

EPCA report number 15 (July 2005)

Assessment and prevention of gas leakage from CNG buses

In response to the Hon'ble Supreme Court Order Dated March 11, 2005

(In the matter of W.P.(C) No.13029 of 1985; M.C. Mehta v/s UOI & others)

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

1. EPCA's mandate

In response to the media reports that nearly 70 percent of the CNG buses in Delhi have been found to be leaking CNG, the Hon'ble Supreme Court of India has issued the following direction in its ruling of March 11, 2005:

E.P.C.A. is directed to look into the concerns, which have recently been expressed in the media regarding the aspect of leakage of gas and other related safety issues, and suggest safeguards, if necessary, after examining the matter. The Report of the E.P.C.A. be submitted within five weeks.

Following the Hon'ble Court's direction, EPCA initiated a technical assessment of the problem of CNG leakage in Delhi Transport Corporation (DTC) buses. EPCA experts met with all the concerned target groups including the bus manufacturers, officials of the DTC, Indraprastha Gas Ltd (IGL), and personnel involved with the third party safety inspection of CNG buses in Burari. The experts also made field visits to the central workshop of the DTC at Okhla on April 4, 2005, to Burari vehicle inspection centre on April 5, 2005, and to IGL refuelling station on April 6, 2005. At the Burari inspection centre experts also made note of the safety related concerns in the Road Trusted Vehicle (RTVs).

EPCA has also discussed its findings with the concerned stakeholders in a meeting held on April 16, 2005. The meeting had representations from the Society of Indian Automobile Manufacturers, Tata Motors, Ashok Leyland, Hindustan Motors, Swaraj Mazda, Delhi Transport Corporation (DTC) and the Ministry of Shipping, Road Transport and Highways (MoSRTTH).

Based on the technical assessment, field visit, and stakeholder consultation, EPCA makes the following observations and recommendations to improve safety inspection of CNG buses in Delhi.

2. EPCA's observations

2. 1. Ascertaining the problem of gas leakage in DTC buses

EPCA has examined in detail the problem of gas leakage in the 70 percent of DTC buses in Delhi as was reported in the media. The Delhi transport department in its representation to EPCA has submitted that the problem of extensive leakage in DTC buses was detected only when DTC had carried out checks in February 2005 in two depots of DTC with methane detectors. According to the data presented by the transport department around 200 vehicles were tested in two depots in February of which 149 (74.5 percent) buses were found to have leakage. Following this, more rigorous corrective measures were implemented during the repair and maintenance of buses. DTC repeated the leakage test in all DTC depots during March 22 to March 28, 2005. Out of the total fleet of 3,105 buses 2,728 buses were checked. This time DTC found that the leakage rate had reduced drastically to only 1.13 per cent of the fleet. Only 31 buses were found with leakage.

EPCA would like to note that the improvement in the method of leakage test with the help of methane detectors has helped to diagnose leakage points more efficiently in numerous joints of a bus compared to the earlier method of soap bubble test. Though it is a matter of serious concern that such widespread leakage persists, it is however, important that this safety drill is also a step forward in improving the maintenance system for DTC buses.

While EPCA appreciates the efforts made by DTC to improve the maintenance practices, the experience however is a dire warning that any negligence towards maintenance of the bus fleet and laxity in enforcement of safety measures can seriously jeopardise the CNG programme that has been instrumental in cleaning up the air of Delhi.

Field observations: CNG leakage points in buses

After careful evaluation of the current systems, EPCA would like to point out that there is no single cause of CNG leakages. However, the common reasons observed are as follows:

1. Leakage is detected in most of the cases at the gas filter inlet. Reason could be either worn out O-rings or dust coming in to the system when the "Dust cap" is missing
2. On a Tata bus there are about 50 joints while on Leyland there are about 70 joints in the gas flow system. These many joints are susceptible to CNG leakages
3. Impurity in the gas distribution system causes malfunction in vital component in the gas system on the vehicle. Impurities include oil and water vapour and to some extent also sulphur (used as a "marker", odorant in the gas). DTC claims that impurities in the gas cause perforation of the diaphragm in the mixing unit and thereby cause leakage of gas
4. The Association of state road transport undertaking (ASRTU) that conducts the third party inspection in CNG buses at the Burari inspection centre informed EPCA, "In majority of the cases, the failure is noticed due to the CNG leakage from the Pressure Regulator, Solenoid Valve and Refilling Valve. In many cases CNG leakage from the Inlet manifold, spark plug suppressor cap and air cleaner assy, was also observed. Failure to comply the norms due to the non-fitment of the catalytic converter and un-proper electrical fittings were also a major reason." The point is further corroborated from the graph (See Graph: The increasing trend in failure of CNG buses).
5. Major problem noted in the minibuses is that the solenoid valve (shut off valve) and the timer switch (prohibit gas flow if engine does not start within specified time) are not functioning or are missing. Leakage along the high-pressure gas piping system is common, and awareness of potential risks is on a very low level

