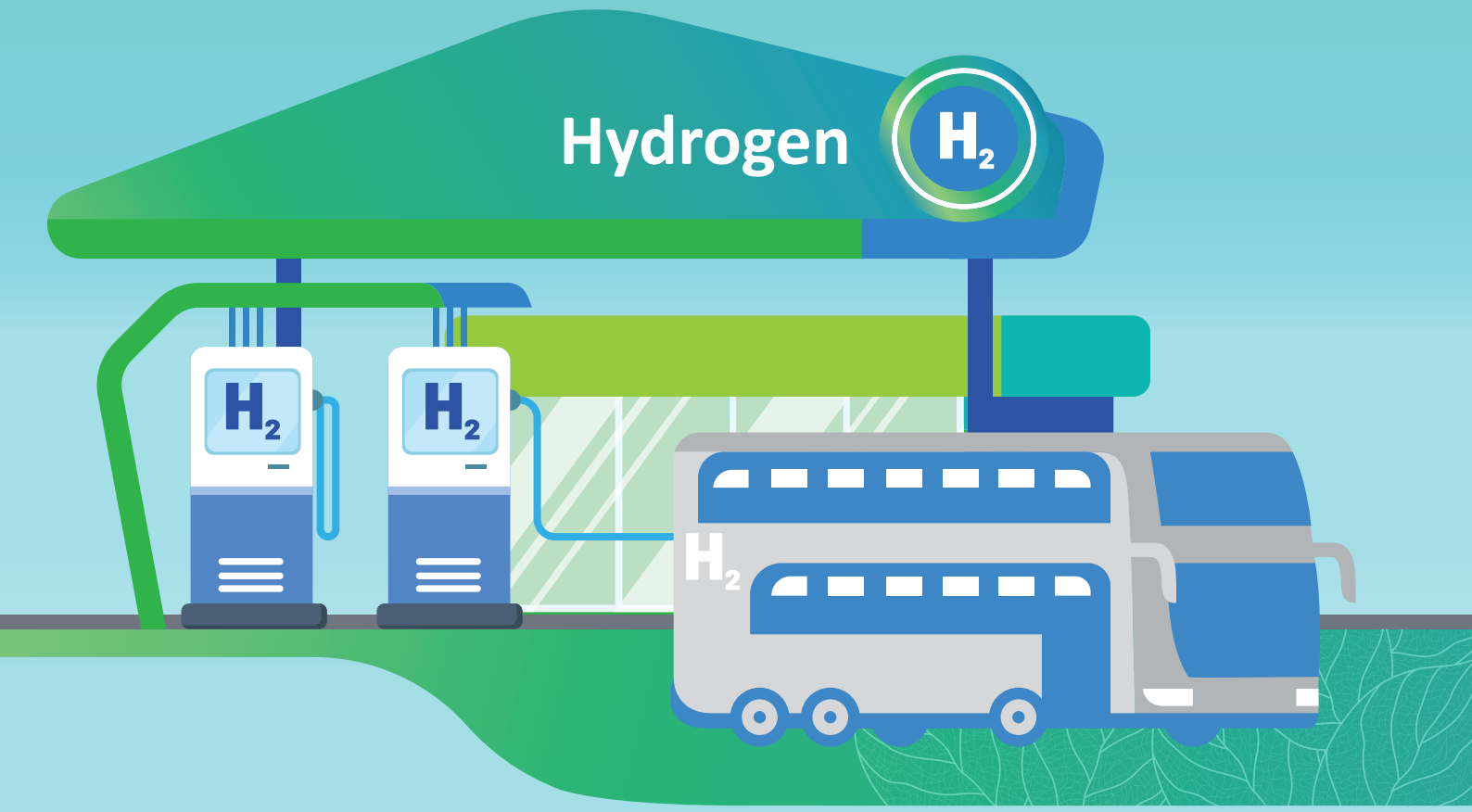
Code of Practice for

Hydrogen Filling Stations



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Code of Practice

for

Hydrogen Filling Stations

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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 equipment inside the hydrogen filling stations.

The basis of this Code of Practice includes:

- ISO standards in relations to hydrogen filling station, e.g., 19880 Gaseous hydrogen — Fuelling stations;
- GB standards in relations to hydrogen filling station, e.g., GB 50156 Technical standard of fuelling station and GB 50516 Technical code for hydrogen fuelling station;
- BCGA Code of Practice 41 The design, construction, maintenance and operation of filling stations dispensing gaseous fuels; and
- NFPA 2 Hydrogen Technologies Code.

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.

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

Buffer cylinders – pressure vessels designed for the purpose of temporarily storing compressed hydrogen, typically located before or after compressors systems to help the dampening or adjustment of the flow pressures.

Compressed hydrogen storage system – in relation to hydrogen fuelled vehicle, refers to hydrogen storage on-board vehicle as defined in the Global Technical Regulation No. 13

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 storage – refers to the storage of hydrogen gas, comprising of fixed pressure tanks/containers/vessels manifolded together to supply gas to the filling station, or tubes mounted on a transportable trailer.

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.

Skid mounted filling stations – a modular design filling stations for hydrogen fuelled vehicle to refuel. It integrates all key components, from storage, to compression and dispensing, and mounted onto one transportable skid.

Stationary filling stations – a filling station where key components are installed on-location.

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 Filling Stations (HFS), 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 hydrogen.

2.2. Scope

2.2.1. This Code of Practice covers the design, installation, testing and commissioning, operation and maintenance of the hydrogen equipment inside the HFS as illustrated in **Appendix B**.

