H2 Mobility

70MPa Hydrogen Refuelling Station Standardization

Functional Description of Station Modules

CONTENTS

1) Document Scope

This document is the functional description of standardized hydrogen refuelling stations (HRS) in Germany. It gives an overview of the required performance in terms of quantity and quality and regulations to adopt.

The boundary limit for the scope of this document runs from the on site H2 storage up to (and including) the fuelling nozzle.

Three station concepts dealing with three modes of hydrogen supply will be described:

1. CHG trailer supply
2. LH2 trailer supply
3. On-site production / pipe line supply

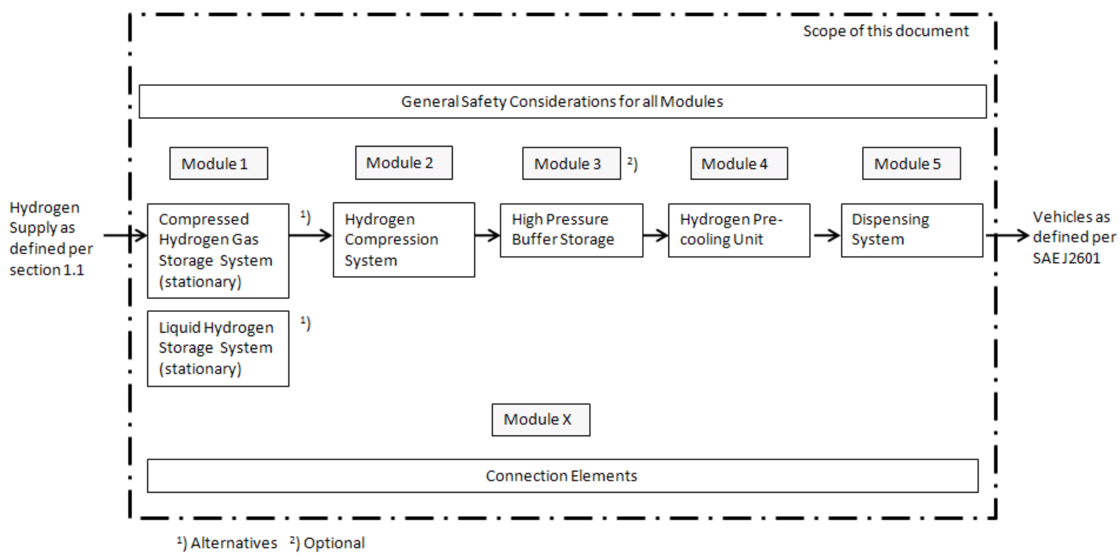

Figure 1: Scope of this document

1.1 Hydrogen Supply to the station

Three different types of hydrogen supply are considered, namely trucked-in compressed hydrogen gas (CHG), trucked-in liquid hydrogen and on-site production / pipeline supply. This section describes the requirements of the different supply methods.

The type of hydrogen supply is indicated by the client to the contractor.

1.1.1 Trucked in compressed hydrogen gas

The delivery frequency will be given to the contractor by the client. It will be once a day or less for small stations and twice a day or less for medium stations. The unloading or tube trailer changeover time shall be 60 minutes or less. It is assumed that delivery is possible every day. The accepted delivery pressures are from 20 to 50 MPa.

1.1.2 Trucked-in liquid hydrogen

If liquid hydrogen is delivered, the station is allowed to store it in liquid or gaseous form.

The delivery frequency will be given to the contractor by the client. It will be once a day or less. The unloading time shall be kept to a minimum.

1.1.3 On-site production / pipeline supply

Some HRS may have an on-site hydrogen production. Pipeline supply is also considered on-site production as long as there is no ubiquitous hydrogen pipeline network available.

The hydrogen delivery pressure at the HRS boundary is at least 1.5 MPa. The maximum allowed pressure at the system boundary will be indicated by the client to the contractor.

1.2 Vehicles to be Refuelled

The vehicles to be refuelled are light-duty vehicles with tank systems as defined in SAE J2601. For the scope of this document the maximum vehicle tank size is assumed to be 7 kg of hydrogen. The average quantity per refuelling is assumed to be 5.6 kg of hydrogen.

