35

Hydrogen: installations for delivery of hydrogen to road vehicles

PUBLICATIEREEKS
GEVAARLIJKE STOFFEN

Hydrogen: Installations for delivery of hydrogen to road vehicles

Hazardous Substances Publication Series 35: version 1.0 (April 2015)

Foreword

This Publication Series provides guidance for companies who produce, transport, store or use hazardous substances and for authorities responsible for granting licences and monitoring these companies. It provides a summary of regulations, requirements, criteria and conditions, based on the current state of the art technology. This Publication Series is the reference framework for granting licences, drawing up general rules, monitoring companies and could be used by companies to implement their own corporate responsibilities. The Publication Series focuses on an integrated approach to occupational safety, environmental safety, transport safety and fire safety.

These guidelines are formulated such that should the case arise a company can choose other measures on an equivalence basis.

PGS 35 was drawn up by PGS team 35 including representatives from the government and the business community. The members of this team are listed in Annex M.

The Publication Series is kept up-to-date by the PGS Management Organisation under the direction of a programme council which is made up of all the stakeholder parties. This comprises representatives from the authorities (the Association of Interprovincial Authorities (IPO), the Association of Dutch Municipalities (VNG), the Social Affairs and Employment Inspectorate (Inspectorate SZW), the Dutch Fire Service, the business community (VNO-NCW and MKB Nederland) and employees.

The contents of the publication were determined by the PGS Programme Council.

The PGS Programme Council states that this publication was produced by a careful and balanced process and agrees to the inclusion of this publication in the Hazardous Substances Publication Series.

More information on the PGS and the most recent publications can be found on: www.publicatiereeksgevaarlijkestoffen.nl.

A summary of the field covered by the Publication Series including a list of relevant legislation and regulations and the stakeholders is included in the note 'Legal Context of the Hazardous Substances Publication Series' (*Juridische context Publicatiereeks Gevaarlijke Stoffen*). It can be downloaded from the website mentioned above.

The chairman of the PGS Programme Council,

Gerrit J. van Tongeren

april 2015

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Summary

This publication provides guidelines for hydrogen delivery installations.

The introduction (clause 0) describes the reason for this PGS publication and gives a survey of the relevant legislation and regulations and the government bodies involved in granting licenses and monitoring. There is also a brief explanation of the equivalence principle and the use of standards and guidelines.

Clause 1 provides a general description of the hydrogen delivery installation, after which the construction requirements are described. Besides the general construction requirements of clause 2, construction requirements have been described that apply specifically to one of the three forms of hydrogen supply (gaseous hydrogen through piping, gaseous hydrogen through mobile units and liquid hydrogen). Some construction requirements are described with not one, but two of the three forms of supply of hydrogen. These descriptions of the construction requirements are not accidental duplicates. The last item defined in this clause is the safety aspects of hydrogen. Clause 3 describes the regulations for supply to the hydrogen delivery installation and delivery to consumers. Clause 4 describes the testing, maintenance, registration, inspection and enforcement. Clause 5 deals with the safety measures. Clause 6 addresses incidents and disasters (and the corresponding requirements).

In this PGS publication the regulations are numbered and shown in blue boxes.

And finally, some informative annexes have been added to this PGS, including a survey of the characteristics of hydrogen, a list of terms, the standards used/relevant, a description of relevant legislation and regulations and the composition of PGS team 35.

0 Introduction

0.1 Reason for this PGS publication

Hydrogen is not a new phenomenon. It is an important component of town gas and as such it has been known as an energy carrier for almost two hundred years. The chemical industries have used large volumes of hydrogen in various industrial production and other processes for over a century. This means that a lot of experience of safely using hydrogen in an industrial environment has been gathered.

What is new in the Netherlands is the use of hydrogen as a fuel for road vehicles. It is then not used by professional users in an industrial environment, but by non-professional users (consumers) in a public environment. This use of hydrogen involves other usage aspects and control measures.

