Code of Practice for

Hydrogen Fuelled Vehicles and Maintenance Workshops

Issue 0
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EMSD

Code of Practice

for

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Electrical and Mechanical Services Department

Preface

This Code of Practice covers the design, installation, testing and commissioning, operation, and maintenance of the hydrogen fuel system in a hydrogen fuelled vehicle (HFV), as well as design, installation, and operation of the maintenance workshop for hydrogen fuelled vehicle.

The basis of this Code of Practice includes:

- GB standards in relation to hydrogen fuelled vehicle;
- Regulation No. 134 (UN/ECE) Uniform provisions concerning the approval of motor vehicles and their components with regard to the safety-related performance of hydrogen-fuelled vehicles;
- Regulation (EC) No 79/2009 of the European Parliament and of the Council on type-approval of hydrogen-powered motor vehicles;
- ISO standards in relation to hydrogen fuelled vehicle; and
- NFPA 2 Hydrogen Technologies Code in relation to maintenance workshop.

In relation to hydrogen fuelled vehicles, where there exists a conflict between requirements prescribed in Section 4 of this Code of Practice, and owner's selected standards according to the relevant clauses in this Code of Practice, the more stringent one shall govern.

In relation to hydrogen fuelled vehicle maintenance workshops, where there exists a conflict between requirements prescribed in Section 6 of this Code of Practice, and owner's selected standards according to the relevant clauses in this Code of Practice, the more stringent one shall govern.

Notwithstanding the standards specified in this Code of Practice, equivalent standards, codes or guidance notes that are prevailing and well adopted will be accepted if deemed appropriate by EMSD.

EMSD reserves the final determination on the interpretation of this Code of Practice.

Content

1. Interpretation of Terms

EMSD – Electrical and Mechanical Services Department of the Government of the Hong Kong Special Administrative Region of the People's Republic of China.

Hydrogen cylinders – in relation to hydrogen fuelled vehicle, means container vessel storing hydrogen as propellant for the vehicle.

Hydrogen fuelled vehicle (HFV) – the vehicle using hydrogen as propellant.

Hydrogen fuel cell vehicle (HFCV) – the vehicle using hydrogen as propellant with fuel cell technology.

Hydrogen fuel system – in relation to hydrogen fuelled vehicle, means the system aiming to generate electricity, or mechanical power, from hydrogen in order to propel the vehicle. The system shall cover components, piping and fitting from receptacle to the energy conversion system, such as fuel cell, with the associated safety component.

Nominal working pressure (NWP) – in relation to hydrogen cylinders in hydrogen fuelled vehicle, means the settled pressure of compressed gas in fully fuelled container or storage system at a uniform temperature of 15 °C.

Pressure – The pressure terminology used in this Code of Practice is based on ISO 19880, and is described in Appendix A.

2. Objectives & Scopes

2.1. Objectives

2.1.1. This Code of Practice provides a general outline of the minimum safety requirement to be followed by the owner of hydrogen fuelled vehicle (HFV), and by the owner of hydrogen fuelled vehicle maintenance workshop, to ensure the health and safety at work of their employees and to conduct their operations in a safe manner so that members of the public are not exposed to undue risks from the hydrogen.

2.2. Scope

2.2.1. This Code of Practice covers the design, installation, testing and commissioning, operation, and maintenance of the hydrogen fuel system in a hydrogen fuel cell vehicle, particularly buses and heavy-duty vehicles.

2.2.2. Other machineries or vehicles, for example, forklifts and sightseeing cars, may be subjected to the relevant requirement of this Code of Practice.

2.2.3. This Code of Practice does not cover hydrogen fuelled vehicle using internal combustion engine technology.

2.2.4. This Code of Practice does not cover hydrogen application in marine vessels.

2.2.5. This Code of Practice covers the design and operation of the hydrogen fuelled vehicle maintenance workshop.

2.3. Regulations and References

2.3.1. The owners of hydrogen fuelled vehicle and the owners of hydrogen fuelled vehicle maintenance workshop shall make reference to the following ordinance where applicable:

- Road Traffic Ordinance (Cap. 374)
- Gas Safety Ordinance (Cap. 51)
- Dangerous Goods Ordinance (Cap. 295)
- Fire Services Ordinance (Cap. 95)

- Occupational Safety and Health Ordinance (Cap. 509)

2.3.2. This Code of Practice refers to the following publications (latest editions of these publications shall be used in each case):

IEC 60079	Explosive atmospheres
GB 50177	Design code for hydrogen station
GB/T 24549	Fuel cell electric vehicles – Safety requirements
GB/T 26779	Hydrogen fuel cell electric vehicle refueling receptacle
GB/T 26990	Fuel cell electric vehicles – Onboar– hydrogen system - Specifications
GB/T 29126	Fuel cell electric vehicles – Onboard Iogen system – Test methods
GB/T 33978	Proton exchange membrane fuel cell modules for road vehicles
GB/T 35544	Fully-wrapped carbon fiber reinforced cylinders with an aluminum liner for the on-board storage of compressed hydrogen as a fuel for land vehicles
GB/T 36288	Fuel cell electric vehicles – Safety requirements for fuel cell stack
ISO 12619	Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blend fuel system components
ISO 14687	Hydrogen fuel quality — Product specification
ISO 17268	Gaseous hydrogen land vehicle refuelling connection devices