2.2.2. The Code of Practice covers both stationery filling stations and skid mounted filling stations. Unless specified otherwise, the requirements in this Code of Practice apply to both types.

2.2.3. This Code of Practice does not cover liquid hydrogen, and hydrogen in the form of hydrogen carriers such as metal hydrides or liquid organic hydrogen carriers (LOHC).

2.3. Regulations and References

2.3.1. The owners of HFS shall make particular reference to the following ordinance where applicable:

- Gas Safety Ordinance (Cap. 51)
- Fire Services Ordinance (Cap. 95)
- Buildings Ordinance (Cap. 123)
- Dangerous Goods Ordinance (Cap. 295)
- Occupational Safety and Health Ordinance (Cap. 509)

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

IEC 60079	Explosive atmospheres
ASME B31.12	Hydrogen Piping and Pipelines
BCGA CoP 33	The Bulk Storage of Gaseous Hydrogen at Users' Premises
BCGA CoP 4	Gas Supply and Distribution Systems (Excluding Acetylene)
BCGA CoP 41	The Design, Construction, Maintenance and Operation of Filling Stations Dispensing Gaseous Fuels
EIGA 211/17	Hydrogen vent systems for customer applications
GB 50156	Technical standard of fuelling station
GB 50516	Technical Code for Hydrogen Fuelling Station
GB 50177	Design code for hydrogen station
GB/T 19773	Specification of hydrogen purification system on pressure swing adsorption
GB/T 19774	Specification of water electrolyte system for producing hydrogen
GB/T 31139	Safety technical regulations for mobile hydrogen refueling facility
GB/T 34425	Fuel cell electric vehicles—Hydrogen refuelling nozzle
GB/T 34583	Safety technical requirements for hydrogen storage devices used in

	hydrogen fuelling station
GB/T 34584	Safety technical regulations for hydrogen refueling station
GB/T 42855	Technical requirements of fuelling protocols for hydrogen fuel cell vehicles
GB/Z 34541	Safety operation management regulation for hydrogen fueling facilities of hydrogen vehicles
ISO 14687	Hydrogen fuel quality — Product specification
ISO 15649	Petroleum and natural gas industries — Piping
ISO 16110-1	Hydrogen generators using fuel processing technologies — Part 1: Safety
ISO 19880	Gaseous hydrogen — Fuelling stations
ISO 22734	Hydrogen generators using water electrolysis — Industrial, commercial, and residential applications
ISO 26142	Hydrogen detection apparatus — Stationary applications
ISO/TS 19883	Safety of pressure swing adsorption systems for hydrogen separation and purification
NFPA 2	Hydrogen Technologies Code
SAE J2600	Compressed Hydrogen Surface Vehicle Fueling Connection Devices
SAE J2601	Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles

SAE J2601-2	Fueling Protocol for Gaseous Hydrogen Powered Heavy Duty Vehicles
SAE J2601-3	Fueling Protocol for Gaseous Hydrogen Powered Industrial Trucks
SAE J2719	Hydrogen Fuel Quality for Fuel Cell Vehicles
SAE J2799	Hydrogen Surface Vehicle to Station Communications Hardware and Software

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 Construction and Agreement for Use

3.2.1. The owner of HFS shall obtain the agreement from the EMSD before construction of HFS, and before use of HFS, and upon any change or modification to the original design, installation, operation, and maintenance arrangement.

3.2.2. Prior to the construction of a HFS, the owner shall submit the following information to EMSD for consideration:

- Quantitative Risk Assessment report for the hydrogen filling station (Refer to Section 3.3).
- A compliance check report to confirm that the requirement in Section 5 have been met. The report should be completed by an independent third party.
- Technical information, such as drawings, design, calculation, specification, which are relevant to the requirement in Section 5, including but not limited to:
  - Overall site layout plan with detailed dimensions;
  - Elevation and sectional views of the hydrogen filling station with all key dimensions clearly specified;
  - Detail P&ID of the hydrogen filling station;
  - Determination and zoning of hazardous areas;
  - Piping layout, including type of protection;

- A list of all hydrogen system and equipment in the filling station. For electrical apparatus, the type of protection appropriate for the respective hazardous zones should be indicated;
- Schematic diagram of safety control systems;
- Layout plan showing positions of hydrogen detectors and emergency devices/switches;
- Installation details of the hydrogen storage;
- Plans showing fire service installations;
- Plans showing the ventilation arrangements for the hydrogen filling station;
- Electrostatic discharge prevention measures;
- Alarm settings from fire and gas detection system arrangements;
- Explosive Atmosphere (Ex) certificates for the relevant electrical apparatus;
- Site security arrangement;
- Specifications of the hydrogen containers, compressors, dispensers, hydrogen detectors and breakaway couplings;
- Flow rate calculations for compressor performance, pipeline capacity, and pressure relief device vent pipe capacity;
- Design and calculation of the lightning protection system; and
- Other relevant information as requested.

3.2.3. Upon completion of all construction work and before the HFS is put into operation, the owner shall submit the following information to EMSD for consideration:

- A compliance check report to confirm that the requirements in Section 6 have been met. The report should be completed by an independent third party.
- Testing and commissioning procedures and programme of the

hydrogen filling station installation.

