of piping in vehicles. High pressure piping in vehicles shall comply with the following requirements:—

(a) No gas piping inside the part of any vehicle occupied by the driver or passengers shall be outside the sealed and vented enclosure.

(b) All piping shall be positioned for protection from impact or collision, and shall be shielded where necessary. It is preferable to position the pipeline beneath the floor pan where it can be shielded by the body shell.

(c) Piping shall not be located in side box sections or in other inaccessible locations and shall not be routed within the drive shaft tunnel.

(d) All piping shall follow the shortest practical route consistent with essential flexibility.

(e) Piping shall be effectively secured to the chassis frame or vehicle body by clips spaced not more than 600 mm apart. Where piping passes through metal panels it shall be adequately protected by grommets.

(f) Manifold connected to cylinders shall be installed in protected location.

3.2 CNG Piping Pressure Not Exceeding 1 Kg/Cm²

3.2.1 All CNG piping of use for service pressure not exceeding 1 Kg/CM² (low pressure piping) shall be of flexible material approved for, and impervious to CNG, for temperatures up to 100°C and capable of sustaining five times the maximum pressure likely to be encountered in service.

3.2.2 Joints and connection not exceeding 1 Kg/CM² joints and connections for low pressure piping shall be suitable for use with CNG and capable of sustaining five times the maximum pressure likely to be encountered in service, and shall comply with clauses 3.1.3 (b), (c), and 3.1.4 (a), (b), (c), (d) & (e) of this part of this standard.

3.3 **Flexibility**

3.3.1 There shall be sufficient length of flexible pipe or hose to accommodate engine movement.

3.4 **Shielding**

3.4.1 All piping shall be adequately protected either by location or separate shields from damage from objects thrown up from the road and from damage due to drive shaft failure or from other damage.

3.4.2 In no case shall the piping be located less than 75mm from an exhaust system. For piping located between 75mm and 150mm adequate shielding against heat shall be provided.

4. **CNG Control Equipment**

4.1 *Definition*

4.1.1 The CNG control equipment includes all the equipment necessary to convert CNG at high pressure at the cylinder to CNG air mixture for supply to the engine.

4.1.2 All control equipment either as components or as a kit shall be approved by the Statutory Authority. (Refer Appendix C).

4.2 *Control equipment*

4.2.1 *Automatic shut-off valve.*—An automatic shut-off valve shall be installed. This valve shall be in the closed position whenever the ignition control is in the off or accessory position and also when the engine is not running.

4.2.2 Pressure regulators and heat exchanger.

4.2.2.1 The regulator assembly shall be capable of withstanding and minimum inlet pressure of 275 kg/Cm² and shall be designed to give the working pressure required.

4.2.2.2 The regulator assembly shall be securely mounted in the engine compartment protected from exhaust heat and as far as practical from the vehicle extremities. It shall not be attached to the engine assembly.

4.2.3 *The gas-air mixture*

4.2.3.1 The function of the gas-air mixer is to mix the gaseous fuel with the air in

correct proportions as required by the engine. The mixer has the same function in a gas system as the carburator has in a gasoline system.

4.2.4 Twin fuel changeover system

4.2.4.1 A twin fuel system is defined as a system equipped to operate with CNG and some other fuel without further modification. Such systems may be of two types:

(a) *Alternative fuel type.*—To operate either on CNG or some alternative fuel (for example gasoline)

(1) An automatic shut-off valve shall be installed in the Alternative Fuels System, between any fuel pump and the engine. This valve is in addition to and similar to the automatic shut-off valve required in clause 4.2.1. of this part of this standard.

(2) The fuel selection control shall have at least three positions, clearly marked for the selection of each of the two fuels. The changeover devices shall prevent operation of both fuels at one time except for the fuel remaining in the common fuel system components at the time of changeover. The selection control shall be placed within easy reach of the driver or operator.

(b) *Partial substitution type.*—To operate on part CNG and part alternative fuel (for example, diesel), or the alternative fuel (diesel) only:

(1) an automatic shut-off valve shall be installed in the CNG system as indicated in clause 4.2.1 of this part of this standard.

(2) Twin fuel systems should be equipped with efficient air filters to arrest flashback.

4.2.5 *Installation.*—The CNG control equipment shall be:

(a) Installed in positions that are accessible for routine inspection, maintenance and adjustment.

(b) Securely mounted and reasonably protected from damage in a collision.

(c) Remote from the vehicle engine exhaust system or protected there from by a metal shield.

(d) No closer to any electrical equipment capable of sparking than is avoidable.

4.2.6 *Wiring.*—Wiring shall be properly installed and protection with a suitable fuse.

4.2.7 *Pressure indicator*

4.2.7.1. *Every system shall have a pressure indicating device.*—This shall be of a type to indicate the pressure in the cylinder. If the device is located inside the passenger compartment the pressure indicator and any pipeline to it shall be gas isolated from the cylinder or piping, to prevent gas leaking into the passenger compartment.