ISO 19881	Gaseous hydrogen - Land vehicle fuel containers
ISO 19882	Thermally activated pressure relief devices for compressed hydrogen vehicle fuel containers
NFPA 2	Hydrogen Technologies
Regulation No. 134 (UN/ECE)	Uniform provisions concerning the approval of motor vehicles and their components with regard to the safety-related performance of hydrogen-fuelled vehicles
SAE J2578	Surface vehicle recommended practice
SAE J2601	Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles
SAE J3089	Characterization of On-Board Vehicular Hydrogen Sensors

3. Agreement Requirements

3.1. General

3.1.1. Upon request, the owner shall facilitate and allow representatives of the EMSD to visit the owner's premises and manufacturer's facilities, as well as access relevant documents, for conducting inspections and verifying compliance.

3.1.2. The application for agreement shall be made in consultation with EMSD.

3.2. Agreement for hydrogen fuel system in hydrogen fuelled vehicle

3.2.1. The owner of hydrogen fuelled vehicle shall obtain the agreement from EMSD prior to use the hydrogen fuel system in hydrogen fuelled vehicle, and upon any change or modification to the original design, installation, operation, and maintenance arrangement.

3.2.2. The owner shall submit the below information to EMSD for consideration:

- General specification of the vehicle, and the hydrogen fuel system, including but not limiting to:
  - Maximum amount of on-board hydrogen, in kg;
  - The volume of individual hydrogen cylinder, in L;
  - Number of hydrogen cylinders; and
  - Pressure rating of the hydrogen fuel system, in MPa or bar.
- P&ID of the overall hydrogen fuel system indicating all the components in Section 4.2.
- Isometric drawings indicating the 3D layout and location of the hydrogen fuel system in relation to the vehicle.
- Approval certificates, test report, or an equivalent document to the same effect, for demonstrating the compliance with Clause 4.1.2. The copy of the full set document submitted to the relevant jurisdiction for applying the approval shall be provided to EMSD.

- Submission for demonstrating the suitability of the components to be used in the hydrogen fuel system of hydrogen fuelled vehicle:
  - Certifications of hydrogen cylinders, automatic shut-off valves, check valves, TPRDs and excess flow valves. If the valves are combined into a cylinder valve, the certifications of the cylinder valve shall be provided instead. Drawing, datasheet and specification shall be submitted; and
  - Certifications, specifications, datasheets, test report, or an equivalent document to the same effect, of receptacles, fuel system, hydrogen leak detection sensor and the "other components" defined in Section 4.
- If the requirements in Section 4.3 are covered by the approval granted for the vehicle as specified in lause 4.1.2, submission is required for demonstrating the compliance with Section 4.3. If owner intends to demonstrate the compliance by calculations or engineering analysis methods, EMSD may request the owner to engage an independent third party to verify and issue a compliance certificate.
- Completed inspection checklist on individual vehicle which demonstrates that it meets the specified performance standards and is safe for use.
- O&M manual of the vehicle. The manual shall at least cover the following items:
  - Procedures for safe vehicle operation;
  - Possible safety hazards in relation to hydrogen, posed by vehicle or system operation and appropriate action(s) if a problem is detected. This shall also include any restrictions relating to the operation, parking or storage;
  - Filling procedures and safety precautions;
  - Precautions related to operator replacement of parts or fluids;
  - Information for roadside emergencies; and
  - Operator service procedures, checks, and maintenance schedules.

- Other relevant information as requested.

3.2.3. If the owner intends to utilize the agreed hydrogen fuel system on a different type of hydrogen fuelled vehicle, a new application shall be submitted for consideration.

3.3. Agreement for hydrogen fuelled vehicle maintenance workshop

3.3.1. A hydrogen fuelled vehicle maintenance workshop can either be converted from an existing conventional vehicle maintenance workshop, or newly built specifically for hydrogen fuelled vehicle maintenance purposes.

3.3.2. The owner of maintenance workshop shall obtain the agreement from the EMSD prior to carrying out maintenance activities for hydrogen fuelled vehicle in the workshop.

3.3.3. The owner is required to submit the following information to EMSD for consideration:

- Submission for demonstrating the compliance with Section 6, including but not limited to:
  - Layout of the workshop, indicating the dedicated maintenance area for hydrogen fuelled vehicle, location of hydrogen leak detection sensors, and hazardous area classification layout of the hydrogen fuelled vehicle maintenance workshop according to IEC 60079-10-1 if applicable;
  - Other relevant drawings, datasheets, and specification;
  - Certificates, test report, or an equivalent document to the same effect, for demonstrating the compliance with Section 6; and
  - Other relevant information as requested.
- If owner intends to demonstrate the compliance by calculations or engineering analysis methods, EMSD may request the owner to engage an independent third party to verify and issue a compliance certificate.

3.3.4. Any change or modification to the design, installation, operation, and maintenance arrangement shall also obtain agreement from EMSD.

3.4. Independent third party

3.4.1. Where the application requires the engagement of an independent third party, the following requirements shall be satisfied:

- The third party should possess the necessary expertise, qualifications, and experience in the relevant field.
- The third party should have a comprehensive understanding of the applicable regulations, industry standards, and best practices.

3.4.2. The qualification and job reference of the third party, which demonstrate its capability, shall be submitted to EMSD for agreement.

3.5. Competent person

3.5.1. A competent person refers to a person who is by virtue of his training, qualification and substantial practical experience

3.5.2. The training shall include, but not limited to, training in the properties of hydrogen, the use of safety devices and emergency handling.

3.5.3. The training records, qualification and experience of the competent person, shall be submitted to EMSD for agreement.

3.6. Hydrogen vehicle mechanics

3.6.1. A hydrogen vehicle mechanics (HVM) refers to a person who possess the necessary qualifications and practical experience for maintenance of hydrogen fuelled vehicle.

3.6.2. The training records, qualification and experience of the hydrogen vehicle mechanics, shall be submitted to EMSD for agreement.

4. Design and Installation of HFV Fuel System

4.1. General requirements

4.1.1. The overall hydrogen fuel system and all its components shall be suitable for the environment and conditions of use, taking all factors into account, including temperature, pressure, material compatibility, hazardous area classification, maintainability, and fire safety.

4.1.2. The hydrogen fuelled vehicle shall fulfil one of the following requirements:

- Listed on《道路机动车辆生产企业及产品公告》issued by the Ministry of Industry and Information Technology of the People's Republic of China. A vehicle converted from a hydrogen fuelled vehicle model listed on the《公告》may be accepted by EMSD, if the owner demonstrates that the modification is irrelevant to the hydrogen fuel system, and to the satisfaction of EMSD. EMSD may request the owner to engage an independent third party to verify and issue a compliance certificate regarding the conversion.

- Granted with approval under Regulation No 134 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of motor vehicles and their components with regard to the safety-related performance of hydrogen-fuelled vehicles (HFCV).

- Granted with approval under Regulation (EC) No 79/2009 of the European Parliament and of the Council on type-approval of hydrogen-powered motor vehicles.

- Alternative approval or mechanism deemed appropriate by EMSD which could demonstrate the safety.

4.1.3. The whole hydrogen fuel system shall be suitable for use with gaseous hydrogen. The following standards are listed as examples which are commonly adopted hydrogen quality standards or composition specifications in the hydrogen fuelled vehicle industry and accepted by EMSD:

- ISO 14687 Hydrogen fuel quality.

- GB/T 37244 Fuel specification for proton exchange membrane fuel cell vehicles—Hydrogen.

- SAE J2719 Hydrogen Fuel Quality for Fuel Cell Vehicles.

4.2. Requirements for the components in the hydrogen fuel system

4.2.1. Hydrogen cylinders

4.2.1.1. The hydrogen cylinders shall fulfil one of the following requirements:

- GB/T 35544 Fully-wrapped carbon fiber reinforced cylinders with an aluminium liner for the on-board storage of compressed hydrogen as a fuel for land vehicles and granted "特種設備(製造)監督檢驗證書(氣瓶)" under TSG 23 Regulation on Safety Technology for Gas Cylinder.

- Granted with approval under Regulation No 134 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of motor vehicles and their components with regard to the safety-related performance of hydrogen-fuelled vehicles (HFCV).

- Granted with approval under Regulation (EC) No 79/2009 of the European Parliament and of the Council on type-approval of hydrogen-powered motor vehicles.

- ISO 19881 Land vehicle fuel containers.

- Alternative approval or mechanism deemed appropriate by EMSD which could demonstrate the safety.

4.2.1.2. It is recommended that a third-party should be involved in the design and manufacturing for each batch of the hydrogen cylinders. This can be achieved by issuance of a certification, a verification statement or report declaring that the hydrogen cylinders are designed, manufactured and tested to the relevant standard.

4.2.1.3. The following closure devices shall be mounted directly on or within each hydrogen cylinders:

- Automatic shut-off valve;

- Thermally activated pressure relief devices (TPRD); and

- Check valve.

These three components may be integrated into a cylinder valve for individual hydrogen cylinders

4.2.2. Automatic shut-off valves

4.2.2.1. Automatic shut-off valves shall be mounted directly on or within each hydrogen cylinders to close to prevent flow from the container to the fuel cell.

4.2.2.2. The automatic shut-off valves shall fulfil one of the following requirements:

- GB/T 35544 Fully-wrapped carbon fiber reinforced cylinders with an aluminium liner for the on-board storage of compressed hydrogen as a fuel for land vehicles and granted "特種設備(製造)監督檢驗證書(氣瓶)" under TSG 23 Regulation on Safety Technology for Gas Cylinder.

- Granted with approval under Regulation No 134 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of motor vehicles and their components with regard to the safety-related performance of hydrogen-fuelled vehicles (HFCV).

- Granted with approval under Regulation (EC) No 79/2009 of the European Parliament and of the Council on type-approval of hydrogen-powered motor vehicles.