2. 2. Other issues related to safety

Private CNG buses- a special cause of concern

While assessing the other issues related to safety, as was directed by the Hon'ble court, EPCA uncovered the shocking fact that there is virtually no check on the private CNG buses, which constitute nearly 70 per cent of the bus fleet in Delhi. Preventive maintenance in the private CNG buses is a serious cause of concern as the private CNG buses avoid going to the authorised workshops for maintenance and repair works. They mostly rely on the roadside garages and mechanics, which may not have the necessary skills to address all engineering aspects of maintenance and repairs. Regular preventive maintenance of vehicle, especially for the electric system, is not carried out in the best way. Probably to avoid cost. The quality of repairs and maintenance of private CNG buses thus becomes a cause of concern for the whole CNG programme. This is of even greater concern among the converted bus owners, as the bus converters do not provide supportive infrastructure for preventive maintenance.

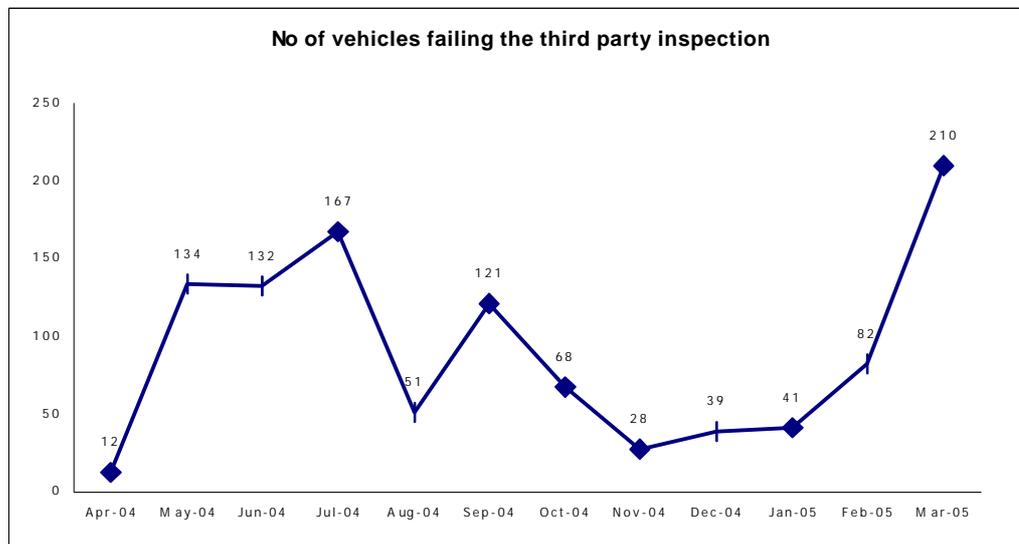
The yearly fitness check and the third party inspection, which is carried out at the Burari centre, is the only means of assessing the safety and the related features of the private CNG buses plying in Delhi. The inspection data provided by the ASRTU, responsible for the annual third party inspection at Burari centre, shows that the number of vehicles failing the third party safety inspection tests is on the rise of late. Amongst the buses that fail to meet the safety specifications, leakage is one of the most common problems.

Gas leakage from the high-pressure gas flow system, not only causes loss of fuel economy but also poses a serious safety hazard. Private fleet owners should be educated on leak detection techniques, preventive maintenance measures and their benefits on fuel economy, reduced operating and maintenance costs. One estimate indicates saving of more than Rs 2 lakh per day in the CNG fuel cost incurred by DTC, by plugging the gas leakages, from their operating CNG fleet.

In view of the fact that proper facilities for periodic inspection of private buses to supplement the once-a-year inspection in Burari, does not exist, alternative arrangement should be made to provide those services to the private bus owners as well. After assessing the existing facilities in the city EPCA concludes that only DTC that owns as many as 3100 buses, has elaborate infrastructure for testing and maintenance of its own bus fleet. The same can be further developed to extend these services to the private bus operators as well. This is urgently needed to ensure that the private bus operators undertake proper repairs after periodic inspection during the year.

This will further require creation of a network of authorised repair workshops.

Graph: The increasing trend in failure of CNG buses



Source: Anon 2005, A Report on Third Party Technical Inspection of CNG buses in Delhi, Association of State Road Transport Undertaking, New Delhi, Pg 2

2. 3. Looking at the remedial measures

Based on the field assessment EPCA feels that achieving high quality of performance, fuel economy, durability and safety from CNG vehicles requires a multi-dimensional approach involving i) Strengthening of the current inspection and maintenance procedures and

facilities ii) adequate inspection and regulations norms iii) Improvements in engineering design including selection of proper materials iv) Standardisation of CNG quality/specifications. It requires engine manufacturers, vehicle owners, DTC, gas suppliers (IGL), regulating authority (MoSRTH) and inspection authority (ARAI/ASRTU) to work in tandem.