The refuelling connector of the vehicles will be defined in a later stage due to inconsistencies in the applicable standards. For this tender the connector defined in SAE J2799 shall be used.

2) Overall Hydrogen Refuelling Station Performance Specification

This section defines the overall HRS station sizes and performance requirements.

2.1 Ambient Temperature

The HRS are to be operated in Germany. The ambient temperatures go from -20°C to +40°C. The temperature is measured on-site.

As an option, a station may be required to operate from -30°C to +40°C ambient temperature.

If the ambient temperature is out of the specified range, means have to be taken in order to ensure safe operations or the station has to be shut down in a safe way.

2.2 Availability of HRS

Vehicle refuelling availability of the HRS and its modules from the customer perspective shall be >95% during the opening hours of the station. The definition of availability is similar to the definition agreed on in the European Funded Project HYLIGHTS (www.hylights.eu):

- Availability in [%] = actual operating time in [h] / potential operating time in [h]

with

- actual operating time in [h] = potential operating time in [h] - Σ down-times in [h]

and

- potential operating time in [h] = opening hours of the refuelling station during the reported project time period (e.g. 10 hours per day, during 300 days = 3000 h)
- Σ down-times*, ** in [h] = total time, no hydrogen refuelling is possible at the refuelling station (= unavailability of HRS, see below)

* Excluded are problems / incidents caused by the vehicle (e.g. problem with the vehicle storage)

** Excluded are problems / incidents caused by the failure of the primary energy supply (e.g. electricity supply for hydrogen generation, NG, LPG or other fuels)

The unavailability to refuel hydrogen vehicles at the HRS (e.g. due to incidents or scheduled repairs (= maintenance) of the HRS) has to be reported to the manufacturers and the operators of the vehicles and other fuelling stations by the refuelling station operator:

- Beginning of the unavailability to refuel H2 at the HRS (start / recognition of the problem) and
- end of the unavailability (end of repair).

The duration of an incident or repair that affects the capability of the HRS to refuel hydrogen (down-time) is derived from the above described unavailability reporting (start and end of the problem to refuel hydrogen vehicles). The downtime is calculated on basis of the HRS operation hours, see examples:

Example 1: A hydrogen refuelling station that opens daily at 07:00 and closes at 22:00 reports the start of a major problem (no H2 refuelling is possible) on Monday at 13:00 and the successful repair on Tuesday at 13:00. Considering the opening hours of the HRS, the duration of the H2 unavailability is 15 h.

Example 2: Due to a problem with the hydrogen compressor the HRS is not able to refuel hydrogen vehicles. The operator reports the start of the problem at 08:00 on Monday, June 01. Because the repair of the compressor is impossible, a new one must be ordered by the equipment manufacturer. Due to a delivery delay of a new compressor of almost four weeks, the repair of the HRS takes more time as expected and the HRS is fully operational on July, 05 at 16:00. The down-time of the HRS is calculated on basis of the HRS operation hours (daily open from 07:00 to 22:00):

Calculation of the down-time:
June 01: 14 hours out of operation
June 02 – July 04: 33 days, each 15 hours out of operation = 495 hours out of operation
July 05: 9 hours out of operation
Total down- time: 518 hours out of operation

2.3 Vehicle Refuelling Process Control

The filling process to adopt is defined in SAE J2601. The type of the filling station required is A-70. The design baseline are vehicle tanks in the range of 1-7kg of hydrogen at 70MPa.

The filling protocol especially covers the following parameters:

- Flow Control (Average Pressure Ramp Rate, APRR)
- Precooling Temperature
- Target Pressure of the process

2.4 Hydrogen Quality

The quality will be defined by the Hydrogen Production and Supply Group of H2 Mobility. The fueling station shall not impair the quality of the hydrogen (including particles).

2.5 Definition of HRS Sizes and Specific Requirements

Four different sizes of hydrogen refuelling stations are defined: Very Small, Small, Medium and Large stations. The general performance specifications of the different refuelling station sizes are given in Table 1. Specific requirements are given below. The definition of "back to back refuelling" and "waiting time" is explained in Figure 2, Figure 3 and Figure 4.