- Test report and certificate relevant to Section 6, including but not limited to:
  - Pipework pressure test certificates;
  - Pressure relief device pressure test certificates (when applicable);
  - Earthing impedance report;
  - Electrical continuity test certificate for hydrogen pipework;
  - Electrical testing certificate for bonding and grounding of dispenser system;
  - Test report for emergency shutdown system;
  - Test report/certificate for lightning protection system;
  - Work completion certificate for fixed electrical installations (WR1);
  - Calibration certificates for pressure gauges and thermometers (if fitted);
  - Certificates of corresponding Explosive Atmosphere (Ex) classification for electrical components and equipment used in hazardous areas (including hydrogen compressors and dispensers;
  - Certificate of explosion-proof electrical components and equipment used in hazardous areas (including hydrogen compressors and dispensers);
  - Calibration and test certificate for hydrogen detector; and
  - Other relevant information as requested.
- The plan and arrangement relevant to the requirements in Section 7, including but not limited to:
  - Operation and Maintenance Manual;
  - Isolation procedure;

- Site security arrangement;
- Signage of the HFS;
- Emergency response plan of the HFS; and
- Other relevant information as requested.

3.3. Quantitative Risk Assessment

3.3.1. A Quantitative Risk Assessment (QRA) report shall be required for the hydrogen filling station as a part of the Agreement for Construction process. The owner of the station shall employ an independent quantitative risk assessment consultant to prepare a QRA report demonstrating that the risk levels associated with the station are in compliance with relevant Hong Kong Risk Guidelines referred to in Section 4.4 of the Hong Kong Planning Standards and Guidelines.

3.3.2. The QRA should demonstrate that the mitigation measures employed are appropriate to achieve the desired level of risk of the station. Reference shall be made to the Guidance Note on General QRA Studies for Hydrogen Installations in Hong Kong issued by EMSD for the standard approach to QRA of hydrogen installations in Hong Kong.

3.3.3. The QRA report shall take into account the hydrogen storage, site topography, meteorological conditions, ignition sources, interaction with other flammable fuels and existing planned population in the vicinity of the filling station.

3.3.4. The QRA report shall consider the appropriate design of forced and/or natural ventilation and the means/placement of hydrogen detection and appropriate station response.

3.3.5. For major alterations of HFS, a fresh QRA may be required if the proposed alterations change the basis of the original QRA.

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.

4. Siting Requirements

4.1. General

4.1.1. This section defines the siting and minimum separation distance requirements from adjacent buildings for hydrogen filling stations from a risk point of view. It also outlines the minimum separation distance requirements between hydrogen filling facilities and other critical features for compliance.

4.1.2. Where multiple fuel types are stored or dispensed on the site, consideration shall be given to the detailed design of these areas separately. The influence of each area on other aspects of the hydrogen filling station shall also be reviewed holistically within the quantitative risk assessment in accordance with the Guidance Note on General QRA Studies for Hydrogen Installations in Hong Kong issued by EMSD.

4.1.3. The hydrogen filling station shall be located along main roads which are considered safe for hydrogen tube trailer transport, or at a location which can be easily reached from the main roads without passing through highly populated areas.

4.1.4. The hydrogen filling station shall not be located near overhead electrical power lines. Overhead electrical lines shall not span across and are at a distance not less than 1.5 times the height of the pole. It shall be sited so that damage to any equipment or vehicles by electric arcing from overhead or other cables cannot occur.

4.1.5. A minimum size of 750 m2 will normally be required for a new stationary hydrogen filling station.

4.2. Separation Distances from Surrounding Land Uses

4.2.1. Hydrogen filling stations should meet the separation distance requirements from surrounding land uses as specified in the following table. However, the final accepted separation requirements shall be subject to the Quantitative Risk Assessment report as in Section 3.3.

	Distance from Hydrogen Storage/ compressor/ vent pipe/ dispenser
Low density residential/ Incidental Dwelling/ Commercial/ Industrial/ Recreational	25 m
High-rise residential/ Educational/ hospital	50 m

Table 1: Minimum recommended separation distances from surrounding land uses

4.2.2. If the separation requirements as specified under Clause 4.2.1 cannot be met, a fire wall complying with Section 5.18 with 2-hour fire resistance rating shall be erected in order to suitably reduce the separation distance subject to the Quantitative Risk Assessment report as in Section 3.3. The height of the fire wall shall be at least 2.5m.

4.3. Equipment Layout Distances within Hydrogen Filling Station Boundary

4.3.1. The minimum separation distance requirements between hydrogen equipment inside the filling station are shown in the following table.

	Hydrogen storage	**Hydrogen vent pipe**	**Hydrogen compressor**	**Hydrogen dispenser**	**Hydrogen unloading facility**
Hydrogen storage	-	Nil	Nil	Nil	Nil
Hydrogen vent pipe	Nil	-	Nil	Nil	6 m
Hydrogen compressor	Nil	Nil	-	Nil	Nil
Hydrogen dispenser	Nil	Nil	Nil	-	Nil
Hydrogen unloading facility	Nil	6 m	Nil	Nil	-
LPG/ petrol/ diesel dispenser	Nil	Nil	Nil	4 m	Nil
EV charging facilities/ ignition source / site boundary	5 m	5 m	5 m	5 m	5 m

Table 2: Minimum equipment layout distances within filling station boundary

Notes:

i. Clause 4.3.1 is not applicable to skid mounted filling station. The separation distances between hydrogen equipment inside the filling station shall be determined in accordance with relevant international standards subject to the Quantitative Risk Assessment report as in Section 3.3.

ii. If the separation requirements as specified under Clause 4.3.1 cannot be met due to site constraint, a fire wall complying with Section 5.18 with at least 2-hour fire resistance rating shall be erected in order to suitably reduce the separation distance subject to the Quantitative Risk Assessment report as in Section 3.3. The height of the fire wall shall be at least 2.5m.

iii. The equipment layout distances between LPG and petrol/ diesel filling facilities and other critical features shall be made reference to the Code of Practice for LPG Filling Stations in Hong Kong issued by the Gas Authority.

iv. The equipment layout distances between hydrogen equipment and non-specified LPG/ petrol/ diesel filling facilities shall be determined in accordance with relevant international standards subject to the Quantitative Risk Assessment report as in Section 3.3.