5. **Identification Markings**

5.1 Vehicles using a CNG system shall be lebelled as follows:

(a) Immediately after the vehicle has been examined and prior to road testing the authorized person shall affix identification labels, one at the front and one at the rear, to identify the vehicle as using CNG for fuel.

(b) These lables shall conform to the specification given in clause 5.2 and the affixed in a vertical position as close to the vehicle number plate as is practicable and be clearly visible from at least an included angle of 120° to 60° each side of the extended centreline of the vehicle front and rear, and from a height of 1.75 m from the ground at a distance of 1 m through to 20 m.

(c) The label shall be in position at all times, shall be in good condition, and the shape, colouring and lettering shall make it easily identifiable.

5.2 *Labels.*—They shall be coloured white, 80mm × 80mm square. They shall have on them the text "CNG" in a central position not less than 20 mm high, coloured 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 to fig. 2, Appendix F.)

6. **Refuelling**

6.1 *Maximum filling pressure.*—No person shall charge any container with a permanent gas at any pressure greater than that pressure which, if the contents of the container attained the assumed maximum temperature of 65°C would then exert a pre on the container exceeding 80 percent of the hydrostatic test pressure. The maximum filling pressure shall be clearly

marked near the filling connection. The maximum filling pressure shall not exceed 200 Kg/Cm at 25°C.

6.2 *Filling connection.*—The filling connections shall be of an approved type designed to receive a probe type refuelling connection with basic dimensions as given in Appendix D. A facility to depressurize the filling connection prior to removal of the probe shall be provided.

6.3 *Non-return valve.*—There shall be a non-return valve fitted on the refuelling 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 is practicable.

6.4 *Position of filling connection.*—The filling connection should be located in the engine compartment or in a suitable protected location that is ventilated.

6.5 *Refuelling interlock device.*—Filling connections in motor vehicles shall be fitted with a device to prevent the vehicle engine starting while the refuelling equipment is engaged.

6.6 *Excess pressure device.*—Every CNG system shall be fitted with a device to prevent the cylinder being charged with a pressure greater than the cylinder test pressure. In the event of operation of this device it shall not, by design or location, be able to dump the cylinder contents. It shall be set to operate at a pressure below the test pressure of the cylinder.

6.7 *Identification plate.*—These shall be installed near the filling connection and clearly visible to the refueller and identification plate that shall bear the following:

"CNG", the maximum filling pressure, the cylinder identification numbers, and the date of the last retest of the cylinder or cylinders and the water capacity of the total installation.

6.8 Procedure *See* Appendix A.

6.9 *Dust Plug.*—A dust plug shall be installed in accordance with Appendix-F.

6.10 *Refuelling System.*—Refuelling system of the vehicle shall be compatible with Appendix-G.

7. **Installation, Inspection, Testing**

7.1 *Installation.*—Installation shall be carried out by or the under the supervision of an authorized person.

7.2 *Inspection*

7.2.1 *Initial inspection.*—The system shall be inspected before initial use. The inspection shall include leak testing under clause 7.3 of this part of this standard. The inspection shall be carried out by an authorized person. When the system meets all the requirements of this standard and performance is satisfactory and approval signed by the person inspecting shall be issued and a copy retained by the owner of the system or vehicle.

7.2.2 *Periodic inspection.*—The cylinder, piping and all components of the system shall be closely examined by an authorized person for corrosion, deterioration and for any modification affecting compliance with this standard, at intervals of not more than one year. The inspection shall include leak testing under clause 7.3 of this part of this standard. (Refer to Appendix B).

7.2.2.1 When the system has been inspected and any defects remedied to the satisfaction of the authorized person, a periodic inspection certificate shall be issued to the owner of the system or vehicle.

7.3 *Leak testing.*—The complete system forward to the outer of the regulator shall be thoroughly leak tested by the "soap bubble" method using CNG at a pressure upstream of the regulator of not less than 165 Kg/cm^2 and not more than 200 Kg/Cm^2. Any leakage shall be corrected.

7.3.1 The testing shall be carried out in adequately ventilated conditions at least 5 m from open flame or other source of ignition.

7.3.2 The operation of the equipment and controls shall also be tested under CNG normal working pressure to prove satisfactory performance of the entire system.

8. Repair

8.1 Any repair operation involving heat shall be carried out with due regard to fire safety.

8.2 Before any repair work is carried out on or near the fuel system the cylinder valve shall be closed except when fuel is required for engine operation.

8.3 Damage fuel lines shall not be repaired, in all cases they shall be replaced.

8.4 Welding, brazing and the application of heat shall not be carried out on any part of the cylinder subsequent to manufacture.

9. Disposal

9.1 All cylinders shall be removed from the system before disposal of the vehicle for scrap, and if the cylinder is condemned it shall be separately disposed of by means adequate to ensure compliance with safe practice (the cylinder shall be cut in two pieces).