Table 1: Performance specification of the different HRS sizes

	Very Small HRS	**Small HRS**	**Medium HRS**	**Large HRS**
Number of Refuelling Positions	1	1	2	4
Number of Refuelling per hour per position	2,5	6	6	10
Number of back to back refuelling per refuelling position	0	1	1	10

Max. waiting time to fuel consecutive cars [min.]	20	5	5	n.a.
Number of consecutive hours to meet the performance specifications	--	3	3	24/7
Average number of fuellings per day	10	30	60	125
Maximum number of fuellings per day	20	38	75	180
Maximum hydrogen hourly throughput in kg	18	33.6	67.2	224
Average hydrogen throughput per day	56 kg	168 kg	336 kg	700 kg
Maximum hydrogen throughput per day	80	212 kg	420 kg	1000 kg
Number of cars per station (approx.)	100	400	800	1600

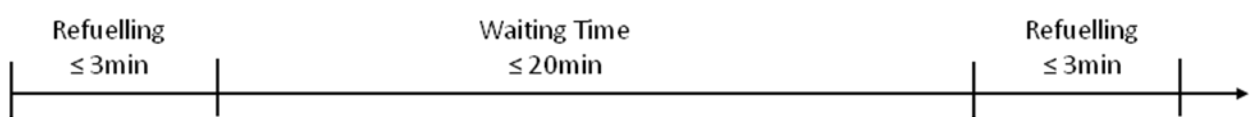

Figure 2: Explanation of the Performance Specification of Very Small HRS

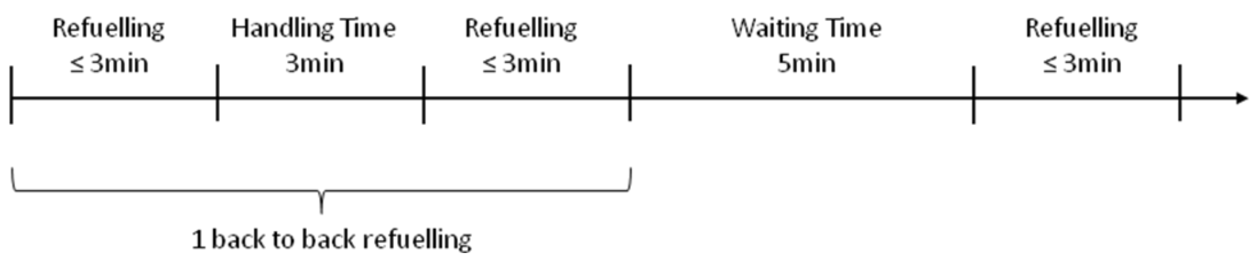

Figure 3: Explanation of the Performance Specification of Small and Medium HRS

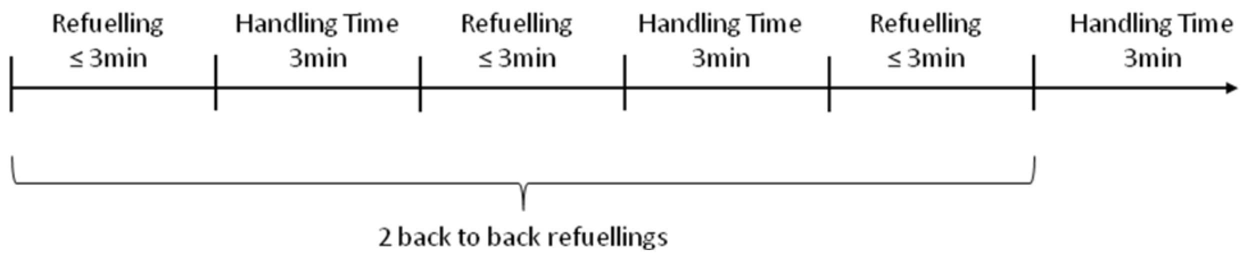

Figure 4: Explanation of the Performance Specification of Large HRS (more than one back to back refueling)

For very small HRS a transportable maximum 40ft. containerised solution (integrating the storage) for easy installation and decommissioning is required. The dispenser should be integrated into the container or easy to connect with an above-ground connection excluding any trenching works. The entire system with container, pavement, dispenser, handling areas (including the refuelling position of the car but excluding the footprint temporarily required for the delivery trailer during unloading) etc. should be integrated in a footprint of approximately 10m x 15m. Safety distances and hazardous areas are excluded. The container lifetime shall at least be the lifetime of the equipment.