5. Design and Installation

5.1. General

5.1.1. Unless the requirements are otherwise stated in Section 4 of this Code of Practice, the overall design and installation of hydrogen filling station shall at least comply with one of the following standards:

- ISO 19880 Gaseous hydrogen — Fuelling stations.
- GB 50156 Technical standard of fuelling station.
- GB 50516 Technical code for hydrogen fuelling station.
- BCGA 41 The design, construction, maintenance and operation of filling stations dispensing gaseous fuels.
- NFPA 2 Hydrogen Technologies Code.

5.1.2. The overall hydrogen filling station and all of its equipment 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.

5.1.3. The hydrogen quality supplied by the filling station shall comply with one of the following standards:

- 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.

5.1.4. Provisions shall be made for the collection of hydrogen samples for the quality testing.

5.1.5. All hydrogen equipment shall be securely mounted on a proper supporting structure or foundation, with due consideration for the added weight from other static and dynamic loadings, such as wind and explosion loads.

5.2. Hydrogen delivery by tube trailers

5.2.1. The tube trailer shall have a valid Dangerous Goods Vehicle license.

5.2.2. A designated parking space for tube trailer shall be provided inside the filling station.

5.2.3. A fire wall complying with Section 5.18 with minimum 4-hour fire resistance rating shall be erected facing the discharge end of the tube trailer. The height and the width of the fire wall shall meet the requirements specified under Clause 5.0.7-3 of GB 50516.

5.2.4. A bump stop with ground markings shall be installed in the parking space to indicate normal parking position.

5.2.5. The tube trailer shall be equipped with a shut-off valve at the downstream of the discharge manifold. The shut-off valve shall be initiated by an emergency shutdown system.

5.2.6. The flexible hose of the tube trailer used for unloading shall be equipped with a safety shut-off system with excess flow device that protects the hazardous effect of the hose rupture, pull-apart and failure.

5.2.7. The tube trailers within the designated tube trailer parking space are deemed as hydrogen storage facilities, so their parking spaces shall meet the requirements in Section 5.4

5.2.8. Whenever the tube trailer parks as specified under Clause 5.2.7, a fire wall complying with Section 5.18 with minimum 2-hour fire resistance rating shall be erected between the vessels of tube trailer and the hydrogen/ LPG/ petrol/ diesel dispensers. The height and the width of the fire wall shall meet the requirements specified under Clause 10.7.15 of GB 50156 Technical standard of fuelling station. This Clause is not applicable to skid mounted filling station.

5.3. On-site production of hydrogen

5.3.1. For hydrogen production using water electrolysis, the system shall be designed and installed with reference to an applicable standard, for example:

- ISO 22734 Hydrogen generators using water electrolysis — Industrial, commercial, and residential applications.

- GB 50177 Design code for hydrogen station.

5.3.2. For hydrogen production using pressure swing adsorption (PSA), the system shall be designed and installed with reference to an applicable standard, for example:

- ISO 16110 Hydrogen generators using fuel processing technologies.
- ISO/TS 19883 Safety of pressure swing adsorption systems for hydrogen separation and purification.

5.3.3. For hydrogen production using Steam Methane Reforming (SMR), the system shall be designed and installed with reference to an applicable standard, for example:

- ISO 16110 Hydrogen generators using fuel processing technologies.
- GB 50177 Design code for hydrogen station.

5.4. Hydrogen Storage

5.4.1. Hydrogen storage refers to any of the followings:

- tube trailers; or
- all type of on-site hydrogen containers, including small buffer cylinders.

5.4.2. The hydrogen storage shall be located above ground and fulfil one of the following requirements:

- in open space with good natural ventilation; or
- in an enclosure or compartment equipped with forced ventilation system, only for small buffer cylinders.

5.4.3. The containers shall be designed and constructed in accordance with an internationally recognised pressure vessel code.

5.4.4. The containers shall be equipped with all of the following:

- automatic shut-off valve;
- pressure relief device or pressure safety valve;

- pressure gauge; and
- nitrogen purging interface.

5.4.5. The supporting structure shall provide individual support to each container.

5.4.6. A fire wall complying with Section 5.18 with minimum 2-hour fire resistance rating shall be erected between the hydrogen storage and the hydrogen/ LPG/ petrol/ diesel dispensers. The height and the width of the fire wall shall meet the requirements specified under Clause 10.7.15 of GB 50156. This Clause is not applicable to skid mounted filling station.

5.5. Compressors

5.5.1. Compressors shall be rated with the correct type of protection for explosive gas atmospheres for explosive gas atmospheres.

5.5.2. The compressor shall be fixed onto independent supports, with vibration reduction measures taken for the suction and discharge pipes.

5.5.3. Safety controls shall be installed to ensure temperature and pressure levels do not exceed or fall below operating levels.

5.5.4. Each compressor should be equipped with means to fully depressurise all parts of the system for maintenance purposes.

5.5.5. In cases where compressors are located within an enclosure or compartment that is not normally open, safety measures such as natural ventilation, hydrogen detection systems, forced ventilation for emergency and the associated interlocks shall be implemented.

5.5.6. A fire wall complying with Section 5.18 with minimum 2-hour fire resistance rating shall be erected between the compressor and the hydrogen/ LPG/ petrol/ diesel dispensers. The height and the width of the fire wall shall meet the requirements specified under Clause 10.7.15 of GB 50156 Technical standard of fuelling station. This Clause is not applicable to skid mounted filling station.