In the past, the Dutch Code of Practice NPR 8099:2010 on *Hydrogen fuelling stations – Guide for safe application of installations for delivery of hydrogen to vehicles and boats with respect to fire, workplace and environment* was available for the construction of hydrogen delivery installations in the Netherlands. This Code of Practice comprised a lot of knowledge relevant to the construction of a hydrogen delivery installation. A tour of safety specialists revealed that they preferred a PGS publication due to the uniformity of regulations that are important in the context of granting licenses and due to the footing and transparency they provide as regards granting licenses for the construction of a hydrogen delivery installation. As regards the necessary physical space, a PGS gives internal safety distances that shall be observed. Thus, a PGS offers a guideline of regulations, requirements and safety distances, enabling licensing procedures for hydrogen delivery installations to be performed in a uniform manner.

This PGS concerns road vehicles that are fuelled by hydrogen. To enable the market introduction of such road vehicles, the Dutch government, frontrunners in the gas and automotive industries, and decentralized governments will gather knowledge and experience of hydrogen projects, such as the construction of hydrogen filling stations. The objective in this phase of market preparation is to formulate the pre-conditions in terms of safety, licensing and tax matters and, at the same time, to introduce hydrogen as a vehicle fuel to the society at large.

0.2 Relation with legislation and regulations

The majority of the requirements or regulations that apply to the use of hazardous substances are laid down in legislation. These requirements may be based on European Directives or follow directly from European regulations. The PGS publications aim to give as complete a description as possible of the way in which companies can comply with the requirements arising from legislation and regulations.

Annex C gives a list of relevant legislation and regulations that are important for a hydrogen delivery installation. These are broken down into the following categories:

General:

- Environmental Licensing (General Provisions) Act (Wet algemene bepalingen omgevingsrecht – Wabo);
- Environmental Management Act (Wet milieubeheer);
- Activities Decree (Activiteitenbesluit);
- Activities Regulation (Activiteitenregeling),
- Major Accidents (Risks) Decree (Besluit risico's zware ongevallen – Brzo);
- External Safety (Establishments) Decree (Besluit externe veiligheid inrichtingen – Bevi);
- External Safety (Establishments) Regulations (Regeling externe veiligheid inrichtingen – Revi).

Requirements for technical integrity:

- Pressure Equipment (Commodities Act) Decree (Warenwetbesluit drukapparatuur – Wbda);
- Explosion-safe equipment (Commodities Act) Decree (Warenwetbesluit explosieveilig materieel).

Operation:

- Working Conditions Act (Arbeidsomstandighedenwet);
- Working Conditions Decree (Arbeidsomstandighedenbesluit);
- Pressure Equipment (Commodities Act) Decree (Warenwetbesluit drukapparatuur – Wbda);
- Safety Regions Act (Wet veiligheidsregio's);
- National and international standards for operation;
- Health & Safety catalogues (Arbocatalogi).

Requirements for spatial context:

- External safety policy and the Spatial Planning Act (Wet ruimtelijke ordening – WRO);
- Building Decree (Bouwbesluit) 2012.

Transport:

- Transport of hazardous substances Act (Wet Vervoer Gevaarlijke Stoffen – VLG), incorporating the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADR).

Note:
The above list is not exhaustive.

For the most up-to-date version of the legislation and regulations we advise you to consult the website http://wetten.nl.

0.3 Government bodies involved

Municipality and province

For most companies the municipality is the competent authority for the Environmental Licensing (General Provisions) Act (Wabo). The provinces are the competent authority for most bigger and often more hazardous companies or companies with more severe environmental pollution. The decision may be taken to use a regional enforcement service (Regionale uitvoeringsdienst – RUD) to perform the tasks of the competent authority.

Dutch Ministry of Infrastructure and Environment / Dutch Ministry of Economic Affairs

In exceptional cases the Minister of Infrastructure and Environment is the competent authority as regards the environmental licence (mainly for defence sites) or the Minister of Economic Affairs (for mining activities and for oil and gas extraction).