- ISO 12619-6 Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blends fuel system components — Part 6: Automatic valve.

- Alternative approval or mechanism deemed appropriate by EMSD which could demonstrate the safety.

4.2.2.3. The automatic shut-off valve shall be in "closed" position when it has no power supply.

4.2.3. Check valve

4.2.3.1. Check valves shall be mounted directly on or within each hydrogen cylinders to prevents reverse flow to the fuel line.

4.2.3.2. The check valves shall fulfil one of the following requirements:

- GB/T 35544 Fully-wrapped carbon fiber reinforced cylinders with an aluminium liner for the on-board storage of compressed hydrogen as a fuel for land vehicles and granted "特種設備(製造)監督檢驗證書(氣瓶)" under TSG 23 Regulation on Safety Technology for Gas Cylinder.
- Granted with approval under Regulation No 134 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform provisions concerning the approval of motor vehicles and their components with regard to the safety-related performance of hydrogen-fuelled vehicles (HFCV).
- Granted with approval under Regulation (EC) No 79/2009 of the European Parliament and of the Council on type-approval of hydrogen-powered motor vehicles.
- ISO 12619-4 Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blends fuel system components — Part 4: Check valve.
- Alternative approval or mechanism deemed appropriate by EMSD which could demonstrate the safety.

4.2.4. Thermally activated pressure relief devices (TPRD)

4.2.4.1. TPRD shall be mounted directly on or within each hydrogen cylinders which is a non-reclosing device that activated by temperature to open and release hydrogen gas.

4.2.4.2. It is recommended to install two (2) TPRD valves at the downstream of each hydrogen cylinder.

4.2.4.3. The TPRD shall fulfil one of the following requirements:

- GB/T 35544 Fully-wrapped carbon fiber reinforced cylinders with an aluminium liner for the on-board storage of compressed hydrogen as a fuel for land vehicles and granted "特種設備(製造)監督檢驗證書(氣瓶)" under TSG 23 Regulation on Safety Technology for Gas Cylinder.
- Granted with approval under Regulation No 134 of the Economic Commission for Europe of the United Nations (UN/ECE) — Uniform

provisions concerning the approval of motor vehicles and their components with regard to the safety-related performance of hydrogen-fuelled vehicles (HFCV).

- Granted with approval under Regulation (EC) No 79/2009 of the European Parliament and of the Council on type-approval of hydrogen-powered motor vehicles.

- ISO 19882 Gaseous hydrogen — Thermally activated pressure relief devices for compressed hydrogen vehicle fuel containers.

- Alternative approval or mechanism deemed appropriate by EMSD which could demonstrate the safety.

4.2.5. Excess flow valve

4.2.5.1. It is recommended to install one (1) excess flow valve at the immediate downstream of each hydrogen cylinder, preferably combined with cylinder valve.

4.2.5.2. The excess flow valve shall comply with an applicable code, standard or specification which could demonstrate its suitability to be used in the hydrogen fuel system of hydrogen fuelled vehicle. The following standards are listed as examples which are accepted by the EMSD:

- GB/T 35544 Fully-wrapped carbon fiber reinforced cylinders with an aluminium liner for the on-board storage of compressed hydrogen as a fuel for land vehicles and granted “特種設備(製造)監督檢驗證書(氣瓶)” under TSG 23 Regulation on Safety Technology for Gas Cylinder.

- Regulation (EC) No 79/2009 of the European Parliament and of the Council on type-approval of hydrogen-powered motor vehicles.

- ISO 12619-11 Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blends fuel system components — Part 11: Excess flow valve.

4.2.6. Receptacle

4.2.6.1. Receptacle shall be installed at the hydrogen fuelled vehicle which the nozzle of the dispenser at the hydrogen filling station could attaches to and through which hydrogen fuel is transferred to the vehicle.

4.2.6.2. The receptacle shall comply with an applicable code, standard or specification which could demonstrate its suitability to be used in the hydrogen fuel system of hydrogen fuelled vehicle. The following standards are listed as examples which are accepted by the EMSD:

- Regulation (EC) No 79/2009 of the European Parliament and of the Council on type-approval of hydrogen-powered motor vehicles.
- GB/T 26779 Hydrogen fuel cell electric vehicle refueling receptacle.
- SAE J2600 Compressed Hydrogen Surface Vehicle Fueling Connection Devices.
- ISO 17268 Gaseous hydrogen land vehicle refuelling connection devices.

4.2.7. Fuel cell system

4.2.7.1. The fuel cell system shall comply with an applicable code, standard or specification which could demonstrate its suitability to be used in the hydrogen fuel system of hydrogen fuelled vehicle. The following standards are listed as examples which are accepted by the EMSD:

- SAE J2615 Testing Performance of Fuel Cell Systems for Automotive Applications.
- GB/T 24554 Performance test methods for fuel cell system and GB/T 33978 Proton exchange membrane fuel cell modules for road vehicles.

4.2.8. Hydrogen leak detection sensor

4.2.8.1. The hydrogen leak detection sensor shall comply with an applicable code, standard or specification which could demonstrate its suitability to be used in the hydrogen fuel system of hydrogen fuelled vehicle. The following standards are listed as examples which are accepted by the EMSD:

- Regulation (EC) No 79/2009 of the European Parliament and of the Council on type-approval of hydrogen-powered motor vehicles.
- ISO 26142 Hydrogen detection apparatus.
- IEC 60079-29-1 Explosive atmospheres - Part 29-1: Gas detectors - Performance requirements of detectors for flammable gases.

4.2.9. Other components

4.2.9.1. "Other components" refers to the following components in the hydrogen fuel system:

- Fittings;
- Flexible fuel line;
- Heat exchanger;
- Hydrogen filter;
- Manual or automatic valve;
- Non-return valve;
- Pressure regulator;
- Pressure relief device (PRD);
- Pressure relief valve (PRV);
- Pressure, temperature, and flow sensors; and
- Rigid fuel line.

4.2.9.2. The "other components" shall comply with an applicable code, standard or specification to demonstrate its suitability to be used in the hydrogen fuel system of hydrogen fuelled vehicle. The following standards are listed as examples which are accepted by the EMSD:

- Regulation (EC) No 79/2009 of the European Parliament and of the Council on type-approval of hydrogen-powered motor vehicles.
- ISO 12619-6 Road vehicles — Compressed gaseous hydrogen (CGH2) and hydrogen/natural gas blends fuel system components.

4.3. Requirements for the overall hydrogen fuel system

4.3.1. Installations

4.3.1.1. All components, including hydrogen cylinders, fuel lines and wiring, shall be securely mounted.

4.3.1.2. The receptacle shall NOT be installed on the external energy absorbing elements of the vehicle, such as bumper. It shall be installed in such a way that access for filling shall not be required in the passenger compartment, luggage compartment, or in any other unventilated compartment.

4.3.1.3. For buses and heavy-duty vehicle, the hydrogen cylinders shall be installed at a high level of the vehicle for mitigating the risk of being crashed by another vehicle from the rear side.

4.3.2. Structural integrity

4.3.2.1. The system shall fulfil relevant requirement regarding structural integrity in the approval granted for the vehicle as specified in Clause 4.1.2 of this Code of Practice, or an alternative standard deemed appropriate by EMSD. Where there is no applicable provision in the approval granted for the hydrogen fuelled vehicle and the alternative standard, the following requirements shall prevail:

- The cylinders shall be able to withstand an acceleration of 8g in all six directions (frontal, rearward, laterally left and right, and vertically up and down). After the crash, the cylinders shall remain attached to the vehicle at minimum one attachment point, and have a relative displacement of not more than 13mm.

A calculation method may be used instead of practical testing if its equivalence can be demonstrated to the satisfaction of EMSD.

4.3.3. Hydrogen leak detection system

4.3.3.1. The system shall be able to detect a hydrogen concentration and triggered a response in accordance with the relevant requirement in the approval granted for hydrogen fuelled vehicle, as specified in Clause 4.1.2 of this Code of Practice, or an alternative standard deemed appropriate by EMSD. Where there is no applicable provision in the approval granted for the hydrogen fuelled vehicle and the alternative standard, the following requirements shall prevail:

- The hydrogen leak detection system shall comprise of at least one hydrogen leak detection sensor installed at high position in fuel system compartment for containing hydrogen cylinders, and at least one hydrogen leak detection sensor for fuel cell;

- The system shall be capable for real-time detection;
- When the system detects a hydrogen concentration exceeds 2.0% by volume, then a visual or display text warning signal, and an audible alarm shall be initiated to the driver;
- When the system detects a hydrogen concentration exceeds 3.0% by volume, then automatic shut-off valve mounted on the hydrogen cylinders shall be closed; and
- When the system malfunctions, such as circuit disconnection, short-circuit and sensor fault, then a visual or display text warning signal, and an audible alarm shall be initiated to the driver.

4.3.3.2. It is recommended that the automatic shut-off valves mounted on the hydrogen cylinders should be fully closed immediately from the moment that triggered under circumstances stipulated in the previous clause. The detection time of the hydrogen leak detection sensor should be less than 2 seconds.

4.3.4. Vent system

4.3.4.1. The system shall fulfil relevant requirement regarding vent system in the approval granted for hydrogen fuelled vehicle, as specified in Clause 4.1.2 of this Code of Practice, or an alternative standard deemed appropriate by EMSD. Where there is no applicable provision in the approval granted for the hydrogen fuelled vehicle and the alternative standard, the following requirements shall prevail:

- The outlet of the vent line for hydrogen relief from TPRD(s), PRV and PRD shall NOT be:
  - Towards exposed electrical terminals, exposed electrical switches or other ignition sources;
  - Into or towards the passenger or luggage compartments;
  - Into or towards any vehicle wheel housing; and
  - Towards hydrogen gas cylinders.
- The outlet of the vent line shall be at the highest level of the vehicle

and protruding vertically out of the vehicle ceiling.

4.3.5. Vehicle exhaust

4.3.5.1. The system shall fulfil relevant requirement regarding vehicle exhaust in the approval granted for hydrogen fuelled vehicle, as specified in Clause 4.1.2 of this Code of Practice, or an alternative standard deemed appropriate by EMSD. Where there is no applicable provision in the approval granted for the hydrogen fuelled vehicle and the alternative standard, the following requirements shall prevail:

- At the vehicle exhaust system's point of discharge, the hydrogen concentration level shall NOT:
  - Exceed 4% average by volume during any moving three-second time interval during normal operation including start-up and shut-down; and
  - Exceed 8% at any time.

4.3.6. Over-pressure protection

4.3.6.1. The system shall fulfil relevant requirement regarding over-pressure protection for the downstream of the pressure regulator in the approval granted for hydrogen fuelled vehicle, as specified in Clause 4.1.2 of this Code of Practice, or an alternative standard deemed appropriate by EMSD. Where there is no applicable provision in the approval granted for the hydrogen fuelled vehicle and the alternative standard, the following requirements shall prevail:

- A pressure relief device or a pressure relief valve shall be installed at the downstream of the pressure regulator.

4.3.7. Fuel system leakage

4.3.7.1. The system shall fulfil relevant requirement regarding fuel system leakage in the approval granted for hydrogen fuelled vehicle, as specified in Clause 4.1.2 of this Code of Practice, or an alternative standard deemed appropriate by EMSD. Where there is no applicable provision in the approval granted for the hydrogen fuelled vehicle and the alternative standard, the following requirements shall prevail:

- The hydrogen fuel line downstream of the shut-off valve(s) of the hydrogen cylinder to the fuel cell system shall not leak; and

- A leak test shall be conducted at least NWP using a hydrogen leak detection sensor, or a leak detecting liquid, such as soap solution. Hydrogen leak detection is performed primarily at joints.

5. Operations and Maintenance of HFV Fuel System

5.1. General

5.1.1. The owner of HFV has the responsibility to ensure that the operation and maintenance of the hydrogen fuelled vehicle, including parking of the vehicle, are conducted in a safe manner so that members of the public are not exposed to undue risks from hydrogen.

5.2. Operations

5.2.1. Hydrogen fuelled vehicle shall only be operated by suitably trained drivers. The training shall at least cover all of the following:

- Basic technical characteristics of the vehicle;
- Potential hazards in relation to hydrogen fuel system which is different from conventional diesel or petrol vehicle; and
- Emergency procedures.

5.2.2. Driver training shall be refreshed yearly.

5.2.3. A hydrogen fuel cell vehicle shall not operate inside a tunnel unless the hydrogen cylinders fulfil all of the following requirements:

- The volume of individual cylinder is not more than 200L; and
- The working pressure of the cylinder is not higher than 70MPa.

5.3. Maintenance

5.3.1. Maintenance activities of hydrogen fuelled vehicle shall only be carried out at:

- maintenance workshops specified in Section 6; or
- manufacturer’s place outside Hong Kong.

5.3.2. Only hydrogen vehicle mechanics (HVM) are allowed to carry out installation and maintenance work on hydrogen fuel system of hydrogen fuelled vehicles.

5.3.3. The owner of the hydrogen fuelled vehicle shall follow the maintenance instruction from the manufacturer, including the periodic validation of the hydrogen cylinders.

5.3.4. The periodic validation of hydrogen cylinders in Hong Kong shall be conducted by a competent person.

5.3.5. It is recommended that a leak test should be conducted for each cylinders annually.

6. Maintenance Workshops

6.1. General

6.1.1. This section is provided for the owner of hydrogen fuelled vehicle maintenance workshop to follow.

6.1.2. The maintenance activities conducted in the hydrogen fuelled vehicle maintenance workshop shall follow recommendation, including all safety precaution, from the manufacturer of the hydrogen fuelled vehicle.

6.1.3. The workshops shall be designed and constructed in consultation with EMSD.

6.1.4. Attention is drawn to NFPA 2 Hydrogen Technologies Code, Chapter 18, for further guidance, which forms the basis of the requirement in this Code of Practice for hydrogen fuelled vehicle maintenance workshops.

6.2. Release of hydrogen

6.2.1. The hydrogen shall be released from the fuel system prior to:

- Modification or repair on the hydrogen fuel system; or
- Any welding or open flame repair on other part of the hydrogen fuelled vehicle.

6.2.2. The release of hydrogen from hydrogen fuelled vehicle shall be performed in open space.

6.2.3. The release of hydrogen from hydrogen fuelled vehicle shall be performed through a closed transfer system or with atmospheric venting following the procedure provided by the hydrogen fuelled vehicle manufacturer.

6.2.4. The atmospheric venting shall be conducted using nitrogen or other non-flammable gas.

6.2.5. The closed transfer system shall be approved by the hydrogen fuelled vehicle manufacturer.

6.3. Designated maintenance area

6.3.1. There shall be a designated maintenance area for hydrogen fuelled vehicle. Maintenance activities shall not be carried out outside the designated area.

6.3.2. The designated maintenance area shall be in:

- Open space with good natural ventilation; or
- Semi-open space with mechanical exhaust ventilation system.

6.3.3. Any vehicle that is known to be leaking hydrogen must not be brought indoors.

6.3.4. There shall be adequate working area provided for maintenance activities. It is recommended that the size of the maintenance area should be no less than the maximum size of the hydrogen fuelled vehicle plus 1.5m on each side and shall be clearly marked on the round.

6.4. Wall and ceilings

6.5. Walls, doors, and ceilings that intersect or enclose designated maintenance area shall be constructed of non-combustible or limited combustible materials or assemblies and shall be securely and rigidly mounted or fastened.

6.6. The interior surfaces of the maintenance area shall be smooth, and designed and installed to facilitate ventilation.

6.7. Access control

6.7.1. There shall be access control and security measures to prevent unauthorised entrance to the maintenance workshop. Clear signage shall be provided to indicate the entrance of the maintenance workshop.

6.7.2. A fixed electrostatic discharge device shall be installed at the entrance of the maintenance workshop for incoming personnel to eliminate their own static electricity.

6.8. Hazardous areas classification

6.8.1. The owner shall develop the hazardous areas classification based on IEC 60079-10-1. This classification shall be clearly signposted throughout the

maintenance workshop.

6.8.2. It is recommended that the area within 455 mm of the ceiling should be designated a Class I, Division 2, Group B or equivalent.

6.8.3. All electrical equipment in hazardous areas shall be protected in accordance with the IEC 60079 series, i.e., IEC 60079-0 and the appropriate other part of the IEC 60079 series for the type of protection used. For example, an intrinsically safe electrical system should comply with IEC 60079-0, IEC 60079-11, and IEC 60079-25.

6.8.4. No electronic equipment uncompliant with the hazardous zone ratings shall be brought into hazardous areas, for example, cell phone without the correct type of protection for explosive gas atmospheres.

6.9. Ventilation

6.9.1. The workshop shall be provided with one of the following ventilation arrangements:

- Fixed natural ventilation when it is demonstrated that there is no undue risk from hydrogen by engineering calculation and analysis by a third-party in accordance with an applicable national / international standard.
- Mechanical ventilation system operated continuously with a ventilation rate based on analysis of IEC 60079-10-1, Explosives Atmospheres- Part 10-1: Classification of Areas- Explosive Gas Atmospheres, using the quantity of hydrogen stored, conducted by a third-party.
- Mechanical ventilation system operated continuously with a ventilation rate of 6 air changes per hour (ACH) or above. The ventilation rate shall be automatically changed to 12 air changes per hour (ACH) or above when 1.0% v/v concentration of hydrogen is being detected by the hydrogen detection system.

6.9.2. The mechanical ventilation system shall be rated with the correct type of protection for explosive gas atmospheres in accordance with the hazardous area classification.

6.9.3. For mechanical ventilation system, a local visual and audible alarm shall activate and maintenance activities shall cease upon the loss of continuous

ventilation.

6.9.4. The mechanical ventilation system shall be designed and installed in accordance with the requirements of the adopted mechanical code.

6.9.5. The location of the exhaust and inlet air opening shall be designed to provide air movement across the maintenance workshop to prevent the accumulation of hydrogen.

6.9.6. The inlet of the ventilation shall be within 305mm of the ceiling. Supplemental inlets are allowed to be installed at the points below the 305mm threshold level.

6.9.7. The mechanical ventilation system shall not be interconnected with other HVAC system servicing serving other occupancies in the workshop building.

6.10. Hydrogen leak detection system

6.10.1. The maintenance workshop shall be provided with a hydrogen leak detection system such that hydrogen can be detected where the hydrogen fuelled vehicle is under maintenance.

6.10.2. The hydrogen leak detection system shall be designed and installed to provide coverage for the designated maintenance area, complying with one of the following requirements:

- A customised hydrogen leak detection system, including the locations and numbers of hydrogen leak detection sensors, specified by a third-party in accordance with an applicable national / international standard. It shall be demonstrated that the hydrogen detection system could provide adequate and effective detection for any hydrogen leak or accumulation.

- A hydrogen leak detection system with:

  - At least four (4) hydrogen leak detection sensors at a high level and evenly spread surrounding the designated maintenance area;

  - At least two (2) hydrogen leak detection sensors at the highest points in the maintenance workshops;

- At least one (1) hydrogen leak detection sensor at each inlet to mechanical ventilation systems; and
- Hydrogen leak detection sensors at other locations where hydrogen is prone to accumulation.

6.10.3. The hydrogen leak detection system shall be designed, installed, tested, inspected, calibrated, and maintained in accordance with manufacturer's instruction.

6.10.4. Maintenance, inspection, calibration, and testing of the hydrogen leak detection shall be conducted in accordance with manufacturer's instruction and by trained personnel. Testing shall be conducted at least annually.

6.10.5. The hydrogen leak detection shall be designed to initiate the response when one of following event happens:

- At or above 1.0% v/v concentration of hydrogen is being detected.
- Failure of the hydrogen detection system.

The hydrogen leak detection shall initiate all of the following responses:

- Initiation of distinct audible and visual alarm signals in the maintenance workshop.
- Deactivation of all heating systems inside the maintenance workshop, if any.
- Activation or increase of ventilation rate of the mechanical ventilation system, where the system is interlocked with the hydrogen leak detection system.

6.11. Safety management

6.11.1. The owner should strictly enforce no smoking in the maintenance workshop area.

6.11.2. No electronic equipment uncompliant with the hazardous zone ratings shall be brought into hazardous areas, for example, cell phone without the correct type of protection for explosive gas atmospheres.

6.11.3. Portable hydrogen leak detection sensors shall be accessible at the entrance

of the maintenance workshop with the following requirements:

- Each mechanic shall wear at least one (1) portable hydrogen leak detection sensors after entering the maintenance workshop.
- The portable hydrogen leak detection sensors shall issue an audio-visual alarm upon the detection of concentration of hydrogen at or above 1.0% concentration by volume.
- All hydrogen leak detection sensors shall be inspected annually.

6.11.4. Flame-retardant and anti-static clothes, complying with a national / international standard, shall be accessible in the maintenance workshop.

6.12. Emergency Response Plan

6.12.1. The owner shall establish an emergency response plan (ERP) to handle all reasonably foreseeable accidents for the maintenance workshop.

6.12.2. The owner shall develop the incident reporting mechanism with response contact parties, actions and response required.

6.12.3. Emergency instructions shall be displayed at clearly visible locations with the phone number of the local emergency services.

6.12.4. The emergency instructions shall at least cover hydrogen leak events. The responses to a hydrogen leak may include:

- Opening the bay doors.
- Increasing the ventilation fan rate.
- Alerting or evacuating personnel within and nearby the workshop.
- Ceasing nearby operations.
- Moving the vehicle outdoors safely.

6.12.5. Training and drills should be conducted regularly.

7. Incident Reporting and Investigation

7.1. General

7.1.1. This section is applicable to both hydrogen fuelled vehicles and the maintenance workshops.

7.2. Incident Reporting

7.2.1. Any of the following hydrogen incidents shall be notified to EMSD within one (1) hour through a telephone call or instant messaging after the incident occurs:

- Traffic incidents involving hydrogen fuelled vehicle;
- Any leak or loss of containment of hydrogen above the design alarm level of the hydrogen fuelled vehicle or maintenance workshop;
- Any damage to the hydrogen fuel system of the hydrogen fuelled vehicle;
- Injury of any personnel involving hydrogen fuelled vehicle or at the maintenance workshop;
- Smoke, fire or explosion of any magnitude; or
- Other incidents that have attracted media attention.

7.2.2. For all hydrogen incidents, including but not limited to those listed in the aforementioned clauses, a preliminary written incident report with the following information shall be submitted to EMSD within two (2) working days after the incident occurs:

- The date and time of the incident;
- The location of the incident;
- Summary of the incident;
- The suspected/preliminary cause of the incident;
- The identification number of the hydrogen leak detection sensor which were activated during the incidents;

- The extent of the damage of the equipment or parts;
- The licence number of the vehicles involved and contact details of the driver;
- The time when maintenance/emergency personnel arrived at the location of the incident;
- The action taken by such personnel to deal with the incident; and
- The rectification time for the incident and service restoration time.

7.2.3. Following the preliminary incident report, a detailed incident report with the following information in addition to the items in previous clause shall be submitted to EMSD not later than seven (7) working days after the incident occurs:

- The extent of the damage of the concerned equipment or parts;
- The date and time of despatch of personnel to deal with the incident;
- The time when such personnel arrived at the place of the incident;
- The actions taken by such personnel to deal with the incident;
- The causes of the incident; and
- The proposed measures to prevent recurrence of similar incident.

7.3. Incident Handling and Investigation

7.3.1. All hydrogen incidents shall be rectified by suitably trained and competent persons as soon as practicable.

7.3.2. The causes of the incidents shall be investigated thoroughly and preventive measures shall be implemented to avoid recurrence of similar incidents.

Appendix A – Pressure terminology

Hydrogen fuel cell vehicles	**Hydrogen service level**	**Hydrogen filling stations**
Maximum Developed Pressure (MDP)	1.5 x HSL	Maximum Developed Pressure (MDP)
	1.375 x HSL	Dispensing system MAWP
		(PSV set point should be between MAWP and MOP)
Maximum Filling Pressure (MFP)	1.25 x HSL	Maximum Operating Pressure (MOP)
Nominal Working Pressure (NWP)	HSL	
(100 % fill settled to 15 degC)		

Hydrogen service level (HSL)	**Pressure class**	**Maximum operating pressure (MOP)**	**Dispensing system maximum allowable working pressure (MAWP)** **Minimum component pressure rating for dispensing system components**
Equal to NWP of vehicle being filled	**-**	**1.25 × HSL** **Highest pressure during normal filling**	**1.375 × HSL** **Highest permissible setpoint for dispenser system pressure protection**
35 MPa	H35	43.75 MPa	48.125 MPa
70 MPa	H70	87.5 MPa	96.25 MPa

Appendix B – Boundary of the hydrogen fuel system