5.6. Dispenser

5.6.1. Dispenser shall be rated with the correct type of protection for explosive gas atmospheres.

5.6.2. A designated dispensing area shall be clearly marked on the ground.

5.6.3. The hydrogen supply to the dispenser shall be capable of being isolated.

5.6.4. The dispenser shall be equipped with at least one automatic shut-off valve which is inaccessible to the public and protected from vehicle impacts.

5.6.5. The dispenser shall be equipped with hose breakaway device. The disconnection of the hose breakaway device shall shut-off hydrogen flow to the nozzle.

5.6.6. The dispenser shall be equipped with check valve to ensure that there is no backflow during hydrogen filling.

5.6.7. The filling hose shall comply with ISO 19880-5 Gaseous hydrogen — Fuelling stations — Part 5: Dispenser hoses and hose assemblies or an equivalent standard.

5.6.8. The nozzle shall be designed in a way that they cannot couple with receptacles of lower nominal working pressures.

5.6.9. The nozzle shall comply with one of the following standards, or an equivalent standard:

- ISO 17268 Gaseous hydrogen land vehicle refuelling connection devices.
- SAE J2600 Compressed Hydrogen Surface Vehicle Fueling Connection Devices.
- GB/T 34425 Fuel cell electric vehicles—Hydrogen refuelling nozzle.

5.7. Filling process

5.7.1. The system shall fulfil relevant requirement regarding filling process in the standards to be adopted as specified in Clause 5.1.1 of this Code of Practice, or an alternative standard deemed appropriate by EMSD. Where there is no applicable provision in the type approval granted for the hydrogen fuelled vehicle and the alternative standard, the requirements in Clause 5.7.2 to Clause 5.7.7 shall prevail.

5.7.2. Prior to filling, the system shall perform a pressure integrity check to verify the integrity of the filling hose, hose breakaway device, nozzle and

connection to the vehicle. It may also determine the pressure of hydrogen within the vehicle prior to filling. The details of pressure integrity check are as follows:

- The pressure shall be monitored for any significant loss while the vehicle is connected.
- If the pressure integrity check is not successful, the filling operation shall be terminated and the emergency shutdown shall be executed.
- As a consequence of the pressure integrity check, a quantity of hydrogen may be transferred. The maximum hydrogen mass allowed to be transferred to the vehicle during this process should be 200 g.

5.7.3. One of the following filling protocols shall be used:

- SAE J2601 Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles.
- SAE J2601-2 Fuelling Protocol for Gaseous Hydrogen Powered Heavy Duty Vehicles.
- SAE J2601-3 Fueling Protocol for Gaseous Hydrogen Powered Industrial Trucks.
- GB/T 42855 Technical requirements of fuelling protocols for hydrogen fuel cell vehicles.
- A filling protocol which is approved by the manufacturers of the hydrogen fuelled vehicle to be filled at the station.

5.7.4. The filling of a vehicle containers shall be conducted within the process limit in the filling protocol, or comply with all of the following limits:

- Ambient temperature between −40°C and +50°C;
- dispenser fuel pressure less than the maximum operating pressure (MOP), which is as high as 125% of the hydrogen service level (HSL), i.e. 35 MPa or 70 MPa;
- dispenser fuel temperature greater than −40°C;
- a maximum of 10 pauses during filling where the fuel flow rate drops

below 0.6 g/s; and

- where communications are used, a communicated compressed hydrogen storage system temperature less than 85°C.

5.7.5. The maximum filling flowrate shall be subjected to the requirements in the table below:

Max. flowrate	Requirements
120 g/s (7.2 kg/min)	· Both the vehicle and the station are designed for the higher flow rate. · The dispenser has a high flow nozzle as per ISO 17268, which prevents connection to a standard vehicle receptacle, i.e., non-high flow receptacle. · Countermeasures are included to prevent vehicles that are not suitable for the filling protocol from being filled.
60 g/s (3.6 kg/min)	· Uses a connection defined in SAE J2600 or ISO 17268.

5.7.6. If vehicle to station communication is used, the requirement shall follow SAE J2799 Hydrogen Surface Vehicle to Station Communications Hardware and Software.

5.7.7. The filling process shall be terminated automatically within 5 seconds If one of the following circumstances occurs:

- An abort or halt signal is received from the vehicle being filled.
- Deviation from the filling protocol arises.

5.8. Piping System

5.8.1. The piping system shall comply with an applicable piping code.

5.8.2. The pipe material is preferrable S31603.

5.8.3. If pipes are located below ground level, the pipes should be laid in trenches made of non-combustible material. The trench should be covered with protection plate with ventilation holes to prevent trapping hydrogen.

5.8.4. If the hydrogen pipe is laid in a pipe trench, the design and arrangement of the pipe and other facilities shall comply with the relevant GB standards.

5.9. Valves

5.9.1. The following valves shall comply with ISO 19880-3 Gaseous hydrogen — Fuelling stations — Part 3: Valves or an equivalent standard.

- Check / non-return valves;
- Excess flow valves;
- Flow control valves;
- Hose breakaway devices;
- Manual valves; and
- Shut-off valves.

5.9.2. Pressure safety valve shall comply with ISO 4126-1 Safety devices for protection against excessive pressure — Part 1: Safety valves or an equivalent standard.

5.9.3. Pressure relief devices shall comply with ISO 4126-1 Safety devices for protection against excessive pressure — Part 2: Bursting disc safety devices or an equivalent standard.