2.3.1 Strengthen third party inspection

The Hon'ble Supreme Court has played an instrumental role in bringing the third party inspection regime for the CNG programme. The Apex court vide its direction dated July 29, 2002 directed the government of the NCT of Delhi to ensure that all such buses conform to the safety norms of GSR 853 (E) of the November 19, 2001. It said, "...with effect from 5th August, 2002, no retro-fitted or converted CNG bus will be allowed to ply unless and until the Director, Transport Department, NCT of Delhi is satisfied and certified that the vehicles confirmed with the safety norms of 19th November, 2001." To comply with this the government of the NCT of Delhi invited the ASRTU in view of its required expertise and infrastructure. Accordingly an agreement was signed between the government of the NCT of Delhi and the ASRTU in the month of the September 2002. Thereafter the third party technical inspection (TPTI) of CNG buses came into existence for the first time in the country.

Currently, the TPTI is the only system available for assessing the safety features of CNG buses on the basis of which the annual fitness certificates for buses are issued or renewed. This is a detailed test patterned along the line of the Annex VII of the AIS 024, the safety standards adopted for CNG buses. The detailed checklist consists of two parts, A & B. The first part is for the verification of documents such as registration certificate, the type approval certificate and installation certificate etc. This verification work also includes physical confirmation of Chassis No, Engine No, and their make, model & capacity etc viz a viz its registration certificate.

Once the documents are found in order, the technical checking as per the part B is conducted. In this part, component-wise safety checks as per the checklist and also noting down of the CNG cylinders numbers, make, capacity, validity of life and details of the CNG related components are carried out. After completion of inspection, irrespective of the result, a certificate is issued. For this purpose a fee is collected from the vehicle owner. TPTI is an additional test that all CNG buses have to undergo before annual fitness and emissions tests are carried out at Burari.

The current concerns regarding the third party technical inspection

EPCA takes strong note of the fact that contrary to the direction of the Hon'ble Court of July 29, 2002 pre-registration third party inspection of buses has stopped. This means a vehicle is inspected for the first time two years after registration. As a result it is not possible to detect the inherent manufacturing or installation flaws in both OEM and converted buses before they come on the road. In reality this means that the vehicle runs for over two years without any check.

In the absence of pre-registration third party inspection inherent technical flaws in the buses may go undetected. For instance, it has been brought to the notice of EPCA that sometime at the time of bus body building the installations in buses are reconfigured. This can undermine the safety features of the bus. It is therefore, important that pre-registration third party inspection is conducted in the presence of the manufacturer/converter, bus body builder and an official of the transport department to prevent such violations. Similarly, the bus converters often do not give the required installation certificate to the bus operators

detailing out the information about the installation of the gas system. As pre-registration inspection is not conducted any more these lapses are not detected on time. Later bus operators have to go back to the conversion agency for the certificate.

EPCA would like to emphasise that pre-registration third party inspection should be reinstated immediately to prevent such violations.

It is also evident that the third party inspection at Burari once a year is not a guarantee against gas leakage during the rest of the year. Moreover, it was noted that the bus operators try to pass the once-a-year third party inspection by borrowing components just for the day of the inspection to avoid being caught for component failure. Some of these key components include "dust cap" and "solenoid valve". This clean- for- the- day syndrome grossly undermines the inspection efforts.

This indicates that round the year periodic safety inspection and surprise checks are required to supplement the efforts of third party inspection.

To strengthen the TPTI further the results of third party inspection should be audited and analysed by ARAI every six months to identify the root causes of frequent failures. Such audit reports should be made available in the public domain.

2.3.2 Revamp periodic safety inspection and maintenance of DTC buses

The DTC is the largest owner of CNG bus fleet in Delhi, around 30 percent of the CNG buses in Delhi. It has developed its own infrastructure to carry out routine testing of buses. It has a well-equipped central workshop at Okhla with two CNG engine test beds and other testing facilities. Over the years DTC has also built up its own inventory of spare parts for CNG engines and has a good strength of technicians, trained for the upkeep and maintenance of CNG buses.

DTC needs to implement fully the preventive maintenance schedule as per the safety checklist -- Annexure VIII of AIS 024 (annexed), that details out the various tests to be carried out on daily, weekly and monthly basis. Implementation of the checklist for preventive maintenance is still inadequate. For instance, the checklist clearly mentions that leakage tests should be carried out daily. But DTC conducts leakage tests approximately only once in two weeks, according to the internal schedule drawn for each CNG bus in their depots.

State transport department should develop a system for monitoring the implementation of the Annexure VIII of AIS 024 in the DTC depots.

2.3.3 Develop facilities for periodic safety inspection of private buses

The immediate thrust should be on creating well-equipped common facilities for safety inspection, and preventive maintenance for private buses in Delhi. Since DTC already has the wherewithal to carry out such services, the process can be initiated by making DTC the nodal agency in developing those facilities in its depots and provide these services to the private bus owners.

