Report on Standards for CNG Vehicles and Refilling Stations

In Response to the Hon'ble Supreme Court Order Dated April 4, 2001
(In the matter of W.P.(C) No.13029 of 1985; M.C. Mehta Vs UOI & others**)**

July, 2001

Environment Pollution (Prevention & Control) Authority
For the National Capital Region

1.0 INTRODUCTION

The Hon'ble Supreme Court vide its order dated April 4, 2001 in W.P.(C) No. 13029/85 directed that:

> *"We request the Bhure Lal committee to examine the existing standards for CNG vehicles including conversion of vehicles to CNG mode and for the CNG refilling stations and submit report to this court for our consideration."*

The Environment Pollution (Prevention and Control) Authority for the NCR (EPCA) held discussions with the following organisations to have their views on the issue:

* Automotive Research Association of India (ARAI);
* Ministry of Road Transport and Highways (MRTH); and
* Indraprastha Gas Ltd. (IGL)

EPCA also discussed the issue with experts from overseas: Mr. Frank Dursbeck from Germany; Mr. Christopher S. Weaver from USA, and, Mr. Lennart Erlandsson from Sweden.

Glossary of some key terms used

Converted CNG vehicle: Old diesel engines retrofitted with CNG kit

Retrofitted CNG vehicle: When old diesel engines in old vehicles are replaced with new CNG engine

New CNG vehicle: New CNG vehicle with specially designed dedicated CNG engines

Wobbe index: This is the indicator of the effect of changes in natural gas composition on air-fuel ratio and engine combustion.

2.0 CNG AS FUEL FOR AUTOMOTIVE VEHICLES

Natural gas is a mixture of hydrocarbons consisting of approximately more than 80 per cent methane in gaseous form. CNG has a long established record round the world as a vehicle fuel. As natural gas is lighter than air, it disperses into the atmosphere in the event of sudden release and does not form a spread pool or vapour cloud at the ground. One unique quality of natural gas is its narrow range of flammability. In the range below 5 per cent and above 15 per cent, it will not burn. Also, due to high ignition temperature, simple exposure to hot surface (such as exhaust manifold) is unlikely to lead to fire.

Methane's simple molecular structure and clean burning characteristics make it one of the most attractive features of the natural gas vehicles as it has the potential for ultra low exhaust emissions.

Overall, CNG vehicles are expected to be as safe as vehicles on conventional fuels. CNG cylinders are built to various safety quality standards. However, CNG has a low energy density and requires very high pressure, 200-250 bars for storage in cylinders to enhance its storage capacity mounted on vehicles. These cylinders and control valves used in the system need to be built to strict standards to ensure safety while in use.

3.0 EXAMINATION OF ISSUES

The current emission standards and safety measures for conversion of in-use vehicles to CNG are extremely lax. The emission standards only require the vehicles to meet the equivalent standards for diesel and petrol vehicles in force in the year of manufacture. This means that a pre-1996 vehicle after being converted to CNG would have to meet only the outdated emission standards of 1991. This regulation does not recognise that CNG technology is an inherently clean technology and can be designed to meet more stringent emissions standards to maximise emissions benefit.

These lax emissions standard can be met even by inadequate and inappropriate conversion technology leading to safety hazards. A bus manufacturing company which is replacing old diesel engines with new CNG engine is not putting in a 3-way catalytic converter in pre-1996 buses because they can meet the outdated standards without catalytic converters. But as the post-1996 standards cannot be met without a 3-way catalytic converter, it will do so for a 1996 and post-1996 bus. Thus, potential emission benefits of CNG are not being achieved because of the manner in which the standards have been set.

3.1 CONVERSION OF OLD VEHICLES TO CNG MODE

a) One important drawback of the current emission standards is that the Ministry of Road Transport and Highways (MRTH) notification allows the extension of the type approval certified to other engine/CNG-kit combinations than the one originally submitted for type approval. This is allowed as long as the engine displacement of the other engine is lower than that of the type-approved system, and within a certain range. This provision is reasonable for conversion of low-technology (i.e. carburetted) petrol engines, but not for retrofitting of diesel engines to CNG. As the current regulation has been interpreted, a conversion system developed and type approved for a specified diesel engine could be used on any other engine of equal or less engine displacement from any other manufacturer without any further type approval or inspection. Technically, the conversion kit and the engine have to be considered as a unique and optimised system. The application of a certified kit to any other than the type approved engine could result in unacceptable exhaust emission levels, poor driveability and performance, etc.

The existing emission regulations will encourage very basic and inadequate conversion technology to come in. These will neither have close loop mixture control or catalytic converters that are essential for lowering of all gaseous pollutants. Without these components though the particulate pollution will still be very low, other emissions like that of NOx and CO can be high. With such lax regulations, Delhi’s air will not benefit

as much as it can from the CNG conversion process. It is technically possible and feasible to develop optimised conversion systems with catalytic converters meeting tighter standards.

Moreover, old engines undergo certain amount of wear and tear. It is most likely that the conversion agencies may not repair the old engines according to manufacturers' specifications while converting these engines. This can lead to higher emissions than a new engine. Therefore, to achieve the best emission results, it will be advisable to retrofit old vehicles with new OEM (original equipment manufacturer) engine that will have much lower overall emissions than a converted engine.

b) As of now, there is no provision for inspection of engine and the high pressure fuel storage system for every converted vehicle before being allowed to enter service to ensure quality of conversion. There is also no provision for subsequent periodic inspection of the converted vehicles or emissions and safety compliance.

In the absence of a proper inspection system, some installations done for conversion are very deficient. In order to ensure that the converted buses comply with the specifications of the type approval, it is important to have an inspection system in place.

c) The workshops authorised to undertake conversion of vehicles are not governed by any technical or legal norms. As of now, the MRTH notification allows kit installation on in-use vehicles only by workshops authorised by the kit manufacturer/kit supplier. In the absence of proper technical and legal norms, the competence of technical manpower employed and adequacy of the facilities available in the workshops cannot be ensured.

3.2 NEW CNG VEHICLES PRODUCED BY ORIGINAL EQUIPMENT MANUFACTURERS (OEM)

It has been brought to our notice that there is further scope of improvement in the standards laid down for manufacturing of the chassis and installation of CNG kits, specifications for materials, and fittings for high-pressure systems. This is necessary to minimise the risk of unwanted incidents.

There are some glaring examples. In the production for the chassis, there is some room for improvement in areas such as: material of the high-pressure piping, fixing of pipes to the chassis, tightening of the couplings, venting of the pressure relief valve, and inspection of gas pipes etc. Mixing of brass fittings with pipes made of steel should be avoided. Under moist conditions, this combination could cause electro-galvanic corrosion.

Similarly, gas pipes should be mounted in such a way that movement and vibrations in the chassis are not transferred to the gas pipes, thereby causing a risk leading to breakage of pipe through scraping after it has been in use for sometime. Therefore, there is a need for laying down proper rules for installation to ensure leak proof high-pressure systems.

Each gas cylinder has a pressure relief valve to vent the gas if the cylinder is exposed to high temperatures and/or high internal pressure. As of today, the venting of the valve is not directed away from the cylinders, thereby releasing the gas close to the cylinder. Since the cylinders are installed beneath the body of the bus, there is a risk that the vented gas will reach an area close to people or may enter the passenger compartment.

When a CNG vehicle has been in use for sometime there is a need to inspect the gas pipes by visual inspection. However, the gas pipes used in some cases are covered with a protective layer of plastic or rubber. This makes it very difficult to inspect the pipes.

Conventional ignition systems with mechanical distributors currently in use are likely to lead to misfiring in one or more cylinders leading to damage of catalytic converters.

This matter has been brought to attention of the Society of Indian Automobile Manufactures (SIAM). In its response SIAM has commented that the existing practices are acceptable and pointed out that ARAI has prepared a Draft Report on "Safety and Procedural Requirements for Type Approval of CNG Operated Vehicles" which is to be finalized soon by the CMVR Technical Committee. The EPCA has not reviewed the draft report and will revert back to the Hon'ble Supreme Court on it. Meanwhile, we would urge bus manufacturers to take all necessary safety precautions.

3.3. NEED FOR MORE STRINGENT EMISSION STANDARDS FOR NEW CNG VEHICLES

CNG technology has the potential to meet more stringent standards within a shorter time frame. Therefore, it is possible to set more stringent standards compared to diesel and petrol vehicle standards.

It is important to point out that the approval requirements for gaseous fuel engines comprise not only emission limit values, but also requirement for durability testing, emissions warranty and other commitments to be made by the manufacturer of the engine. In addition, the test procedure for engines using gaseous fuels such as CNG needs to be changed so that it is more representative of actual on road driving under various conditions.

3.4. QUALITY OF NATURAL GAS

There is as yet no proper specification for CNG used as automotive fuel in India – it is only stipulated in the regulations that the gas used for emission testing should contain not less than 70 per cent methane. The technical development of an engine must go hand in hand with the improvement of fuel quality available in the market. There are analyses of gas showing that the amount of methane is about 85 per cent in the gas delivered to Delhi via the

pipeline and has remained stable over time. However, no specification has been laid down for these.

3.5. SAFETY ISSUES IN CNG FILLING STATIONS:

When CNG buses are filled at filling stations, normal precautionary measures are implemented according to Indian and also international standards. But there is scope for improving the layout of the existing gas filling stations to ensure better approachability and safety. In a number of gas filling stations catering to non-DTC vehicles in Delhi, there is a minor risk of damaging the gas pump. This is because there is too tight a radius for a bus to approach the pump easily. The lay-out of filling stations should give the privately operated buses plenty of room for a safe approach. If there is not enough room, the "island" where the pump is located could either be made larger or a steel barrier could be anchored in a suitable way for protection of the pump.

3.5.1. Nozzles and safety: As of now, type approval certificate has been given to CNG vehicles fitted only with nozzles meeting New Zealand Standards (NZS). These are prone to frequent o-ring failures – an item in nozzles. We are informed that they occur on an average about once every 20 fills. This failure not only interrupts fueling and requires replacement of the o-ring, it also creates a fire hazard due to the release of a significant amount of high-pressure gas.

Standardising of all vehicle-refuelling receptacles on the NGV-1 standard would reduce fuelling time requirements and queues, and make possible more efficient use of existing compression capacity.

3.6. CERTIFICATION PROCESS

The capabilities and capacities of the type approval institutions are inadequate leading to delays in testing. This should be improved in order to reduce the duration of the whole type approval procedure to reasonable, internationally common timeframes. The type approval procedure including the "Information on Technical Specification to be Submitted by Manufacturer" used by testing agencies needs to be reviewed in order to delete unnecessary

test items and administrative procedures, and to make the system more cost-effective and less time consuming.

3.7 SAFETY OF CNG CYLINDERS

As of today, the cylinders meet the common standards set for all high-pressure gas cylinders from oxygen to hydrogen by the Bureau of Indian Standards and approved by the Chief of Comptroller of Explosives. But these standards do not take into account on-board high- pressure gas cylinders mounted on moving vehicles. International standards have been specially set for on-board cylinders. There is a need for enforcement of these safety regulations as well.

4.0 RECOMMENDATIONS

4.1 Conversion of old Vehicles to CNG Mode

a) To achieve the best possible results for the conversion of existing buses to CNG, we recommend retrofitting (i.e. exchange of the old diesel engine for a new OEM CNG engine) rather than conversion (i.e. fitting a CNG conversion kit on an existing diesel bus).

b) Both converted buses and retrofitted vehicles should meet Bharat Stage II emission standards for gaseous pollutants. While particulate pollution is not a problem from a converted bus, other emissions like that of CO and NOx should be regulated as per the Bharat Stage II emission norms.

c) Engine converters should be required to obtain a new type approval for each separate diesel engine model they seek to retrofit/convert. The present provision of extension of type approval certificate to other engine/kit combination than the one originally submitted for type approval should not be allowed.

d) In order to avoid deficient installations, each and every converted bus must undergo inspection of the engine and high-pressure fuel storage system before being allowed to enter service. This inspection programme should

subsequently be extended to comprise periodic inspections (at least annually) on all operating CNG buses for emissions and safety compliance. This inspection should be equivalent to the conformity of production (COP) inspections for OEM buses. Furthermore, it should comply with the respective regulations prevalent in other countries. The Ministry of Road Transport and Highways needs to set inspection norms for:

- Visual check of components relevant to emissions including the exhaust emissions systems.
- Measurements of CO, HC, CO_2 and O_2 levels with the engine idling.
- Close loop control check
- Determination of NOx and CO levels under full engine load (as specified in the rule 115, sub rule 2 of the Central Motor Vehicles Rules) on a simple dynamometer.

e) According to the rules, the Department of Transport of GNCTD is responsible for safety and roadworthiness inspection. But realising that their inspectors lack expertise in the field of CNG vehicles, we recommend that the task of inspecting every converted bus for its engine and high pressure fuel storage system before it enters service, be entrusted to the Gas Authority of India Ltd (GAIL) and the Indraprastha Gas Ltd (IGL) who are having requisite expertise.

4.2 Norms for setting up of conversion workshops and development of technical infrastructure

a) Ministry of Road Transport and Highways needs to issue technical and legal norms for the approval of conversion workshops.

b) Concerned Ministries should initiate steps in cooperation with OEM manufacturers, conversion workshops and technical institutions to develop technical infrastructure such as trained workshop personnel, availability of spare parts, test resources, etc to make it possible to enforce strict emissions standards.

4.3 OEM CNG Vehicles

a) All new CNG buses should meet Bharat Stage II emission standards. In fact, the new buses already meet Bharat Stage II emission standards.

b) Procedures for the durability testing, emissions warranty and other commitments to be made by the manufacturer of the engine should be laid down by the Ministry of Road Transport and Highways.

4.4 Need for more stringent emissions standards for future CNG vehicles

a) MRTH may be asked to notify Euro IV equivalent standards for new CNG buses from 2005 and simultaneously provide fiscal incentives for achieving European Environmentally Enhanced Vehicles standards.

b) Test procedure for engines using gaseous fuels such as CNG be changed from a “steady state” test to a “transient” test as this type of test is more representative of actual driving on the road under various conditions.

4.5 Quality of Natural Gas

Ministry of Petroleum and Natural Gas may be asked to lay down the specifications of pipeline gas. The gas composition – as indicated by methane content and the Wobbe index (indicator to measure the effect of changes in gas composition on air-fuel ratio and engine combustion) -- should be laid down.

4.6 Safety Aspects in CNG Refilling Stations

a) Ministry of Petroleum and Natural Gas may be asked to review the layout of the dispensing stations to ensure easy approachability to dispensers and protection of the installed pumps.

b) Standardise all vehicle-refuelling receptacles or nozzles on the NGV-1 standard to reduce filling time, minimise safety risk posed by leakage of gas due to O-ring failure, and allow more efficient use of existing compression capacity.

4.7 Certification and Testing of CNG Vehicles

a) The capabilities and capacities of the type approval institutions should be improved in order to reduce the duration of the type approval procedure to reasonable, internationally common time frames. The type approval procedure including the “Information on Technical Specification to be Submitted by Manufacturer” of testing agencies needs to be reviewed in order to delete unnecessary test items and administrative procedures, and to make the system more cost-effective and less time consuming. A complete test should not take more than three weeks, and for minor modifications – specified by a competent authority – the vehicle should not need to undergo the complete new type approval procedure. Rather, only those parts affected by the changes should require testing.

4.8 High-pressure Cylinders and Piping for Storage of CNG on Board Motorised Vehicles

The Bureau of Indian Standards may be asked to lay down standards for high-pressure cylinders and piping for the on board storage of CNG as a fuel for automotive vehicles on the lines of prevailing international standards such as ISO 11439 Gas cylinders – “High-pressure Cylinders for the On-board Storage of Natural Gas as a Fuel for Automotive Vehicles”.

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