5.10. Overpressure protection

5.10.1. The minimum component pressure ratings for the hydrogen dispensing system shall be 1.375 of HSL.

5.10.2. All pressurised parts shall be protected from overpressure by pressure relief devices (PRD) or pressure safety valves (PSV) other than rupture discs. The set point of the pressure protection shall be lower than 1.375 of HSL.

5.10.3. The flow capacity of pressure relief devices installed shall exceed the full flow capacity of the supply.

5.11. Vent system

5.11.1. All vent lines from pressure relief devices and pressure safety valves shall be connected to a vent stack.

5.11.2. The vent diameter shall not be smaller than the diameter of any connected PSV or PRD outlet, and large enough that it shall not prevent the PRD from functioning properly and does not restrict PRD flow.

5.11.3. The vent stack shall be adequately supported to cope with thrust loads created during discharge, as well as those created by the weather, such as wind loading.

5.11.4. The vent stack outlet shall terminate at 2m above the highest point of the station, or 5m above the ground level, whichever is the higher. The termination point should have adequate ventilation to prevent accumulation of gas, and thus forming a potentially explosive atmosphere.

5.11.5. The vent stack outlet shall be facing vertically upwards, or any direction in between horizontal and vertically upwards. Ingress of water and debris should be prevented. Caps shall not be used to cover the outlet.

5.12. Ventilation

5.12.1. When the hydrogen equipment is situated in a semi-enclosed area, such as beneath canopies or shaded structures, the design shall incorporate measures to prevent the accumulation of hydrogen. Specifically, the use of canopies with waffled slabs, which could potentially accumulate hydrogen within the void spaces, is prohibited.

5.12.2. Enclosures and compartments containing hydrogen equipment shall be equipped with forced ventilation systems with the correct type of protection for explosive gas atmospheres. The ventilation systems shall be initiated by:

- Maximum 1 % v/v hydrogen concentration detected by the hydrogen detection system.
- Emergency shutdown system.

5.12.3. Enclosures and compartments containing hydrogen equipment shall be

equipped with adequate ventilation of minimum 5 air changes per hour (ACH).

5.13. Hydrogen Detection System

5.13.1. The hydrogen detectors shall comply with the accuracy requirements of ISO 26142 Hydrogen detection apparatus or an equivalent standard.

5.13.2. Hydrogen detectors shall be installed at the highest points in all of the following locations:

- Inside the enclosures or compartments containing hydrogen equipment;
- Near each hydrogen dispenser; and
- Fill-connection between the tube trailer and filling station.

5.13.3. Upon detection of maximum 1.0% v/v hydrogen concentration, all of the following response should be initiated:

- An audible alarm sounds inside and outside the enclosure.
- A red light flashes inside and outside the enclosure;
- A respective % v/v alarm sounds and indicator light illuminates at a monitoring station.
- All hydrogen supplies shut-off.
- All bay doors open (if any).
- Forced ventilation of enclosures and compartments set to minimum 15 air changes per hour (ACH).
- Shutdown of all hydrogen production systems.

5.13.4. Upon detection of maximum 2.0% v/v hydrogen concentration, further response should be initiated:

- A respective % v/v alarm sounds and indicator light illuminates at the monitoring station.
- All electrical power is disconnected, with the exception of the forced ventilation fan and other explosion proof equipment (such as

emergency equipment, lights and signs, if any).

- The fire alarm sounds for evacuation.

5.13.5. Hand-held, portable hydrogen leak detectors shall be accessible at the entrance of any enclosed or semi-enclosed area, and the tube trailer parking space.

5.14. Emergency shutdown system

5.14.1. The filling station shall be equipped with emergency shutdown system.

5.14.2. Without further manual intervention, the emergency shutdown system shall be initiated by any of the following:

- Manual emergency stop devices;
- Unsuccessful pressure integrity check of the dispenser system;
- Disconnection of the hose breakaway device;
- Detection of hydrogen concentration at maximum 2.0% v/v hydrogen concentration;
- Failure of the forced ventilation system; or
- Failure of hydrogen detection system.

5.14.3. In addition to Clause 5.14.2, the emergency shutdown may also be initiated by any of the following:

- Detection of a dispenser fuel pressure below the level targeted by the filling protocol;
- Detection of an unexplained reduction in dispenser fuel pressure; or
- Detection of a higher-than-expected dispensing flow and/or closure of an excess flow valve.

5.14.4. At least one manual emergency stop button shall be installed at each of the below locations:

- Next to hydrogen dispenser;

- Inside the hydrogen storage areas;
- Inside the filling station office; and
- Inside the skid or next to the compressor.

5.14.5. The response initiated by the emergency shutdown system shall include:

- Closing the automatic shut-off valve of the dispenser; and
- Activate the forced ventilation systems provided for enclosures and compartments containing hydrogen equipment to the specifications in Clause 5.13.3.

5.15. Hazardous areas classification

5.15.1. The owner shall develop the hazardous areas classification based on IEC 60079-10-1 Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres.

5.15.2. 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.

5.16. Lightning protection

5.16.1. Lightning protection shall be provided for the station. Guidance can be found in BS EN/IEC 62305 Protection against lightning.

5.16.2. In the case where vent stacks are designed to carry lightning currents, this may be considered to achieve the requirement for lightning protection.

5.17. Earthing

5.17.1. Earthing shall be provided for the filling station, with electrical continuity covering the dispenser system, vent stack and all relevant piping.

5.17.2. A fixed electrostatic discharge pole shall be installed at the entrance of the filling station for incoming personnel to eliminate their own static electricity.