Appendix A

FILLING INSTRUCTIONS AND PROCEDURE

A.1 *Filling Instructions*

A.1.1 These instructions should be pasted in a conspicuous place adjacent to the dispensing hose.

Ensure that:

(a) The identification labels are approved and in position.

(b) There is no smoking within 6m of the vehicle.

(c) The vehicle hand-brake is firmly applied and the vehicle parked in gear of "P" with automatic transmission.

(d) All vehicle ignition, electrical system and radio (including shortwave communication equipment) are switched off.

(e) The cylinder is within the periodic test life and the system complies with this standard and any statutory requirements, including inspection certification.

(f) There are no obvious leaks in the vehicle's CNG equipment.

(g) The fuel connection is in good condition and matches the dispenser filler nozzle.

Filling procedure:

(a) Remove dust plug from vehicle refuelling connection.

(b) Attach refuelling hose to fill point.

(c) It is desirable not to leave the vehicle during filling operations except in the case of trickle fill.

(d) Open refuelling valve slowly allowing the CNG to transfer from storage cylinders to vehicle cylinder. CNG should be slowly introduced into the vehicle to avoid shock loading and a rapid increase in gas temperature.

(e) Close the refuelling valve on completion of fill.

(f) Carefully disconnect filling hose allowing small escape of gas from filling nozzle.

(g) Return hose to correct position on dispenser.

Final check.—Before any vehicle is driven away from any dispensing point it is imperative that there are no gas leaks either :—

(a) On the vehicle or

(b) On the dispensing point

That may have been caused through faulty filling or any leakage caused by replacing and removing connections.

Appendix B

PERIODIC INSPECTION CERTIFICATE

B1 This appendix is written as a detail clarification of the periodic inspection certificate examination quoted in clause 7.2.2 of this part of this standard and shall be read in conjunction with the full requirements of clause 7.2.

B2 The inspection instructions listed are recommended for use by the Statutory Authorities in considering the issuing of a periodic inspection certificate.

B2.1 These inspection instructions are as follows :

(1) Examine the approval certificate issued for the initial installation and check regularity. Use for data comparison with present status of installation and system.

(2) Examine the vehicle for appropriate CNG marking labels and ensure that the cylinder tank is located within the body configuration well clear of the rear bumper and in accordance with this part of this standard.

(3) Examine the cylinder mounting location to ensure that it complies with the part of this standard.

(4) Examine the cylinder for type approval, freedom from corrosion, compliance with marking and ensure cylinder is within its mandatory test requirements.

(5) Inspect cylinder hold-down straps or attachment fittings for condition, bolting to structure, and general security.

(6) Examine the vapour seal and venting gas-proof compartment for compliance with this part of this standard.

(7) Ensure that ventilation of gas-proof compartment is correctly positioned and is adequate. Check that vents are free from obstruction.

(8) Check fittings on cylinder for security and condition.

(9) Ensure that there are no sources of ignition in the compartment.

(10) Check that filler fittings, unions washers and threads are in position, gas-tight, and in satisfactory working conditions.

(11) Check cylinder valve for accessibility and working order.

(12) Inspect fuel lines and unions from the cylinder to pressure reducing regulator for gas-tightness, and check that piping material is in accordance with this part of this standard. Carry out the leak test of clause 7.3.

(13) Inspect fuel lines for freedom from damage and check that clearances from exhaust heat sources are adequate. Check that no pipes have been repaired (*See* clause 8.3).

(14) Check fuel hose supply to engine to ensure that adequate length has been allowed for engine movement under load.

(15) Examine regulator assembly for security of attachment.

(16) Check each CNG component fitted between the regulator and the gas-air mixer.

(17) Inspect the automatic shut-off valve for shut-off capability when the engine is not running but the ignition is on. In the twin fuel system check that the automatic shut-off valve and the alternative fuel shut-off valve are operated by a single change-over switch control.

(18) Check any instrument on the driver's panel used for information to the driver on the CNG system to ensure that no CNG is led in the instrument, or in any pipeline leading to that instrument, in the driver or passenger compartment.

Appendix C

APPROVAL

C1 The approval and statutory authority.

This part of standard refer to HDIP or any other agency approved by the DG (Gas) Ministry of Petroleum & Natural Resources.

C1.1 Specifications currently approved for cylinder design include :—

NZS 5454 — 1989

AS 2337.1—1989

C1.2 Testing and Certification must also meet following requirements :—

(a) The cylinder valve shall include the fitment of a burst disc backed with a fusible material.

(b) Valve threads and valve markings shall comply with the requirements of BS 341 Part 1. The preferred nominal size is 1 in.

(c) The thread on the outlet from the service valve shall be 1/4 in NPTF internal of 12mm × 1mm pitch parallel internal thread.

Appendix D

COMPRESSED NATURAL GAS CHARACTERISTICS AND SAFETY ASPECTS

D1 Compressed Natural Gas Gas (CNG) is the term given to those hydrocarbons which are present as Natural Gas (Predominantly mechane —CH_4) and which can be compressed to pressures in the order of 270 Kg/Cm^2 for purposes of storing or conveying. Even at these high pressures the CNG is still present as a gas.