For small HRS a transportable container solution for easy installation and decommissioning is required. The container lifetime shall at least be the lifetime of the equipment.

The small HRS design elements shall allow for an upgrade to a medium size HRS.

Different dispensers, as defined in the medium and large stations shall be able to perform independently from each other.

All HRS shall be able to have storage capacity added to accommodate increasing station throughput over time whilst complying with maximum daily supply frequency.

Large HRS shall have the ability to grow number of refuelling positions in modular fashion to match the expected hourly demand.

TOTAL requires a storage capacity of 3 days in line with the average daily throughput – reflecting supply limitations in Germany!

2.6 Testing and Acceptance of the Fuelling Protocol

Before the fuelling station is released for the fuelling operation of vehicle tanks, the fuelling station requires approval for the fuelling of vehicle tanks. For the approval process a testing procedure for the fuelling protocol is to be performed according to industry best practice.

2.7 Optional 35 MPa refueling dispenser

In this tender an optional 35 MPa dispenser shall be offered. The specification is as follows:

- Tank systems to be refueled: according to the definition given in SAE J2601;
- Refuelling connector: according to SAE J2600;
- Vehicle Refuelling Process Control: Two options shall be offered:
    a. SAE J2601-A35 (-40°C precooling)
    b. no precooling, constant mass flow = 10 g/s

All other specifications (e.g. performance specification of HRS sizes, hydrogen quality etc.) are identical to the specifications given for 70MPa vehicles.

3) Module Performance Specification

The hydrogen refuelling stations are described in functional modules. The modules are described in the following subsections.

3.1 General safety considerations for modules

All equipment used for HRS shall be designed for hydrogen operations and fit for purpose.

All personal safety related devices and equipment provided by the Contractor, such as hydrogen detectors, flame detectors, level, temperature and pressure detectors and interlocks, shall be hard wired or have an equivalent Safety Integrity Level.

Consideration shall be given to any potential hazard or risk in relation to the location and operation of the facility. More specifically, measures to reduce fire and explosion risks shall be applied in the following order of priority:

1. Prevention of the formation of a flammable or explosive mixture and reduction of the explosion strength potential of explosive atmosphere generated by potential leaks or releases;
2. Avoidance of ignition sources;
3. Mitigation of the effects of a fire or explosion.

All modules comprising active equipment located within an enclosed area such as the compression system container shall be equipped with forced ventilation and include a hydrogen gas and fire detection system.

The dispenser frame shall not necessarily include gas/fire detection but shall be naturally ventilated via two openings.

The standard safety assessments to be provided are the following:

1. Detailed description of the safety concept of the plant
2. List of critical equipment on which FMEA is performed
3. HAZOP of the whole HRS

Adequate lighting shall be provided.

3.2 Module 1 – On–Site Hydrogen Storage System

3.2.1 Gaseous Hydrogen Storage System

Compressed hydrogen gas is stored in either aboveground, under-ground or roof top cylinder bundles, tubes or vessels. The pressure level(s) and the capacity of the storage system shall be designed taking into account to the supply pressure, delivery frequency, footprint implications, economics and the performance specification of the process. The gaseous on-site storage system has to be designed in such a manner that it is able to safely handle a hydrogen flow coming from a trailer within the pressure range of 20 to 50 MPa.

If the gas is to be delivered with a liquid cryocompressed system then the operating temperature of the components, which are part of this module, will have to be defined.

Direct buried tanks shall be equipped with corrosion protection.

The storage system is provided with pressure gauges, a vent system and isolation valves to enable the system to be shut down for maintenance or inspection.

A fail-safe emergency isolation valve shall interrupt the hydrogen flow to the compressor in case of an off-spec event. It shall be located as close as possible to the storage system.

3.2.2 Liquid Hydrogen Storage System

LH2 supplied to an HRS via a LH2 trailer, is stored in either an aboveground or under-ground LH2 storage vessel.

The storage vessel is providing a maximum Hydrogen boil off rate of 1.4 % of the capacity per day (24h) at 15°C ambient temperature. Boil off recovery may be applied if desired.

Direct buried tanks shall be equipped with corrosion protection.

A fail-safe emergency isolation valve shall interrupt the hydrogen flow to the compressor in case of an off-spec event. It shall be located as close as possible to the storage system.

Based on the performance defined in chapter 2.5 for very small, small, medium and large sized stations, the pressure and capacity of the on site storage shall be designed taking into account the delivery frequency, footprint implications and economics.

The Client will define whether a visible plume is acceptable or not.

3.3 Module 2 – Hydrogen Compression System

The compression system comprises:

- The compressor system and driver (e.g. electric motor).
- Cooling system
- Controls
- Safety devices.

The compression system throughput will depend on the overall HRS capacity. The power required to drive the compressor depends on the size of the HRS and also the inlet pressure that is available.

Based on the performance defined in chapter 2.5 for very small, small, medium and large sized stations, the pressure and capacity of the hydrogen compression system shall be designed taking into account the footprint implications and economics.

The compression system shall be designed in accordance with the performance specification in section 2.5.

Vehicle refuelling can be achieved by direct fill from the compression system or via high pressure cascade, in both cases the system shall be designed in accordance with the performance specification in section 2.5.

The compressor unit should be delivered as a package including complete instrument and HRS control package to ensure safe and reliable operation.

The type of compression system may vary. All types of compressors are acceptable (e.g. diaphragm, reciprocating, hydraulic, ionic liquid or cryo pump) provided that they have been specifically designed with reference to hydrogen service.

Important compressor safety requirements are related to the following:

- Safety controls shall be installed to ensure that temperature and pressure levels do not exceed or fall below set operating levels.
- No oxygen contamination shall occur in hydrogen supply
- Vibrations from the compressor must not be transferred to connecting pipe work.

The control sequence that starts-up and shuts down of the machine also stops the compressor if temperatures or pressures deviate from the required values.

Safety from over-pressure is provided by soft-wired pressure relief and relief valves through the compression system.

Positive isolation shall be applied such that the compressor can be isolated for maintenance.

The compressor system and enclosure shall be designed in order to allow ease for maintenance work and have adequate lifting devices.

3.4 Module 3 – High Pressure Buffer Storage

Sufficient buffer storage is provided to help maintain refuelling rates during busy periods of the day and to provide more even loading on the station compressor.

The amount of storage is designed to meet the performance requirements described in chapter 2.5. The maximum operating pressure of the storage should be less than 100 MPa.

The storage is arranged in groups or banks. The gas is fed to the dispensing system from these banks. The low and/or medium banks can be considered from the Module 1 main site gaseous storage in order to allow for example a 2 to 3-stage 'cascade filling' of CHG vehicles.

The storage system is provided with pressure gauges, a vent system and isolation valves to enable the system to be shut down for maintenance or inspection.

If the high-pressure cascade is located in the compressor enclosure means shall be taken in order to protect the cylinders.

3.5 Module 4 – Hydrogen Pre–cooling Unit

In order to reach very low refuelling time without overheating or overfilling the vehicle on-board gaseous hydrogen storage tank, the hydrogen gas shall be temperature compensated.

The pre-cooling temperature at the dispenser outlet shall be in accordance with the SAE J2601 standard for A-70 stations.

3.6 Module 5 – Dispensing System

The dispenser cabinet shall be made from non-combustible and anti-static materials. Openings shall be provided for making connections and for inspection and adjustment of the operating mechanism after installation. Openings shall require a key or toll to open.

The interior of the dispenser cabinet shall be adequately naturally ventilated.

The CHG dispensing system shall include mass flow meters, a control system, filtration, flow shut off valves, start/stop buttons, a sales display (indicating quantity of hydrogen dispensed and hydrogen price per mass unit and the total price) and the ability to connect a card reader system.

The customer provides the card reader and defines the data requirements. The contractor will assist in implementing the system. The interface to the card reader will be defined by the CEP infrastructure working group. The agreed system approach is LOAN.

For the flow meter an accuracy of +/- 5% is required for refuellings of more than 1kg. (Note that intensive R&D work is being done in this field at the moment. As soon as better accuracies can be achieved with commercially available systems, this will be required.)

Multiple dispensers shall operate independently from each other.

The dispensers shall be fitted with an anti-tilt device able to detect and shut down the refuelling process if a vehicle crashes into the dispenser.

Dispenser hoses shall be fitted with breakaway connections. All hoses, breakaway connections and vehicle refuelling connectors shall be approved for hydrogen service. Only an authorized person shall be able to reconnect the breakaway coupling once activated.

The fuelling hose assembly shall be strong enough to withstand reasonably expected loads (tensile and torsion) in normal use for refuelling purposes. The fuelling hose shall at all time be supported, to ensure against abrasion or kinks, and to facilitate the easy withdrawal for use without contact with the ground. Fuelling hose scuff/abrasion protection is desired if practically available in the market.

Each fuelling hose shall have been hydraulically tested by the manufacturer and will comprise a certificate issued to that effect. The fuelling hose shall be permanently marked with its dates of manufacturing and expiration and its maximum operating pressure.

The hose shall be protected from vehicle damage and shall not be allowed to fall on or touch the ground when the refuelling nozzle is in the stowed position.

Hoses shall be designed for hydrogen service. Hose design and qualification shall be done according to ISO 10380 or ISO 14113:2007.

The vehicle refuelling connectors will be defined in a later stage due to inconsistencies in the applicable standards. For this tender the latest version of the SAE J2799 is mandatory.

As an option, the dispensing system may have an infrared communication system to the vehicle according to SAE J2799. It will be indicated to the contractor if an infrared communication system is required. For this tender, the infrared communication system is required.
Dispensers shall be equipped with means to protect all operating controls and electrical wiring from climatic conditions.

Dispensers shall be equipped with means to secure and protect the fuelling nozzle and hose when not in use.

Means shall be provided to ensure that both the nozzle and the receptacle are at ground connection before connection.

Pressurized gases emerging from pressure relief devices shall be able to be ventilated and dissipated in a safe manner, avoiding any explosive gas atmosphere within the dispenser cabinet.

The dispenser shall be designed so as to prevent the release of any vented gas into the interior of the dispenser cabinet during any stage of vehicle fuelling operations.

3.7 Module X – Connection elements

The connection elements are defined as being the link between the different modules, these are mainly constituted by piping, valves and fittings. All connection elements shall be suitable for liquid or gaseous hydrogen service as applicable and for the pressures and temperatures involved.

All hydrogen piping and pipe connections shall be done in accordance with appropriate hydrogen industry practice and local regulations. Screwed joints shall be kept to an absolute minimum and shall only be used where necessary to mate into specialized equipment or other equivalent requirement.

Hydrogen piping is to be routed and isolated as much as possible to minimize/prevent exposure to other system components/hardware.

Electrical continuity shall be maintained throughout the system to ensure proper grounding.

All welding shall follow procedures to prevent hydrogen embrittlement or crack initiation.

All bends shall be free of cracks, wrinkles, bulges, kinks and other defects. Maximum out-of-roundness shall not exceed 8 percent of the nominal outside diameter. The instructions given by the pipe suppliers must be followed and documented.

Means shall be provided to minimize exposure of personnel to piping operating at low temperatures and to prevent air condensate from contacting piping, structural members and surfaces not suitable for cryogenic temperatures.

Where it is necessary to run gaseous hydrogen pipelines in the same duct or trench used for electrical cables, then all joints in the hydrogen pipelines in the ducted/trenched section shall be welded above 25 MPa. The hydrogen pipeline should be run at a higher elevation than other pipelines.

Pneumatic testing of the piping at a pressure level of 1.1 times the design pressure is permissible with an inert gas.

The Contractor shall minimize the potential for mechanical damage to small-bore pipe work containing hydrogen by protecting this pipe work from mechanical damage where appropriate. This requirement shall apply particularly for any pipe work run above ground between the pumps, cylinder buffer storage and the dispenser.

Isolation Valves and Pressure Relief Valves shall be suitable for liquid or gaseous hydrogen service as applicable and for the pressures and temperatures involved.

Isolation Valves shall be "quick acting" (< 2 seconds closing time) and positioned such that one part of the installation can be isolated in order to prevent an incident from escalating.

Primary Isolation Valves shall be located as close to the source of stored hydrogen as possible for each storage bank. Isolation valves used at equipment/units shall not replace the need for the primary isolation valves at the hydrogen storage bank.

Pressure relief devices shall be arranged to discharge unobstructed to atmosphere and in such a manner as to prevent impingement of escaping liquid or gas upon the tank, adjacent structures or personnel. All vents shall be piped away to the vent stack.

Pressure relief devices or vent piping shall be designed or located so that moisture cannot collect and freeze in a manner, which would interfere with proper operation of the device.
Consideration shall also be given in the design of the installation to facilitate the access for maintenance of the pressure relief devices.

Vent lines shall be able to cope with detonation of hydrogen / air mixtures inside the pipe.

Pressure gauges shall be equipped with safety glasses.

4) General Site Layout Considerations

4.1 General

The layout of the plant requires that sufficient space is given to the various components of the HRS system while still maintaining the necessary separations for safety and for the requirements of the Hazardous Area classifications.

4.2 Component Lifetime

All parts and components of the HRS shall be designed for at least 8 years. Otherwise this has to be explained and mentioned.

4.3 Safety Distances

For the determination of the safety distances, local German regulation shall be referred to.

Note: A working group on safety distances (TG1) is working on the topic on an ISO level. As soon as new tables are published they shall be considered.

If the HRS is supplied by trucked-in CHG or LH2, sufficient space will need to be provided for the ingress/egress of the trailers and tankers and for parking of CHG trucked-in trailers parked on-site (include safety distance for unloading and refer to norms governing this).

It shall be ensured that the plant is arranged so that there is adequate access for maintenance.

4.4 HRS Plant Hazardous Areas

The hazardous area as defined in the ATEX regulation is the area around a HRS where a flammable / explosive atmosphere may be present inherent to the hydrogen properties and activities of that HRS. In these areas, work and maintenance activities are restricted or subject to special precautions e.g. no naked flames, no smoking, no hot work without a work permit.

4.5 Emergency Shut Down System

The emergency shutdown system is activated by large mushroom head push buttons located as follows: one on the dispensing module, one in the compression area and one in the retail shop. The activation points are indicated with bold high visibility signs. The ESD buttons should be of the manual reset type such that once pushed they have to be reset on the electrical control panel before energising the station.

4.6 Protection of HRS Modules

Equipment requires protection from mechanical damage and from tampering.

For the compression system, buffer storage and other plant equipment the enclosure provides the principal protection from mechanical damage – for example by vehicles. Tampering can be prevented by adequate surveillance from staff during operating hours and by locking the plant enclosure when unattended.

Storage areas are protected by a combination of fencing and locks.

For sites at which vehicles are moving or parking close to the HRS plant, barriers shall be installed as added mechanical protection. They shall be designed so that they can be removed when access is required for removal of components.

4.7 Influence of Hazardous Areas

Hazardous Area classification identifies areas in the HRS plant where there are risks of flammable atmospheres forming. The classification of the area is to ensure that electrical equipment has the appropriate type of protection to keep the risk of fire or explosion to an acceptably low level. The probability of a flammable gas being present is used as the basis for defining different areas of the plant.

The classification is based on the IEC system, which defines the zones in the HRS plant as follows:

Zone 1: An area where hydrogen gas is likely to occur periodically in normal operation.

Zone 2: An area where hydrogen gas is not likely to occur in normal operation and if it does so will only exist for a short time.

Reference shall be made to IEC 60079-10 for the definition of the hazardous zones.
Ventilation can have an effect on the classification of the hazardous area and hence hazardous area drawings reflect the scenarios based on adequate or inadequate ventilation. Idem for fire resistance walls.

Hazardous areas are plotted to indicate areas around the HRS plant and equipment in which flammable gaseous mixtures may be present. The electrical equipment within those areas is then specified for the designation of the area or zone.

4.8 Enclosures and Buildings for CHG Plant

Buildings and/or enclosures in which CHG plants are installed shall be designed for the purpose of use and be well ventilated with outlets at the high points. The degree of enclosure should be at a minimum level consistent with providing a reasonable working or plant protection environment in relation to local weather conditions.

Precautions shall be taken to ensure that hydrogen cannot penetrate into service ducts, electrical wiring, electrical conduits, access ways etc that connect to locations that are designated as safe areas, i.e. outside the hazardous zone.

Buildings and enclosures used for hydrogen operations shall built according to applicable local codes and regulations. If explosion relief is used it should be provided only in exterior walls or roof and should be designed in such a way that if an explosion occurs, the resulting pressure will be relieved without the explosion relief system emitting dangerous projectiles.

Lighting shall be provided that is of an adequate intensity for all enclosures and operating areas so that at all times operations can be carried out safely. The lighting plant shall be suitable for use in hydrogen areas.

Where heating is required in cold environments, it should preferably be by hot water or warm air from sources remote from the buildings/enclosure.

The building or enclosure shall have good low and high-level natural ventilation to the open air. Outlet openings shall be located at the highest point of the room in the exterior walls or roof.

4.9 Vent Design

The vent shall be designed in order to ensure safe high-pressure releases. The vent shall be unobstructed to the atmosphere. If a silencer is used, it shall be designed so that the necessary hydrogen flow is ensured.

Means shall be taken against flow obstruction by water, dirt, insects etc. A self-closing water drain (not collected) shall be installed at the lowest points of the line.

The vent lines shall be adequately supported by a metal structure.

4.10 Noise

The noise emissions of the HRS shall be less than 35dB according to German regulations for residential zones. The station has to allow a 24/7 use on inner city sites.

4.11 Power and Utility Requirements

The Equipment Supplier will provide necessary data to the operator concerning utility and power requirements.

5) Regulations

When building a HRS all relevant regulations and laws have to be adopted. This has to be demonstrated by issuing a “CE” mark (*Conformité Européenne)*.

6) Abbreviations

ATEX	(Appareils destinés à être utilisés en) Atmosphères Explosibles
CE	Conformité Européenne (European Conformity
CHG	Compressed Hydrogen Gas
DIN	Deutsches Institut für Normung (German Institute for Standardization)
EIGA	European Industrial Gases Association
EN	Europäische Norm (European Standard)
ESD	Emergency Shutdown
FMEA	Failure Mode and Effects Analysis
H2	Hydrogen
HAZOP	Hazard and Operability (Study)
HRS	Hydrogen Refuelling Station
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
LH2	Liquid Hydrogen
MAWP	Maximum Allowable Working Pressure
MPa	Megapascal
PED	Pressure Equipment Directive
SAE	Society of Automotive Engineers
TG	Technical Group

TIR	Technical Information Report
TÜV	Technischer Überwachungsverein (German Technical Inspection Association)

7) Requirements on Documentation

1) General description of technology concept
2) Operations manual
3) Maintenance Manual
4) Maintenance plan or scheme including all periodicities
5) CE certificates
6) Equipment data sheets/certificates
7) Product data sheets
8) P&ID's
9) Process flow diagrams
10) Logic trees
11) Piping welding procedures and certificates/testing certificates
12) Pressure testing procedures
13) List of critical equipment on which FMEA is performed
14) HAZOP of the whole HRS
15) Safety considerations - safety system (detailled description)