5.18. Fire wall

5.18.1. The fire wall shall be without openings or penetrations. Penetrations of the fire wall by conduit or piping shall be permitted provided that the penetration is protected with a firestop system in accordance with the Code of Practice for Fire Safety in Buildings issued by the Buildings Department.

5.18.2. The fire wall shall be constructed of non-combustible material with the fire resistance rating specified in accordance with the Code of Practice for Fire Safety in Buildings issued by Buildings Department or equivalent is provided.

5.18.3. The fire wall may be built on a boundary, but in such a case, it shall be wholly under the control of the owner of the station.

5.18.4. Whenever a fire wall is erected as specified under any clauses of this Code of Practice, a minimum separation distance of 1.5m should be maintained between the fire wall and any part of the tube trailer or hydrogen storage or compressor or dispenser.

5.19. Security fence and wall

5.19.1. A fence or wall shall be erected around the hydrogen storage and compressor area to ensure no unauthorised entry of the public into the operating site. Alternatively, any other means or measures that can effectively cordon off the operating area may be considered if approved by EMSD.

5.19.2. The fence or wall may be built on a boundary, but in such a case, it shall be wholly under the control of the owner of the station.

5.19.3. Whenever the fence or wall is erected as specified under Clause 5.19.1, a minimum separation distance of 1.5m should be maintained between the fence or wall and any part of the hydrogen storage or compressor.

5.20. Accessibility for works

5.20.1. Equipment installed at heights should have walkways and working platforms to be accessible for operation, inspection and maintenance.

5.20.2. The station shall be designed to allow the use of suitable manual handling equipment.

5.21. Vehicle collision protection

5.21.1. Vehicle collision protection shall be provided for tube trailer, hydrogen storage and dispensers as below:

- Continuous crash barriers where high speed (>50 km/h) and high vehicle impact is anticipated; and
- Bollard type for low-speed (<20 km/h) impact potential from on-site traffic.

5.21.2. Traffic calming measures, such as speed bumps and high containment kerbing, shall be provided.

6. Testing and Commissioning

6.1. General

6.1.1. The hydrogen filling station and all the equipment shall be tested and commissioned according to its design standards, manufacturers' instructions and the requirement of this Code of Practice.

6.2. Testing and commissioning plan

6.2.1. Prior to the actual testing and commissioning work, a plan shall be in place to clearly outline all relevant activities. Factory Acceptance Tests (FAT) and Site Acceptance Tests (SAT) shall be indicated in the plan.

6.2.2. Reference could be made to "Table I.1 — Minimum fuelling station acceptance inspection, testing and validation checklist" in ISO 19880 for the preparation of testing and commissioning plan.

6.3. Tests on components

6.3.1. All components, including compressor and dispenser, shall be tested according to the manufacturer's instructions.

6.3.2. All measuring instruments, including temperature sensor and pressure sensors, shall be calibrated.

6.3.3. Electrical continuity for bonding and grounding shall be tested.

6.3.4. Work completion certificate for fixed electrical installations (WR1) shall be obtained.

6.4. Pressure Test

6.4.1. Pressure tests shall be conducted for all pressure bearing parts for the hydrogen equipment, except tube trailers.

6.4.2. For pressure test on the vent pipe, the scope should include the piping between PSV or PRD, and the vent stack. The vent stack recommended design pressure shall be at least 40 bar.

6.4.3. The pressure test could be either hydraulic or pneumatic. If a pneumatic test is used, then either air, nitrogen, or helium is recommended as the medium.

6.4.4. The test pressure and procedure shall be based on the design standard of the filling station. The test pressure shall be no less than 1.1 of MAWP. No permanent deformation or mechanical failure shall be allowed.

6.4.5. Following the pressure and leak test, all isolation devices introduced to perform the test must be removed.

6.4.6. The test report shall include:

- name of contractor, and signature of the competent person who supervised the tests;
- test scope in the form of P&ID;
- materials, pressure rating and specification;
- test date;
- test pressure, test medium and duration; and
- test results.

6.5. Leak Test

6.5.1. Leak tests shall be conducted on the whole hydrogen system after assembled. The leak test should be conducted in conjunction with or following the pressure test.

6.5.2. The leak test should be pneumatic using non-flammable gas, such as nitrogen or helium as the medium.

6.5.3. The test pressure and procedure shall be based on the design standard of the filling station. The test pressure shall be no less than 0.85 of MAWP, which is equivalent to 1.1 of MOP. The system leakage shall be acceptable as per the design standard.

6.5.4. The test report shall include:

- name of contractor, and signature of the competent person who supervised the tests;
- test scope in the form of P&ID;
- materials, pressure rating and specification;

- test date;
- test pressure, test medium and duration; and
- test results.

6.6. Functional test for safety features

6.6.1. Functional test for hydrogen detection system shall be conducted at its design setting and the requirement in Section 5. The test procedures shall follow ISO 26142 Hydrogen detection apparatus or an equivalent standard.

6.6.2. Functional test for the emergency shutdown system shall be conducted as per its design settings and the requirement in Section 5.

6.6.3. Each device in the circuit or system should be checked individually for each input activation or simulation. Care should be taken to ensure that only the circuit under test caused the required action.

6.7. Purging

6.7.1. The filling station shall be purged with inert gas, such as nitrogen, prior to injecting hydrogen into the system.

6.7.2. When purging, any gas released should be vented through the vent system or through dedicated discharge points which vent into a safe area.

6.7.3. After the purging, the residual oxygen concentration shall be tested as less than 1 % v/v.

7. Operation and Maintenance

7.1. General

7.1.1. The owner of the HFS has the responsibility to ensure that the operation and maintenance of the station and the equipment therein, are conducted in a safe manner so that members of the public are not exposed to undue risks from hydrogen.