However, in the long run the Government should ensure that there is an adequate network of approved testing centres equipped with proper tooling, instruments and trained manpower for regular periodic checkup, and maintenance of CNG vehicles in Delhi.

EPCA in its meeting held with all stakeholder on April 16, 2005 had discussed this proposal. DTC has agreed to undertake the following to initiate the process:

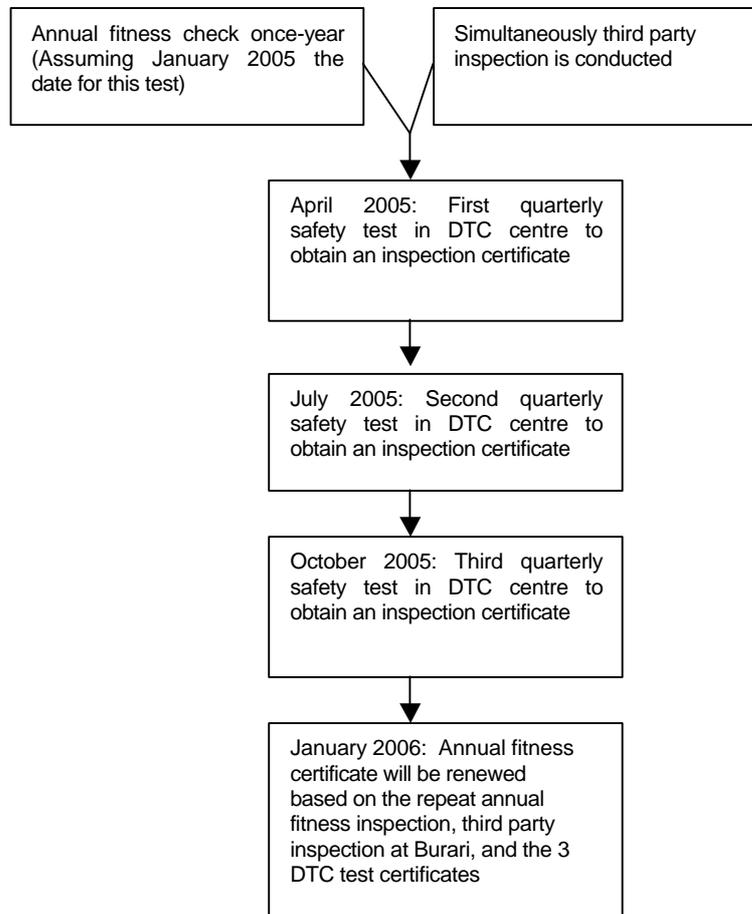
1. Commissioning of the CNG leakage cum pollution checking centre for private CNG buses including RTVs
2. DTC will initiate training programme for private bus operators involving the bus manufacturers

Thereafter, DTC has submitted the following proposal for CNG leakage and pollution checking centre to EPCA in April 2005:

1. **The total number of vehicles to be tested annually:** As per initial assessment about 11,000 CNG private vehicles up to the RTVs are operating in Delhi. On making the checking of leakage in vehicles mandatory along with PUC every quarter, DTC will have to test approximately 33,000 vehicles in a year
2. **Number of centres:** DTC has planned to open 3 centres initially, and increase to 6 centres within a year. These centres will be at Nehru Place Terminal, Hauz Khas Terminal, Uttam Nagar Terminal, Raja Garden Terminal, Mangol Puri Terminal and Anand Vihar Terminal
3. **Daily throughput for tests:** These centres will work in single shift for 300 days in a year. Each centre will get a load of 17 vehicles per day for fresh checking and additional 10 vehicles for re-checking (failed buses)
4. **Facilities to be provided:** DTC will provide computerised infrastructure, leakage detection equipments, 4-5 Gas analysers along with lambda checking. Printed report will be provided to operators along with their Number Plate to avoid blank checking. The trained manpower will be deputed by DTC at each centre.
5. **Payment for tests:** The facilities will be provided on a payment basis as decided in consultation with the State Transport Authority, Delhi

EPCA has examined the proposal from DTC on CNG leakage cum pollution checking centres. EPCA would like to point out that the protocol for safety tests should strictly follow all the leak tests included in the checklist prepared as per the Annexure VIII of AIS 024.

The new inspection system for a private CNG bus



To ensure that the new leakage testing facilities to be created by the DTC are used effectively, the transport department will have to make it mandatory for the private bus operators to undertake quarterly tests at the DTC centers authorised by the transport department. This mandatory check at DTC centers should be linked with the permit condition of the private buses in addition to the annual third party inspection at Burari. This should be enforced in next 6 months

Simultaneously, the transport department should set up fully equipped mobile testing diagnostic facility to conduct surprise CNG leakage checks on on-road CNG bus fleet within 1 month. Mobile facilities should check for leakage, damage and corrosion. The transport department inspectors should coordinate closely with ARAI and ASRTU team doing third party annual inspection, to interpret current norms, regulations and other relevant documents.

2.3.4 Role of the CNG bus manufacturers

EPCA has observed from discussions that there are still engineering features in CNG buses that need to be redressed and improved to minimise the 'weak points' in the buses.

EPCA would like to draw attention to some of its observations in this regard. For instance, in Ashok Leyland's CNG buses it has been reported that the cylinder heads invariably fail well within the warranty period and even the replaced cylinder heads do not last. Obviously it's a typical case of engineering failure and needs design improvement to withstand mechanical and thermal stresses produced during the engine operation.

EPCA has further noted that many Tata buses have not yet provided for venting of gas from the bus in case of leakage. The manufacturers should retrofit this immediately.

More fundamental changes would have to be undertaken in the new buses to address some of the current weaknesses. Some of these are as follow:

1. Misfiring is a common occurrence in both makes of the buses. The resulting high temperature in the catalytic converter destroys the catalyst rendering the catalytic converter ineffective with consequent high exhaust emissions.
2. Use of all electronic distributor-less ignition system instead of the conventional ignition system with mechanical distributor eliminates the high voltage wires in the ignition systems, which are known to cause trouble in heavy-duty CNG engines. Coil-on-plug is the preferred design of such a system. EPCA has made these recommendations from time to time but these changes have not been implemented adequately yet.
3. Better engine performance and fuel economy requires sophistication of the fuel metering system. The old generation system of mechanical fuel metering needs to be replaced by fuel injection with closed loop control / with OBD capabilities added.
4. Chances of gas leakage from the high-pressure piping and fittings can be reduced by improvements in the materials used and methods of fitting employed. Use of brass fittings with steel pipes can lead to electro-galvanic corrosion under moist conditions. Such mixing of material should be avoided. Gas piping and fittings should be made of stainless steel. Compression fittings, wherever possible or fittings with tapered thread instead of cylindrical thread should be used. Use of Teflon sealing tape in threaded fittings could reduce the chances of leakage considerably.
5. Engine sub-systems such as lubrication system, air cleaner system need improvement. Ill designed and improperly functioning sub-systems can cause oil entering into the engine adversely affecting the durability and performance of the emission control system.

Clearly, concerted R & D effort is required by engine manufacturers to improve the engine design, achieve material compatibility of the components and their durability, ensure leakage-proof operation of the high pressure gas system by minimizing the number of joints, and providing leak proof joints in the system.

EPCA notes with great concern that the bus manufacturers have not yet developed a strategy to ensure easy availability of spare parts and essential components at affordable prices to the bus owners. Non-availability of original make components in the retail market and their high cost is leading to widespread use of duplicate and cheaper components with adverse effects on the performance, durability and safety.

It has been reported that some of the major original make components and sub-components are not available in the retail market and can be procured from the manufacturers only, who

do not allow the suppliers to sell them directly even to bulk consumers like DTC. The prices fixed by the manufacturers for components such as pressure regulators, mixers and even for minor items such as diaphragms; ignition system cables etc are exorbitantly high. The fleet owners feel that there is a monopolistic control over the supply of spare parts aimed at profiteering through the sale of essential components and sub-components. The manufactures should evolve proper pricing policy and practices on supply of spare parts and rationalise the prevailing price structure.

2.3.5 Need changes in emissions regulations

EPCA would like to draw attention to the fact that the engineering developments related to safety and emissions can be pushed if emissions regulations for CNG buses are adequately tightened. It has been noted that while Bharat III standards for the CNG engines have come into force in Delhi and 10 other cities, test procedures for testing these norms have not been fully aligned with the Euro III standards of Europe for CNG vehicles. For instance, in Europe emissions norms for CNG buses are tested on a transient driving cycle (that simulates driving pattern on road) that is more difficult to meet than the steady state cycle which is currently followed in India. This softens the impact of the norms.

In this context, EPCA would like to draw attention to the fact that even in India MoSRTTH in its notification GSR 686 (E) of October 20, 2004, on Bharat Stage III norms has already adopted the European Transient Cycle (ETC) for heavy-duty diesel vehicles if they are fitted with particulate traps and DeNOx catalyst. The government ironically has made provision for a technology like particulate traps that does not exist in India yet. But the one that exists – CNG, and requires these tests has been kept out of its ambit.

EPCA would therefore recommend that the provision of this clause made for diesel buses with advanced after treatment systems should be immediately extended to include the Euro III compliant CNG buses in India.

Similarly, requirements for durability of emissions control components including catalytic converters should be increased from the current levels of 80,000 km to at least 150,000 km and emission warranty should be extended accordingly. With these regulations more holistic technology development can be ensured.

2.3.6 Role of CNG fuel quality

The quality of fuel has marked bearing on the performance and durability of the engine and emissions control components. As vehicular engines operate within much wider ranges of pressure and temperature than conventional gas burning appliances, the general-purpose gas quality standards do not necessarily serve the needs of engines and vehicles.

It seems that presently there are no proper specifications for the CNG used as automotive fuel. It is necessary that proper specifications are laid down on the lines of established international standards such as SAEJ1616, ISO 15403, SAE, 2001 and Detroit Diesel corporation, 1998.

Thus for example Wobbe Index for automotive CNG should be in the range of 48-51. The octane rating (MON) should be in the range 115-118. The methane number should be 80 and lower heating value of the gas in the range of 33.74 to 43.7 MJ/m³. These and such other properties must be specified/standardized by Gas Authority of India Limited (GAIL)/IGL

More importantly the CNG shall not contain any dust, dirt, gums or other substances that are injurious to the fuelling system of the vehicles. Particulate and foreign concentrations should be minimized to avoid contamination, clogging and erosion of the fuel system components. Particulate size greater than 5-micron size should get filtered out from the gas being dispensed.

The total content of sulphur compounds, including odorants should be limited to 8-30ppm by mass to avoid excessive catalyst poisoning by sulphur.

Currently, in parallel efforts Bureau of Indian Standards and an industry group consisting of IGL, GAIL and Mahanagar Gas Ltd (MGL) are deliberating on the CNG fuel specifications. Ministry of petroleum and natural gas should expedite the process urgently.

3. EPCA's recommendations

The technical study undertaken by the EPCA clearly points out that proper enforcement of safety inspection and regular preventive maintenance are necessary to avoid any future cases of CNG leakages. Though requisite safety norms are in place- only strict adherence to these norms can ensure a quality programme and maximise the pollution gains from it. CNG leakage not only compromises the safety of the buses, but also adds to the emissions and results in considerable fuel economy loss. Safety, emissions and economics of the CNG programme can improve significantly with good maintenance practices.

EPCA would like to make the following recommendations:

Delhi Transport Corporation

1. Delhi Transport Corporation, as stated in their proposal to EPCA, should set up 6 leakage cum pollution checking centres within 6 months for testing of the private buses including RTVs. Three of these centres should be operational within the next 3 months. DTC will issue a certificate for these tests
2. The protocol for safety tests should strictly follow all the leakage tests included in the checklist prepared as per the Annexure VIII of AIS 024
3. For their own buses DTC should conduct leak tests from each bus before it moves out of the depot everyday as prescribed in Annexure VIII of AIS 024

Delhi transport department

1. The transport department will make it mandatory for the private bus operators to undertake quarterly safety checks at the DTC centers in addition to the annual fitness and third party inspection. This mandatory check at DTC centers should be linked with the permit condition of the private buses. This should be enforced in next 6 months
2. The transport department should reinstate immediately pre-registration third party inspection of CNG buses
3. Third party inspection should be further strengthened by directing ARAI to audit the system every 6 months

4. The transport department should set up fully equipped mobile testing diagnostic facility to conduct surprise CNG leakage checks on CNG buses within 1 month
5. With regard to the lapses in the converted buses the transport department should coordinate with conversion agencies and bus operators to correct them. Within three months conversion agencies should be directed to retrofit venting pipes in converted buses
6. Authorise a network of repair workshops in the city to undertake repair works related to safety and emissions related components in CNG buses within three months
7. With immediate effect, the compliance plates on the CNG cylinders should be checked in all the vehicles at the time of annual fitness

Bus manufacturers

1. In view of the information that the cylinder heads in Ashok Leyland buses fail frequently, even during the warranty period indicates that there is an inherent technical flaw in them for which customers cannot be held responsible. Therefore Ashok Leyland be directed to submit to EPCA within three months the engineering modifications made to improve their durability and also inform if the old cylinder heads in the on road fleet have been replaced with the improved version
2. Many CNG buses in Delhi still do not have venting pipes, both Tata Motors and Ashok Leyland, should retrofit all in-use CNG buses which still do not have proper venting pipes at their own costs, and submit a compliance report to EPCA within 3 months
3. To prevent monopolistic control over the supply of spare parts, essential components and sub-components, aimed at profiteering, the manufactures should submit a pricing policy and practices on supply of spare parts to rationalise the prevailing price structure. This should be submitted to EPCA within two-weeks for necessary steps

Indraprashta Gas Limited

1. Before dispensing gas, IGL should check the dust caps in buses and dust plugs in RTVs. Refueling should be refused to those vehicles, which do not have the dust caps/plugs. This should be enforced with immediate effect

Ministry of Shipping, Road Transport & Highways (MoSRTTH)

To address the fundamental engineering issues related to safety, Bharat III standards for CNG buses should be amended to include the following:

1. As detailed out in the report, Bharat III standards and test procedures for CNG buses have not been fully aligned with the Euro III standards of Europe for CNG buses. For instance, Euro III norms for CNG buses are tested on a transient driving cycle (that simulates driving pattern on road) that is more difficult to meet than the steady state cycle that is currently followed in India. This softens the impact of the norms. Since the MoSRTTH through its notification GSR 686 (E) of October 20, 2004, on Bharat Stage III norms has already adopted the European Transient Cycle (ETC) for heavy-duty diesel vehicles if they are fitted with particulate traps and DeNOx catalyst, this provision should be immediately extended to include the Euro III CNG buses as well

2. Durability requirements for the catalytic converters in CNG buses should be increased from the current 80,000 km to at least 150,000 km. These amendments to the current notification should be implemented within three months

Ministry of petroleum and natural gas

1. For better performance and durability of CNG engine components CNG fuel specifications should be finalised within the next 3 months and submitted to the Hon'ble Supreme Court

**CHECKLIST FOR PREVENTIVE MAINTENANCE OF IN-USE
CNG VEHICLES**

This checklist is A GUIDE for preventive maintenance of fully built in-use CNG vehicles. Preventive maintenance shall be carried out by authorized installer at authorized workshop only, as prescribed in CMVR. Reference to relevant clauses of Safety Code of Practice, e.g. AIS 028, and guidelines issued by Central Government from time to time should be made wherever appropriate.

<u>A. Details of CNG Vehicle</u>		
<u>1. Name and address of owner of vehicle</u>		
<u>2. (a) Type of vehicle (LCV/HCV)</u> <u>(b) Model</u>		
<u>3. (a) Name of OE manufacturer</u> <u>(b) Name of kit retrofitting agency</u>		
<u>4. Name and address of bus body builder</u>		
<u>5. Name and address of approved inspecting agency at R.T.O.</u>		
<u>6. Chassis No., Engine No. and Vehicle Registration No.</u>		
<u>7. (a) Year of manufacture of vehicle</u> <u>(b) Date of endorsement of CNG kit in RCTC book</u>		
<u>B. Detail of CNG System</u>		
<u>1. Checking of Cylinders as per DOE/ vehicle testing agency approvals</u>	<u>Approved Specification at the time of Type Approval</u>	<u>Remarks of Inspection Authority</u>
<u>a) No. of Cylinders</u>		
<u>b) Approval from DOE</u>		
<u>c) Validity of DOE Certificate</u>		<u>Check or Re-test cylinders as per Gas Cylinder Rules, 1981</u>

<p><u>Other checks</u></p> <ul style="list-style-type: none"> • <u>Check for corrosion on any CNG components / mountings of gas cylinders</u> • <u>Ensure cylinder is securely mounted within the vehicle; check tightness of nuts and bolts</u> • <u>Ensure minimum 5 mm clearance is kept between cylinders and vehicle body structure</u> • <u>Distance between cylinder valve and bus body extremities shall not be less than 200 mm.</u> 		<p><u>Periodicity of checks</u></p> <p><u>Weekly</u></p> <p><u>Weekly</u></p> <p><u>Weekly</u></p> <p><u>Weekly</u></p>
<p><u>2. Cylinder Valves</u></p>		
<p><u>a) Approval from DOE</u></p>		<p><u>Periodicity of checks</u></p>
<p><u>b) Check for Shield / protection and physical damage to valves</u></p>		<p><u>Weekly</u></p>
<p><u>c) Leak test using non-corrosive foaming agent or Methane leak detector</u></p>		<p><u>Daily</u></p>
<p><u>3. Refilling Valve</u></p> <ul style="list-style-type: none"> • <u>Check for dust cap / plug</u> • <u>Check that engine should not start when dust cap / plug is removed or open</u> • <u>Check leakage for non-return valve using non corrosive foaming agent or Methane leak detector</u> 		<p><u>Periodicity of checks</u></p> <p><u>Weekly</u></p> <p><u>Weekly</u></p> <p><u>Daily</u></p>

4. <u>Fuel Line</u>		<u>Periodicity of checks</u>
<ul style="list-style-type: none"> • <u>Check for corrosion on CNG fuel line</u> • <u>Ensure fuel line is securely mounted</u> • <u>Check for deformation of U & pigtail bends</u> • <u>Check hose for twists, kinks and damage or abrasions to the cover, which expose the wire/fiber and shall be condemned on detection of any one of these defects.</u> • <u>During servicing hose shall be replaced by new hose; after removal from vehicle</u> • <u>Check distance between fuel line and exhaust heat source is more than 75 mm.</u> • <u>Leak test using non-corrosive foaming agent or methane leak detector</u> 		<u>Weekly</u> <u>Weekly</u> <u>Weekly</u> <u>Weekly</u> <u>Weekly</u> <u>Weekly</u> <u>Daily</u>
5. <u>Shut Off Valve (Solenoid Valve(s)) wherever separately provided</u>		<u>Periodicity of checks</u>
<ul style="list-style-type: none"> • <u>Ensure shut off valve is securely mounted</u> • <u>Check operation for “Close & Open” as required and replace if found damaged</u> • <u>Leak test using non-corrosive foaming agent or methane leak detector</u> 		<u>Weekly</u> <u>Weekly</u> <u>Daily</u>
6. <u>Regulator</u>		<u>Periodicity of checks</u>
<ul style="list-style-type: none"> • <u>Ensure regulator is securely mounted</u> • <u>Check for shield or protection</u> • <u>Replace regulator diaphragms, hot water hoses, seals in accordance with _____ manufacturer's recommendation</u> • <u>Leak test using non-corrosive foaming agent or methane leak detector</u> 		<u>Weekly</u> <u>Weekly</u> <u>Weekly</u> <u>Daily</u>

7. <u>Gas-Air Mixer</u>		<u>Periodicity of checks</u>
<ul style="list-style-type: none"> • <u>Ensure gas-air mixer is securely mounted</u> • <u>Leak test using non-corrosive foaming agent or methane leak detector</u> 		<u>Weekly</u> <u>Daily</u>
8. <u>Electrical wiring</u>		<u>Periodicity of checks</u>
<ul style="list-style-type: none"> • <u>Ensure that current limiting device (fuse) is fitted as per manufacturer's specs and make</u> • <u>Check any loose or open or broken wiring harness in engine compartment, under chassis and driver's cabin and take corrective action.</u> • <u>Cable harness has to be as recommended/ approved by the OE _____ vehicle manufacturers/retrofiters)</u> • <u>Battery terminal has to have a positive locking</u> • <u>Check operation of battery cut-off switch as per manufacturer's recommendations</u> • <u>Check for proper tight fitness and clamping of terminal fitting. Replace high tension cables as per manufacturer's recommendation.</u> 		<u>Weekly</u> <u>Monthly</u> <u>Monthly</u> <u>Monthly</u> <u>Monthly</u> <u>Monthly</u>
9 <u>Service shut-off valve</u>		<u>Periodicity of checks</u>
<ul style="list-style-type: none"> • <u>Check operation, replace in case inoperative</u> • <u>Ensure service shut off valve is securely mounted</u> • <u>Leak test using non-corrosive foaming agent or methane leak detector</u> 		<u>Weekly</u> <u>Weekly</u> <u>Daily</u>

<u>10. CNG Filter</u> <ul style="list-style-type: none"> • <u>Ensure CNG filter is securely mounted</u> • <u>Leak test using non-corrosive foaming agent or methane leak detector</u> 		<u>Periodicity of checks</u> <u>Weekly</u> <u>Daily</u>
<u>11. CNG Pressure Gauge</u> <ul style="list-style-type: none"> • <u>Ensure CNG pressure indicator is securely mounted</u> • <u>Check for operation, replace if it is inoperative</u> • <u>Leak test using non-corrosive foaming agent or methane leak detector</u> 		<u>Periodicity of checks</u> <u>Weekly</u> <u>Weekly</u> <u>Daily</u>
<p><u>12. Following additional points need to be complied for carrying out preventive maintenance every month, unless and otherwise specified.</u></p> <ul style="list-style-type: none"> ➤ <u>Replace spark plugs and high tension cables as per manufacturer's recommendations.</u> ➤ <u>Check ignition timing by using timing light at engine idle speed (and other speeds as specified) and correct, if required.</u> ➤ <u>Check function of O₂ sensor output (milli-volt variation using multimeter) as per manufacturer's recommendations.</u> ➤ <u>Check for any exhaust gas leak before the catalytic converter and correct, if necessary.</u> ➤ <u>Replace catalytic converter as per manufacturer's recommendations.</u> ➤ <u>One number each type of dry powder type fire extinguisher (2 kg) shall be provided in driver and passenger compartment</u> ➤ <u>Buses should be properly maintained and checked every day before starting and bringing on road.</u> ➤ <u>Distance between the exhaust line , muffler and fuel line shall be a minimum of 75 mm. If not a radiant heat shield of 2mm thickness shall be welded in between.</u> ➤ <u>Safety plates / shield below the pipe joints shall be welded and proper inspection windows shall be provided near the cylinder joints.</u> ➤ <u>Check for First-Aid kit as per CMVR</u> ➤ <u>Minimum two copies of safety instructions shall be displayed in passenger compartment.</u> ➤ <u>Any other preventive safety recommendations provided or advised by chassis manufacturers/ retrofitters to be complied with.</u> <p><i>Note: The instructions issued by OE manufacturer/retrofitter for preventive maintenance, in their instruction manual ,shall contain all the necessary details on the methodology & the procedure for carrying out these checks.</i></p>		
<u>Signature & Seal with Date</u>		