D2 CNG at atmospheric pressure is lighter than air and will therefore disperse quickly if released.

D3 Typical characteristics of CNG in Pakistan

(a) Relative density (air = 1)
at 15°C and 1 Standard Atmosphere 0.587

(b) Spontaneous ignition temperature
Premium Gasoline Approximately 450 °C
Natural Gas 700 °C

(c) Limits of flammability
at 1 Standard Atmosphere expressed as a percentage of Natural Gas by Volume in an air[3] gas mixture:

Lower limit	Upper Limit
5 percent	15 percent

(d) Gross calorific value (approximate):

1 M^3 of Natural Gas at 15°C and 1 Standard Atmosphere	40 MJ
1 L Premium Gasoline	34 MJ

(e) Air volume required to burn unit volume of Natural Gas (Stoichiometric ratio) 10 to 11

(f) Research octane rating

Natural Gas	130
Premium Gasoline	87

(g) Toxicity
Natural gas has a low level of oral dermal toxicity but is classed as a simple asphyxiant with a threshold limit value of 1000 ppm.

(h) Action in the event of a serious leak

ON NO ACCOUNT SHOULD A NAKED FLAME BE USED TO DETECT A LEAK

Shut off all engines and any electoral equipment in the immediate vicinity and leave off until the gas hazard is removed.

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

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

Do not start engines or operate any electrical equipment unless this is flame proof — until the gas hazard is removed.

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

Appendix E
(Part - III)

FILLING CONNECTION AND DUST PLUG

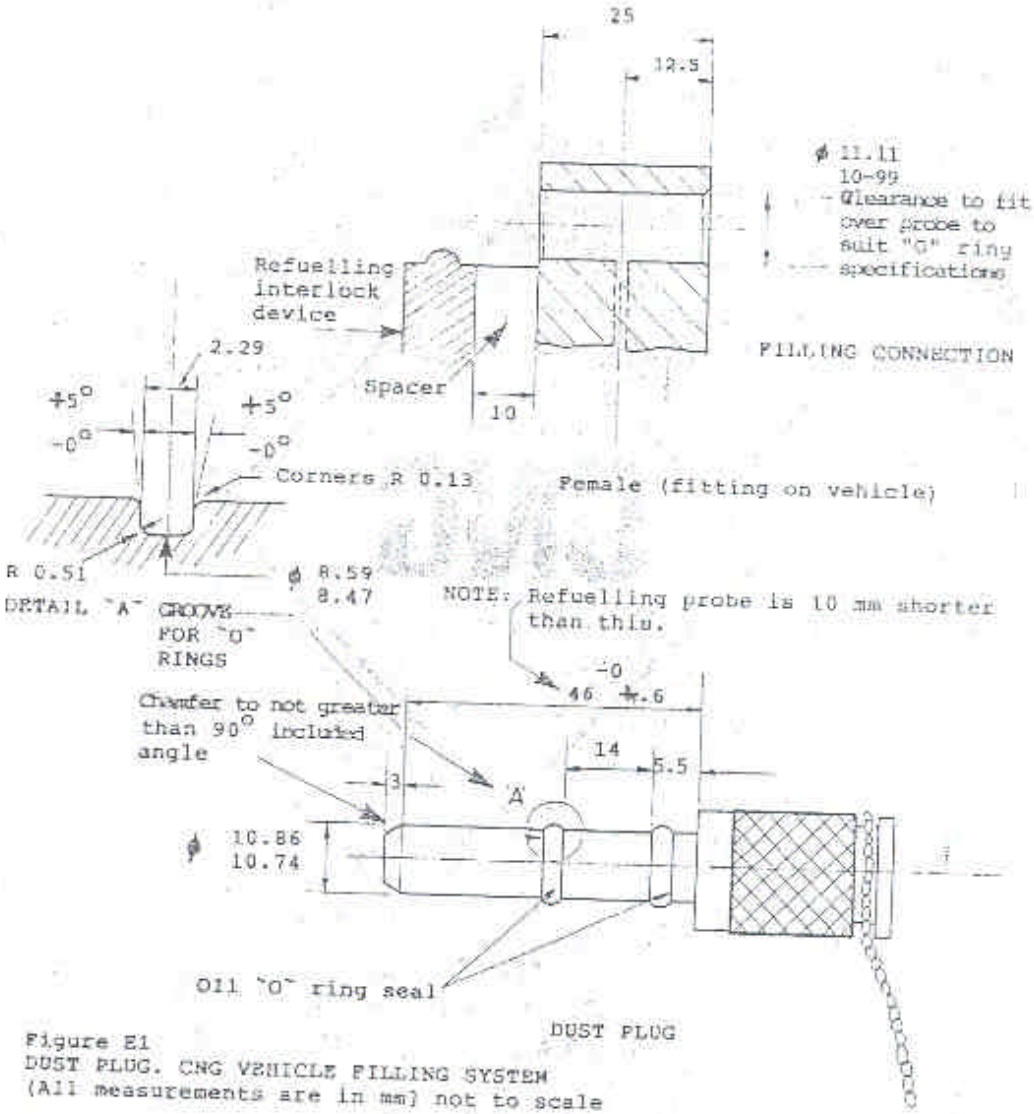


Figure E1
DUST PLUG. CNG VEHICLE FILLING SYSTEM
(All measurements are in mm) not to scale

APPENDIX - F
Part - III)

LABEL

Fig. 2

Appendix E
(Part - III)

FILLING CONNECTION AND DUST PLUG

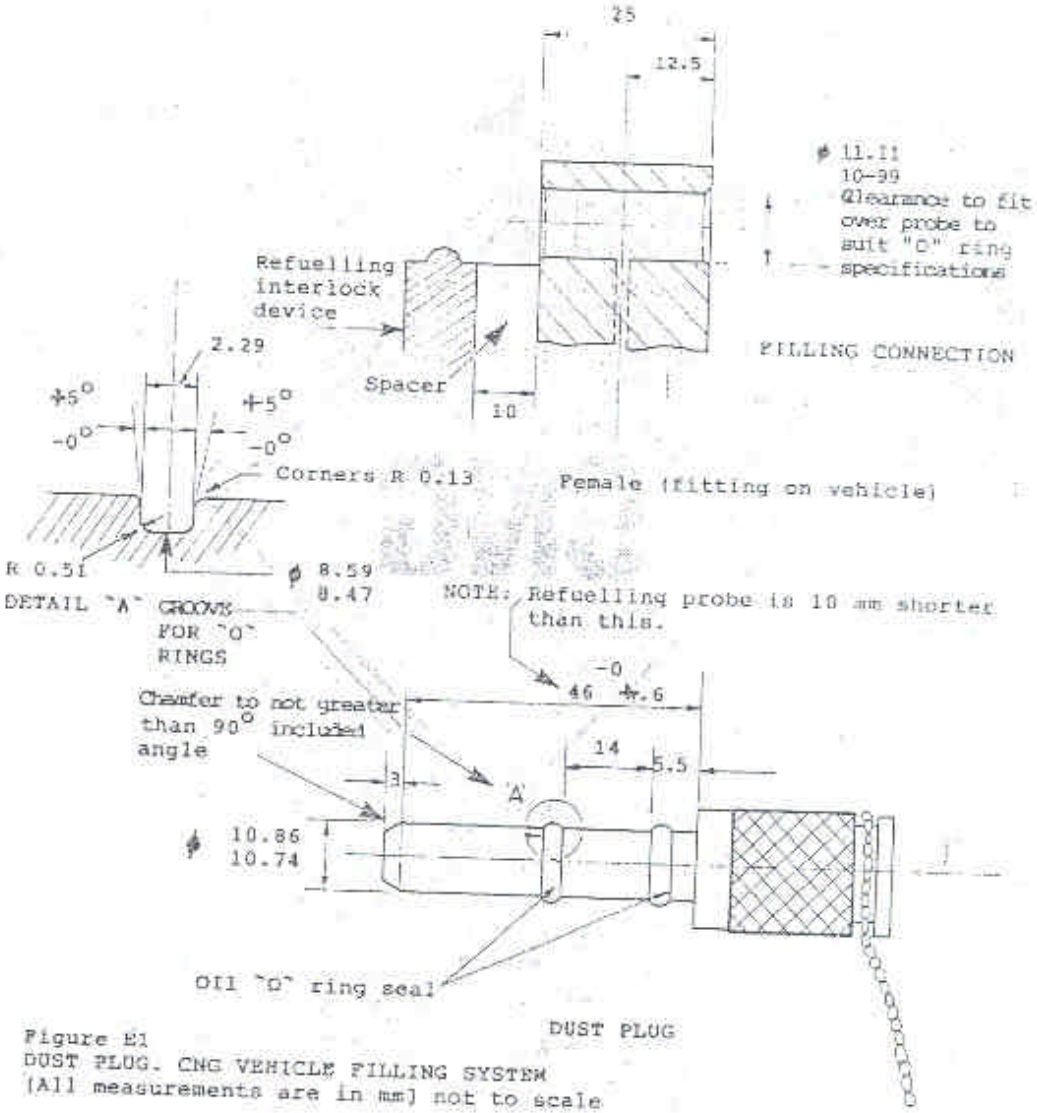
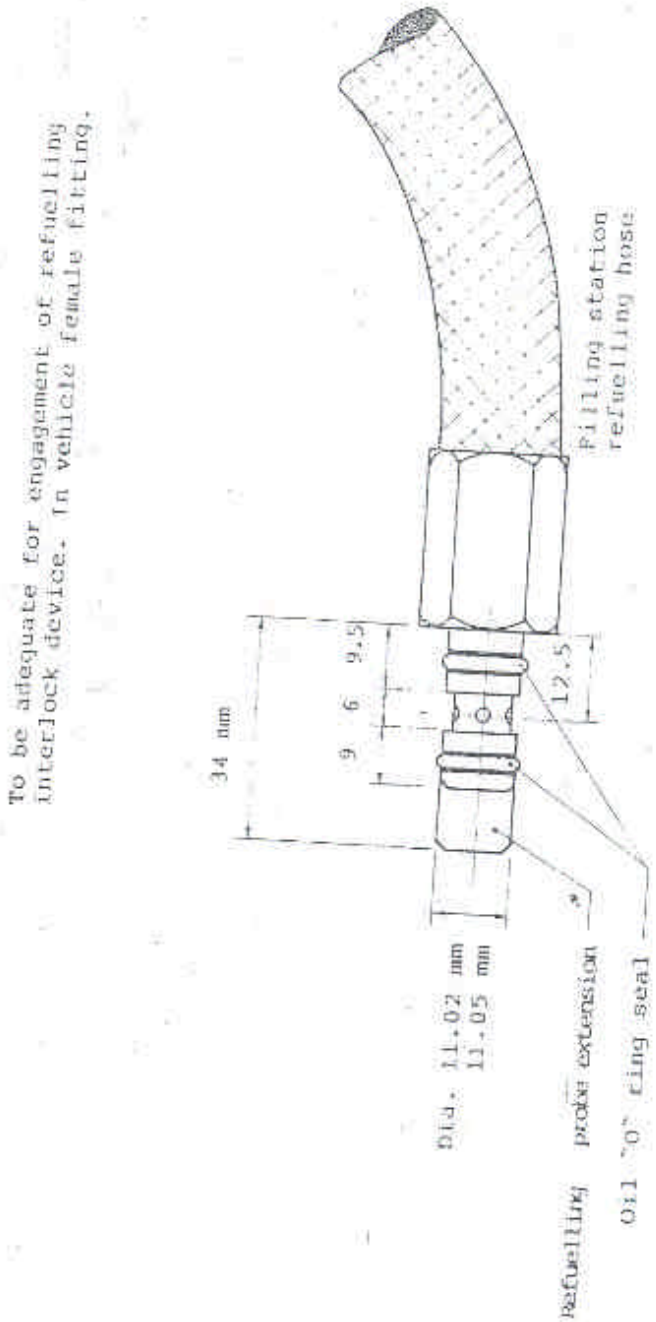


Figure E1
DUST PLUG. CNG VEHICLE FILLING SYSTEM
(All measurements are in mm) not to scale

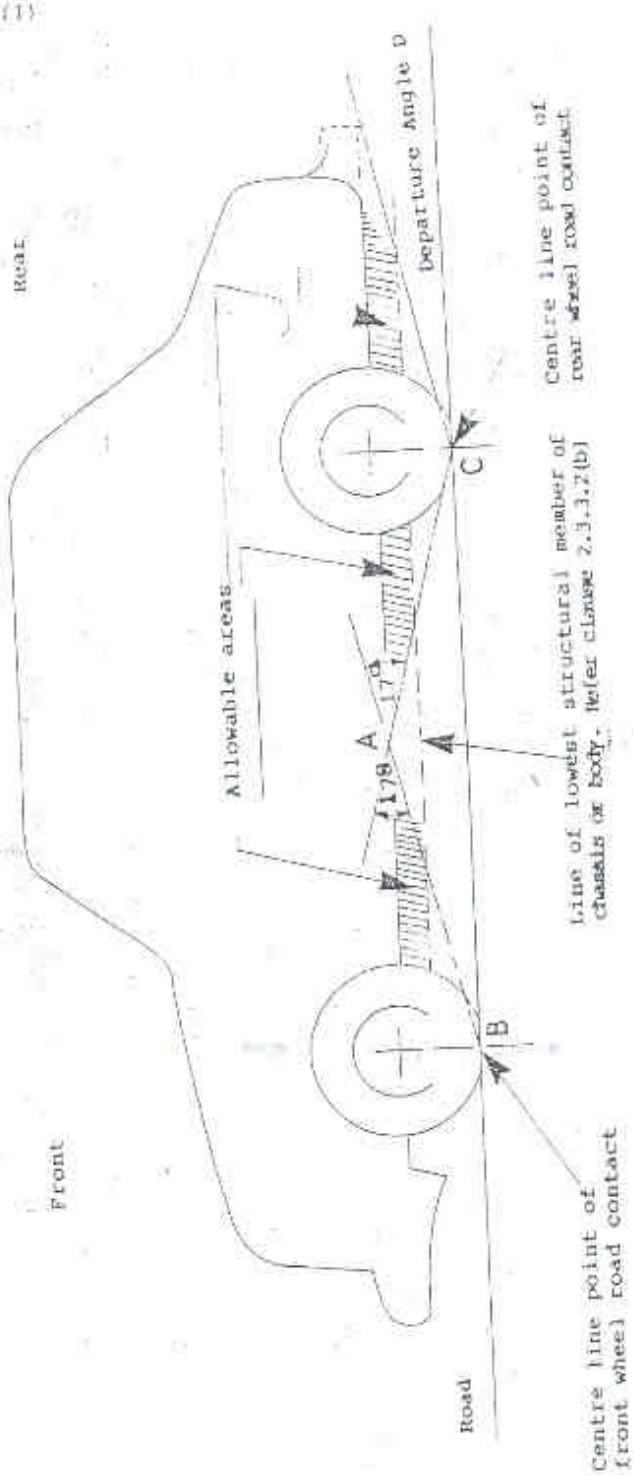
APPENDIX - G
(Part - III)

CNG REFUELLING PROBE

Dimensions in mm



APPENDIX - H
(Part - I(I))



APPENDIX - J
(PART-III)

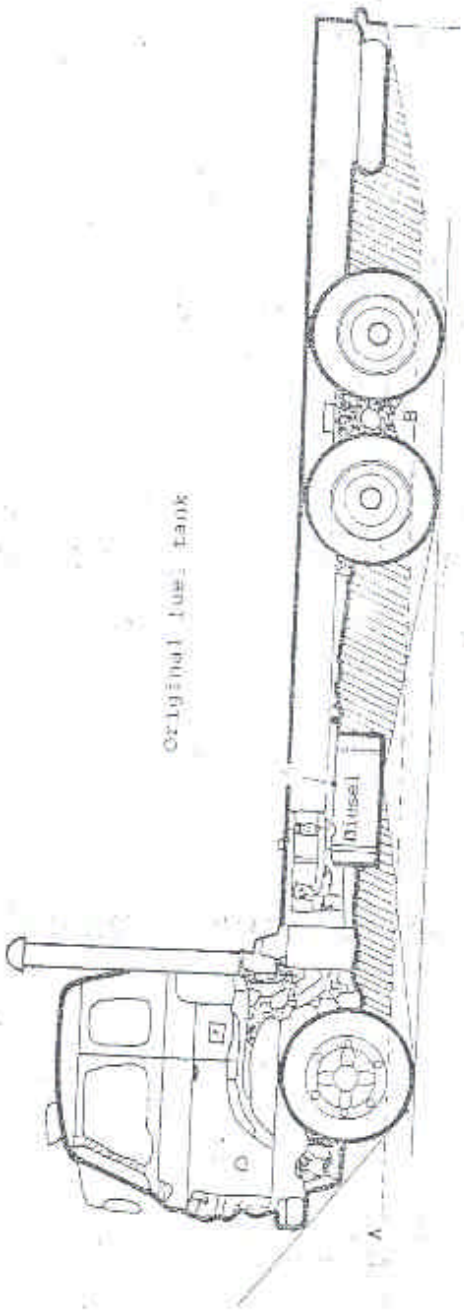


Figure 1 - Typical position of original fuel storage tank ground clearance

APPENDIX - J(A)
Part - III

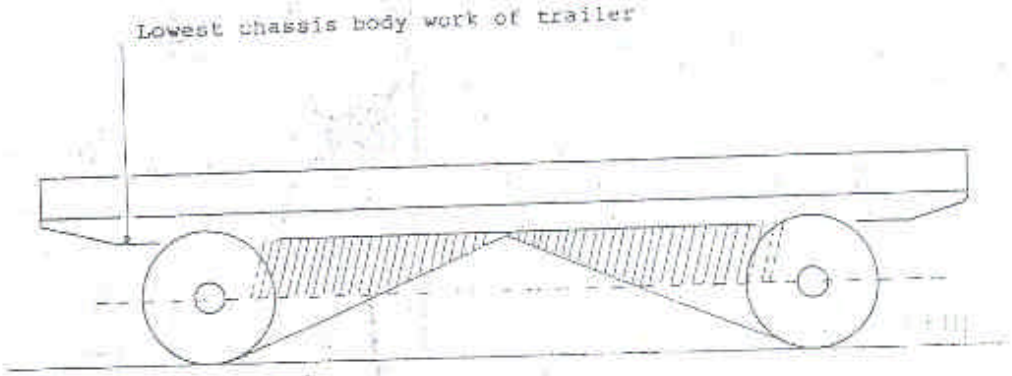


Figure 2 Trailer mounting of cylinders ground clearance

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ISLAMABAD, TUESDAY, OCTOBER 13, 1998

PART II

Statutory Notifications (S. R. O.)

GOVERNMENT OF PAKISTAN

MINISTRY OF FINANCE AND ECONOMIC AFFAIRS

NOTIFICATIONS

Islamabad, the 13th October, 1998

CUSTOMS

S. R. O. 1047 (I)/98.—In exercise of the powers conferred by section 19 of the Customs Act, 1969 (IV of 1969), the Federal Government is pleased to direct that the following further amendments shall be made in its Notification No. S. R. O. 502 (I)/94, dated the 9th June, 1994, namely :—

In the aforesaid Notification, in the Table, for S. No. 1 in column (1) and the entries relating thereto in columns (2) and (3), the following shall be substituted, namely :—

"1.	Tractors falling under PCT heading 87.01 :	
	(*i*) agricultural tractors	0%
	(*ii*) others	10%".

[C. No. 2 (2) Tar. II/98.]

MUMTAZ ALI,
Additional Secretary.

Price : Rs. 3.00

[3947 (98)/Ex. Gaz.]

MINISTRY OF FOOD, AGRICULTURE AND LIVESTOCK

(Livestock Wing)

Islamabad, the 9th October, 1998

S. R. O. 1048 (I)/98.—In exercise of the power conferred by section 3 of the Pakistan Veterinary Medical Council Act, 1996, the Federal Government is pleased to constitute the Pakistan Veterinary Medical Council as under :—

(*i*) Director General (Extension) Livestock & Dairy Development Deptt. Govt. of Punjab, Lahore.	*Member*
(*ii*) Secretary, Livestock & Fisheries Deptt., Government of Sindh.	*Member*
(*iii*) Director General, L&DD, Govt. of Baluchistan, Quetta ...	*Member*
(*iv*) Director, Livestock & Dairy Development Govt. of N.W.F.P., Peshawar.	*Member*
(*v*) Dean, Faculty of Vety. Sciences University of Agriculture, Faisalabad.	*Member*
(*vi*) Dean, Faculty of Animal Husbandry University of Agriculture, Faisalabad.	*Member*
(*vii*) Prof. Dr. Miandad, Faculty of Animal Husbandry & Veterinary Scieness, Sindh Agriculture University Tandojam.	*Member*
(*viii*) Principal, College of Veterinary Sciences Lahore.	*Member*
(*ix*) Prof. Dr. Iqbal Shah, Deptt. of Animal Production, Agriculture University, N.W.F.P.	*Member*
(*x*) Director, RVFC, GHQ, Rawalpindi.	*Member*
(*xi*) Animal Husbandry Commissioner, Livestock Wing, MINFAL.	*Member*
(*xii*) Four elected representative from PVMC Central Executive.	*Member*
(*xiii*) Dr. Syed Wajid Pirzada Pakistan Agricultural Research Council.	*Member/ Secretary*
(*xiv*) Dr. S.M. Jaffery, Former President, PVMA.	*Member*
(*xv*) Dr. M. Aslam, Chairma , PPA Islamaba .	*Member*

2. The Members shall hold office for a term of four years, but shall be eligible to be re-elected or re-nominated.

3. The Council shall have a President and a Vice-President to be elected by the members from among themselves.

IFTIKHAR AHMAD KHAN,
Deputy Secretary.

MINISTRY OF PETROLEUM AND NATURAL RESOURCES

Islamabad, the 12th October, 1998

S. R. O. 1049 (I)/98.—In exercise of the powers conferred by section 2 of the Regulation of Mines and Oils Fields and Mineral Development (Government Control) Act, 1948 (XXIV of 1948), the Federal Government is pleased to direct that the following further amendments shall be made in the Compressed Natural Gas (CNG) (Production and Marketing) Rules, 1992, namely :—

In the aforesaid Rules,—

(*i*) for rule 7, the following shall be substituted, namely :—

"7. *Period of Licence.*—(1) A licence granted under these rules shall be initially valid for a period of up to two years during which period the licensee shall execute the works in pursuance of rule 10. On completion of works, satisfactory to the Authority, the period of licence shall be extended up to a maximum period of fifteen years.

(2) On the expiry of the licence granted under these rules, a licence, unless earlier revoked under rule 8, may be renewed from time to time for a period of five years each time on payment of a fee of twenty five thousand rupees.

(3) Every licensee desiring to have his licence renewed shall make an application in that behalf to the Authority not less than three months before the expiry of the period for which the licence is valid.

(4) No application for a renewal of a licence shall be refused unless the licensee has been given an opportunity of being heard.

(5) In case of refusal to renew a licence, an appeal shall lie from the decision of the Authority to the Federal Government" and

(2) for rule 10, the following shall be substituted, namely :—

"10. *Execution of Works after Commencement of Licence.*—(1) The licensee, after the commencement of the licence, shall execute to the satisfaction of the Authority his works in accordance with the code of practice, appended to these rules, within a period of one year or such further period as the Authority may allow under special circumstances proved by the licensee to be beyond his control.

(2) The Authority shall appoint third party inspector or inspectors for the purpose of verification of works of the licensee in pursuance of sub-rule (1) of rule 10 and the licensee shall pay to such third party inspector or inspectors a reasonable fee, as determined by the Authority from time to time, for the purpose of such inspection or inspections".

DR. GULFARAZ AHMED,
Secretary.

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