7.1.2. The owner shall ensure sufficient manpower and resource for the operations and maintenance of the HFS.

7.1.3. The owner shall implement a Permit to Work system for the operation and maintenance.

7.1.4. The owner shall assign a designated competent person for HFS to ensure its safe operation and maintenance.

7.2. Training

7.2.1. The owner shall ensure that no person shall carry out any operation or maintenance work in relation to the HFS, unless the person carrying out the work is competent by virtue of training and practical experience.

7.2.2. The owner shall provide training at least to the following persons:

- Station manager for on-site monitoring;
- Operator for dispensing; and
- Maintenance personnel.

7.2.3. The training content shall at least cover the following items:

- Properties of hydrogen and the relevant safety considerations;
- Normal operation of the station;
- The use of safety devices; and
- Emergency handling.

7.2.4. Induction training to newcomers and regular refresher trainings shall be

conducted.

7.2.5. Testing or examination shall be arranged to ensure the training outcomes

7.3. Operation and maintenance manual

7.3.1. The owner shall establish proper operation and maintenance manual to at least cover:

- Procedure for station start-up and shutdown;
- Procedure for depressurisation, isolation, purging and inerting; and
- Procedure for resuming the station from hydrogen free condition.

7.3.2. All personnel shall eliminate their own static electricity before accessing the hydrogen equipment. This may be achieved by using a fixed electrostatic discharge pole placed at the entrance of the filling station, or other equivalent means.

7.3.3. The manual shall cover the provision of personal protective equipment for staffs working in the HFS.

7.3.4. No smoking policy shall be strictly enforced in the HFS.

7.4. Dispensing operation

7.4.1. Outside normal operating hours, the hydrogen supply to the dispenser shall be isolated.

7.4.2. The owner shall establish proper dispensing instructions displayed at the dispenser. These instructions shall include prohibitions against all of the following:

- The use of incompatible adapters, for example, 35 MPa vehicle filling from 70 MPa nozzle, or alternative fuel nozzles; and
- The filling into the hydrogen cylinders that are incompatible with the fuelling protocol employed at the station.

7.5. Emergency handling

7.5.1. The owner shall establish an emergency response plan (ERP) to handle accidents for HFS. The ERP shall cover all reasonably foreseeable incidents.

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

7.5.3. Emergency instructions shall be displayed at all of the following:

- Next to hydrogen storage, including tube trailer parking area;
- Next to dispensers;
- At control desk; and
- In the station office.

7.5.4. The emergency instructions shall at least cover all of the following:

- measures taken when the emergency shutdown system activates;
- measures taken for any hose ruptures; and
- measures taken for the prevention of over-pressurisation of the hydrogen storage.

7.5.5. A drill for emergency scenario shall be carried out every half year.

7.6. Hydrogen quality check

7.6.1. The owner shall establish a hydrogen quality assurance plan following the recommendation from equipment manufacturer and an applicable standard, e.g., ISO 19880-8 Gaseous hydrogen — Fuelling stations — Part 8: Fuel quality control.

7.7. Inspection and maintenance

7.7.1. The owner shall establish a maintenance plan following the recommendation from equipment manufacturer and an applicable standard, e.g., ISO 19880-1 “Table 4 for guidance on HFS periodic inspection and testing.”

7.7.2. The periodic inspection shall at least cover all of the following:

- Hydrogen leak check once per day;
- Calibration of each hydrogen detector, and function test on the overall detection system once per year; and

- Fixed electrical installation (Form WR2).

7.8. Hazardous areas

7.8.1. Only the tools and equipment with the correct type of protection for explosive gas atmospheres shall be used in the hazardous areas.

7.9. Hot work

7.9.1. While the station contains hydrogen, hot work shall only be performed in case of service necessity and with a portable or fixed hydrogen detector to continuously analyse the atmosphere in the work area.

7.9.2. A proper work permit system incorporating formal procedures shall be instituted for hot work.

7.10. Maintenance for skid mounted unit

7.10.1. If the skid mounted unit is to be out of service for a long period of time, equipment and pipelines shall be replaced with nitrogen until the hydrogen concentration does not exceed 0.4% v/v. The nitrogen pressure after replacement should be maintained above 0.3 MPa.

8. Incident Reporting and Investigation

8.1. Incident Reporting

8.1.1. 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:

- Loss of containment of hydrogen from tube trailer or vehicle conveying hydrogen cylinder(s)/tank(s);
- Damage to hydrogen equipment or tube trailer or vehicle conveying hydrogen cylinder(s)/tank(s);
- Any leak or loss of containment of hydrogen above the design alarm level leading to the triggering of the emergency shutdown system or direct link system connecting to the Fire Services Communication Centre or such other premises as may be agreed with the Director of Fire Services;
- Smoke, fire or explosion of any magnitude;
- Injury of any personnel involving the HFS;
- Vehicle drive-away with hydrogen leakage and without leakage; or
- Other incidents that have attracted media attention

8.1.2. For all hydrogen incidents, including but not limited to those listed in the aforementioned clause, 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 sensors which were activated

during the incidents;

- the extent of the damage of the equipment or parts;
- the licence number of the hydrogen fuelled vehicle 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.

8.1.3. Following the preliminary incident report, a detailed incident report with the following information in addition to the items in previous Clause 8.1.2 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.

8.2. Incident Handling and Investigation

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

8.2.2. 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 – Typical hydrogen filling station

The scope of this Code of Practice is indicated in the below diagram of a typical hydrogen filling station: