

Keeping Up the Good Safety Record of CNG Cylinders

Hydrostatic waterjacket testing of a large CNG bus cylinder in Sydney, Australia.

On-board compressed natural gas (CNG) cylinders are a central component of a CNG vehicle's gas system in terms of their function, space, weight, cost and very importantly, safety. Fortunately, the safety record of CNG vehicles is very good relative to other fuel types, with the majority of incidents attributed to causes other than CNG component failure. Of the few that are, the majority could have been prevented by effective enforcement of safety protocols.



The author's multi-nation survey of in-service cylinder failures over the last three decades, from safety incident reports provided by the Clean Vehicle Education Foundation and other sources, has shown that in the vast majority of cases they occur during, or shortly after, refuelling, or in a CNG vehicle fire. Although the types of circumstances seem to be few, their causes are many and diverse. The lessons learned from the incidents have provided very important material for effective training.

The international natural gas vehicle industry has conducted CNG cylinder safety workshops in recent years. Although a large number of workshops cover a comprehensive list of installation, operational and inspection issues, some have been mainly directed at cylinder standards, cylinder description, and testing and inspection. As the occurrences and consequences of cylinder safety incidents are influenced by many factors, it is important for all trainers and all training programs to cover as much as possible the whole range of the issues involved.

Furthermore, in addition to preventing safety incidents, the safety program should include measures to eliminate or minimise the resulting injuries or fatalities, and economic losses.

Major factors affecting CNG cylinder safety

CNG cylinder safety depends on a wide range of factors encompassing the entire range of activities from cylinder production, inspection, handling, through to operation and maintenance. The list is long, some of major ones are summarised in the following:

- Handling procedures
- Vehicle installation design and procedure
- Operational and maintenance program and procedures
- Inspection program and procedure, and inspection personnel qualification
- Safety management systems for refueling facilities, vehicle workshops and parking facilities
- Emergency response program and procedures

A comprehensive training program should consider their inclusion.

Who should be given CNG cylinder safety training?

It would seem logical that training should be selected which is directly relevant to the trainee's work. With CNG safety, however, it has been found that safe work procedures which are essential to one person's work may, in many cases, have to be provided to other persons who may, at first glance, not appear to need them in their normal tasks. For example, the cylinder inspection procedure is important to the authorised cylinder inspector, but a similar knowledge or awareness of the cylinder's physical condition may be just as important to cylinder warehouse staff or vehicle conversion mechanics, whose prime responsibility is not inspection but who are otherwise working with the cylinders in their day-to-day operation. Even simple, quick observation or screening by these persons will detect gross damage (e.g. those detected with the naked eye, needing no specialised inspection tools) incurred by incidents or activities prior to reaching their work area, probably preventing an in-service incident before the next periodic inspection.

Hard as it is to believe, the unauthorised drilling or grinding of cylinder surfaces has been reported in some CNG vehicle workshops. In one case it was within a large, well resourced, otherwise well managed vehicle fleet. If such infringements were committed by formally trained and registered CNG vehicle mechanics in a registered natural gas vehicle workshop, the cylinder(s) would have been fitted on a vehicle without any chance of early defect detection.

In another example, cylinder inspectors were seen walking on roof mounted composite cylinders on top of a CNG bus during in-situ inspection. Was this activity clearly specified in the workshop procedure, for example, people should not walk on unpressurised Type 4 (full composite) cylinders, and that only soft sole shoes would be permitted after positively confirming that there were no hard objects lodged in the sole prior to stepping on the cylinders? And is this issue included in the training of staff – especially newly recruited persons – as well as in their refresher training?

Such unsafe work practices may be indicative of a gap of training for workshop staff and their supervisors, or gaps in the work procedures.

Public or workplace training programs should therefore attempt, within the limits of practicality, to provide all personnel with safety related knowledge that may be judged not to be relevant to their immediate work, but which may affect the safety of their workmanship. For example, if the periodic inspection procedure calls for the search for composite cylinder surface damage by the mounting system and other hard objects, then the cylinder's on-board installation procedure should include warnings against mountings that may deteriorate in service to the extent that they will damage the composite, and against allowing objects to be dropped or lost in the gaps between the cylinders and the mounting system.

In many cases the training may have to be extended beyond persons directly engaged in CNG work. For example, training in emergency response procedures should be given not only to CNG business personnel and customers or operators, but also external emergency services which have to attend to facility and vehicle emergencies. They should be armed with the necessary knowledge and procedure, compatible with the facility's procedure, in order to be effective in their task and not to put themselves and others at risk while doing so.

Monitoring, control and enforcement

A good safety program or system requires constant vigilance to ensure the ongoing safety of staff, vehicles and facilities. To this end, monitoring, control and enforcement of safety practice and measures should be instituted. They can be exercised at the industry/user level and at the regulatory level, in the following ways:

- Adequate, practical and technically sound regulatory prescription, control and enforcement are included in the regulatory framework
- Safety information, training and refresher training is given to all persons involved in the CNG vehicle and cylinder business, including regulatory and management staff
- Safety audits of vehicles, facilities and personnel are conducted to ensure continuing observance of safety requirements
- Industry data bases and dissemination (via publications, workshops, seminars and training courses) are maintained for technical and safety information, including safety incident reports, investigation results and lessons drawn

The above article was based on the author's work with several large CNG vehicle fleets and safety training programs. It contains some elements of the one-day CNG Cylinder Safety Workshop that he will jointly present at the [ANGVA 2011 Conference](#) in Beijing on 18-21 October 2011.

Clean Fuels Services International is an NGV industry consultancy providing safety audits of CNG vehicle fleets, vehicle workshops and refuelling stations, incident investigation and CNG safety training. Dr Ly can be contacted at hienly@cfsinternational.com.au.

Opinions expressed in this item are those of the author. Publication by NGV Global does not imply endorsement or agreement.