Safety region

With the arrival of the safety regions, the municipal and regional fire brigades will be integrated into the safety regions as part of the fire service.

As regards fire safety, the safety region may be involved on two levels:

- firstly because of its statutory advisory task in the situation where this involves a company that falls under the Major Accidents (Risks) Decree (Brzo) and/or the External Safety (Establishments) Decree (Bevi);
- secondly, the safety region may be consulted by the competent authority when determining requirements for fire prevention and fire suppression provisions that may be laid down in environmental licences.

SZW Inspectorate (I-SZW)

The Dutch Ministry of Social Affairs and Employment (SZW) is responsible for all regulations relating to working conditions. The SZW Inspectorate (I-SZW) monitors compliance with these regulations.

Human Environment and Transport Inspectorate (ILT)

The Human Environment and Transport Inspectorate monitors compliance with the regulations regarding the transport of hazardous substances and regularly conducts local checks at shippers and storage and transhipment companies. They have also been given the task of monitoring the proper classification of packaged hazardous substances.

1 Application of the publication

1.1 General

Monitoring, enforcing and granting licences are regulated in the relevant legislation. Companies should comply with the current state of the art technology described when a reference is made from a binding document to the PGS. Binding documents could be, for example, the Activities Decree or an environmental licence. Another option is for PGS regulations to be imposed on a company by means of a requirement for compliance by the Inspectorate SZW (Social Affairs and Employment).

For the application of an updated PGS an updated PGS for granting licences under the Environmental Licensing (General Provisions) Act) (Wabo) we can make a distinction between the following situations:

- new company to be set up;
- extension and/or change of an existing company;
- existing company.

For questions about the application of an updated PGS in existing situations or in the case of an extension of or change to an existing company, please refer to the 'Responses and questions' (*Reacties en vragen*) on www.publicatiereeksgevaarlijkestoffen.nl.

1.2 Objective

The objective of this PGS publication is to provide regulations on the design, construction, maintenance and management of hydrogen delivery installations. Complying with the regulations identified in the PGS ensures an acceptable level of protection for people and the environment, taking the relevant and foreseeable internal and external risks into consideration.

1.3 Scope

1.3.1 Scope of PGS 35

This PGS applies to hydrogen delivery installations on land, including the associated and/or necessary auxiliary equipment, with a maximum delivery pressure of 350 bar or 700 bar of gaseous hydrogen[1] for road vehicles with European type approval.

Delivery takes place in the open air. An installation, or installation components, placed outside can be fitted with an enclosure that features safety devices.

This PGS distinguishes three options for the supply of hydrogen to a hydrogen delivery installation:

1) gaseous hydrogen through piping (Figures 1.1 or 1.2), or
2) gaseous hydrogen through mobile units (tube of cylinder trailers) (Figures 1.3 or 1.4), or

[1] See the definitions in annex A.

3) liquid hydrogen through other mobile units (Figures 1.5 or 1.6).

No specific internal safety distances other than those referred to in clause 5 have been included for hydrogen delivery installations. In order to determine the internal distances, it is important to know whether the Major Accidents (Risks) Decree (*Brzo*) applies to the establishment. Clause 5 is referred to in this respect. A quantitative risk analysis (QRA) shall be carried out in order to determine the external safety distances.

Figure 1.1 – Supply of gaseous hydrogen through piping

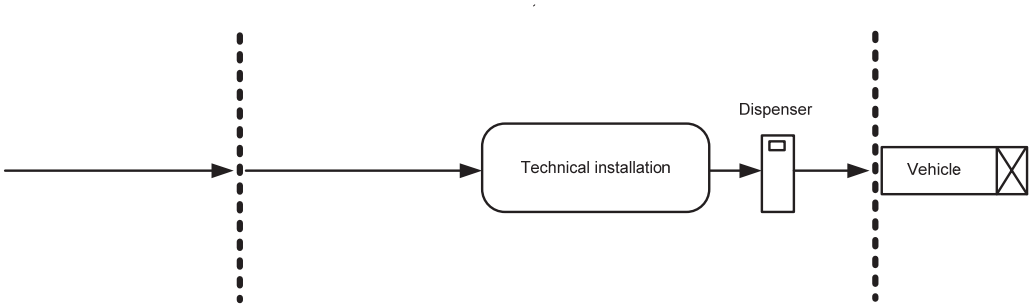


Figure 1.2 – Supply of gaseous hydrogen through piping from local production

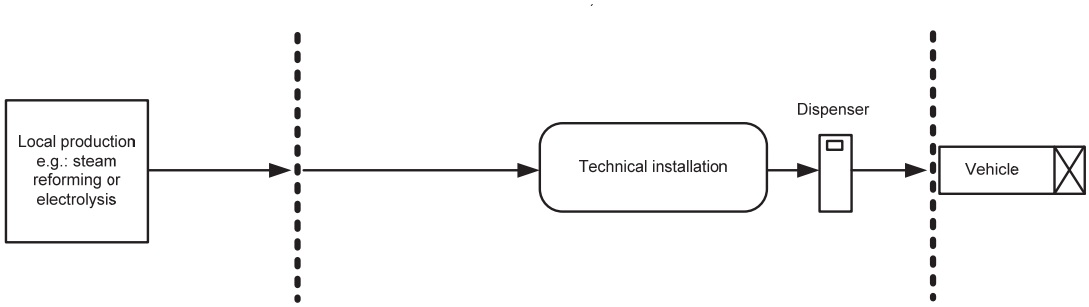


Figure 1.3 – Supply of gaseous hydrogen by mobile units

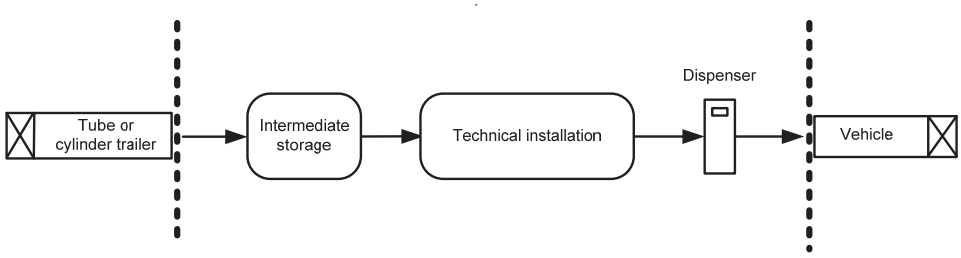


Figure 1.4a – Supply of gaseous hydrogen by temporarily stationed mobile units

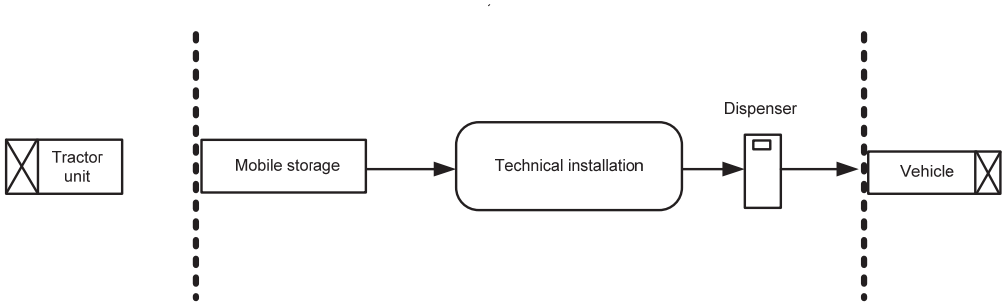


Figure 1.4b – Supply of gaseous hydrogen by temporarily stationed mobile units (tractor unit has left)

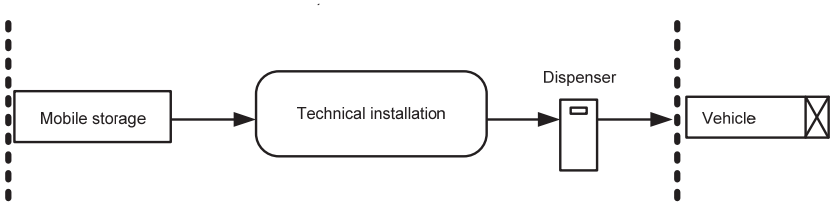


Figure 1.5 – Supply of liquid hydrogen by mobile units

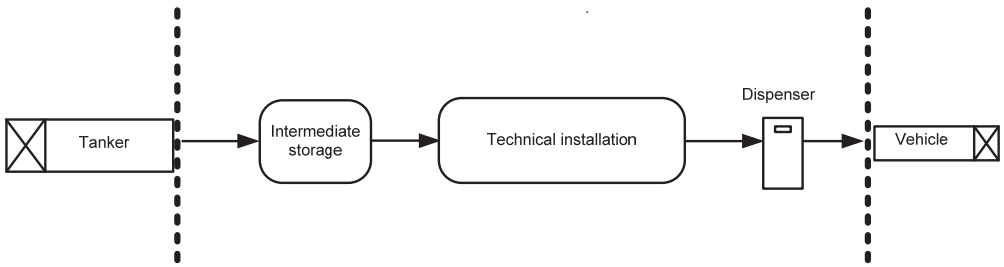
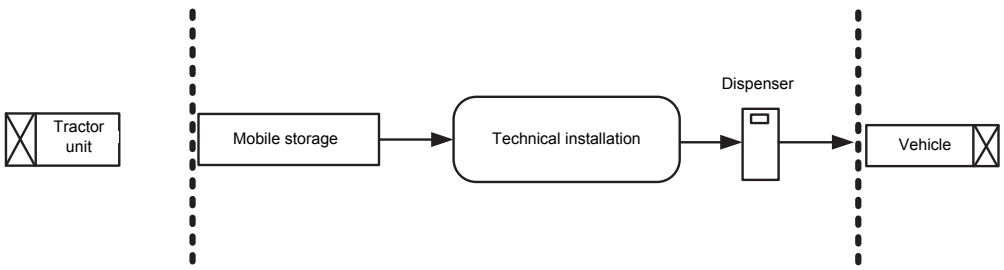


Figure 1.6 – Supply of liquid hydrogen by temporarily stationed mobile units



Key

System boundary

1.3.2 Exclusions

This PGS does not apply to:

- local production of hydrogen;

  Note:
  Due to the many different possibilities (e.g. electrolyser or steam reforming, see Annex E) the technical configuration of the local production installation is not described within the scope of this PGS. However, the local production installation will have to be considered in the external risk assessment.

- the delivery of liquid hydrogen as a fuel to road vehicles;
- the delivery of hydrogen to ships;
- delivery to separate refillable cylinders or intermediate storage.

  Note:
  In practice, situations can occur that are not covered by the scope of this PGS. As long as no legislation and regulations have been developed for such situations, parts of this PGS may continue to apply as a reference document.

1.3.3 Limits of the system

The limits of a hydrogen delivery installation depend on the supply option chosen, in accordance with 1.3.1 of this PGS. These options are shown in Figures 1.1 to 1.6 as supply through piping or mobile units.

The filler coupling of the liquid or gaseous hydrogen storage unit forms the system boundary on the supply side of a hydrogen delivery installation.

The delivery side of the system is limited by the road vehicle that is being filled (these boundaries/limits are shown in 1.3.1 of PGS 35 as dotted red lines).

1.3.4 Manned/Unmanned hydrogen delivery installations

As it is presumed that the safety aspects for filling up at unmanned delivery stations shall be described the most extensively, this PGS starts from the principle of unmanned hydrogen delivery installations.

In addition, this PGS also applies to manned hydrogen delivery installations.

This PGS also describes specific issues for personnel that are not described in the Working Conditions Act.

1.4 Equivalence principle

The equivalence principle applies to the application of PGS 35. This means that other measures may be taken than those included in PGS 35. In practice this means that during the preliminary consultation between the party applying for the licence and the party granting the licence, data shall be submitted showing that at least the required safety at work and fire safety can be achieved, as well as protection of the environment. When granting licences, the competent authority assesses whether equivalent protection can be achieved by applying such other measures. I-SZW reviews this during inspections in connection with the enforcement of the Working Conditions Act.

1.5 Use of standards and guidelines

European and other harmonised standards are available in order to interpret legislation and regulations. Where other reference documents are referred to, the version in force at the time when this PGS was published shall apply (e.g. NEN, ISO, BRL).

1.6 Relation to testing criteria and assessment guidelines

1.6.1 Products bearing the CE marking

The hydrogen delivery installation shall bear CE marking to demonstrate compliance with the applicable European legislation such as:

- European Pressure Equipment Directive (PED);
- Machine Directive (MD);
- Electromagnetic Compatibility (EMC) Directive;
- Construction Products Regulation(CPR);
- Measuring Instruments Directive (MID);
- ATEX Directive.

Note:
This is not an exhaustive list. See annex C for further information.

2 Construction and design of the hydrogen delivery installation

2.1 General description of the installation

This clause describes the requirements laid down for the construction and design of a hydrogen delivery installation.

This paragraph describes the possible setups of the hydrogen delivery installations, using schematic diagrams. Each of these setups contains the components that shall be present in a hydrogen delivery installation as a minimum. These schematic diagrams are not exhaustive and are possible examples of hydrogen delivery installation setups as used in practice.

Note:

a. *The diagrams are based on a single dispenser. In practice there can be several dispensers.*
b. *Dispensers for both 350 bar and for 700 bar may possibly be constructed next to each other, or a dispenser with different hoses for 350 bar to 700 bar may be constructed.*
c. *There may also be several facilities for intermediate storage, compressors, etc., to enable rapid filling of the tank of a road vehicle.*
d. *The possibility that a combination of liquid and gaseous hydrogen is supplied to a delivery station has not been included as an option in any of the diagrams, but is covered by the scope of PGS 35.*

In 2.2.1 and 2.2.2 aspects which are important for the construction of hydrogen storage units, piping and fittings are described, and also where requirements are laid down by law. When not provided for by the current legislation and regulations, additional regulations are described in this PGS.

The design of the hydrogen delivery installation is defined by the manner in which the hydrogen is supplied or produced and how it is delivered to road vehicles. This PGS assumes that the supply methods can be connected to the installation variants shown, in accordance with the following figures.

Figure 2.1 – Schematic diagram of a hydrogen delivery installation with gaseous hydrogen through piping or local production

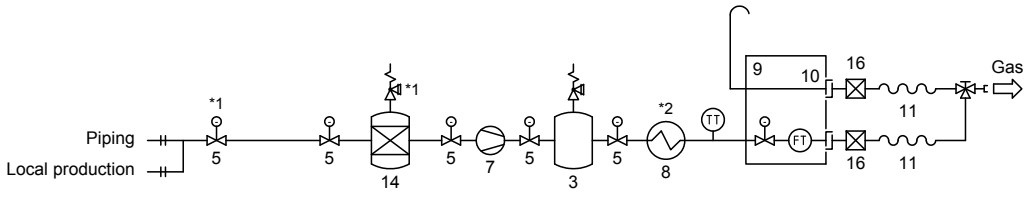


Figure 2.2 – Tube trailer carrying gaseous hydrogen, coupled to the hydrogen delivery installation

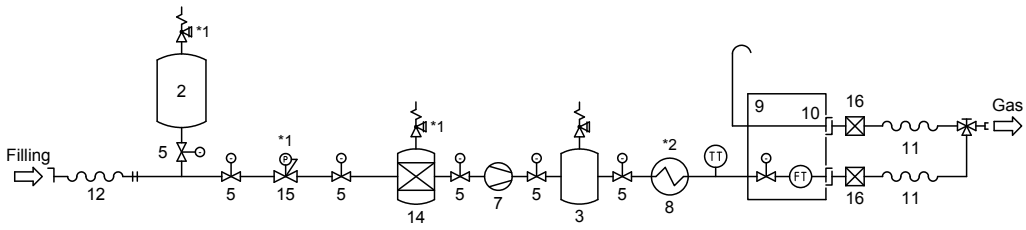


Figure 2.2 alternative option – Gaseous hydrogen: supply through a tube or cylinder trailer

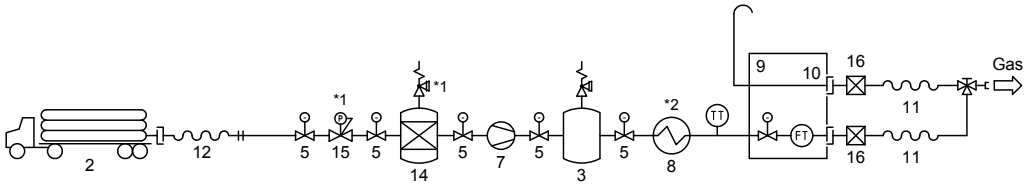


Figure 2.3 – Tanker carrying liquid hydrogen, coupled to the hydrogen delivery installation (including a pump)

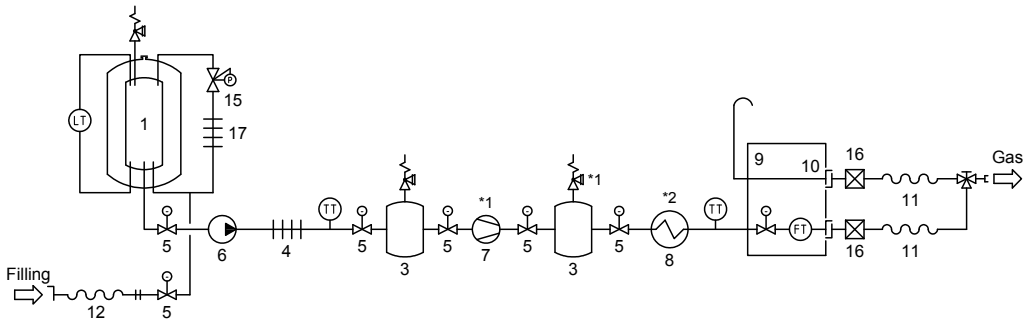


Figure 2.3 (alternative option) – Tanker carrying liquid hydrogen, coupled to the hydrogen delivery installation (excluding pump)

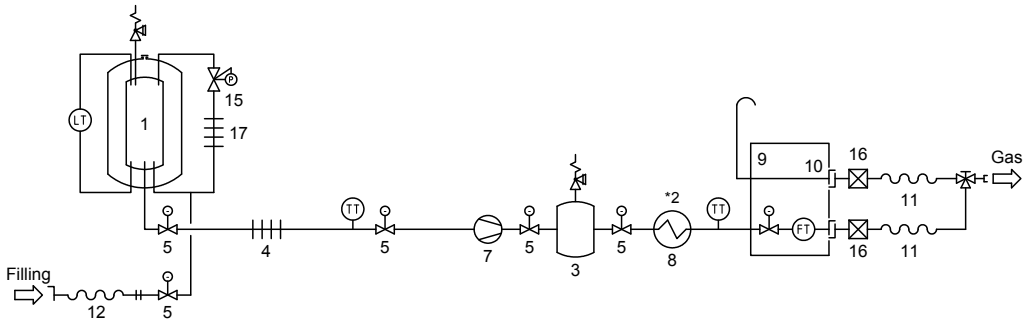


Figure 2.4 – Liquid hydrogen (including a pump): supply through a tanker

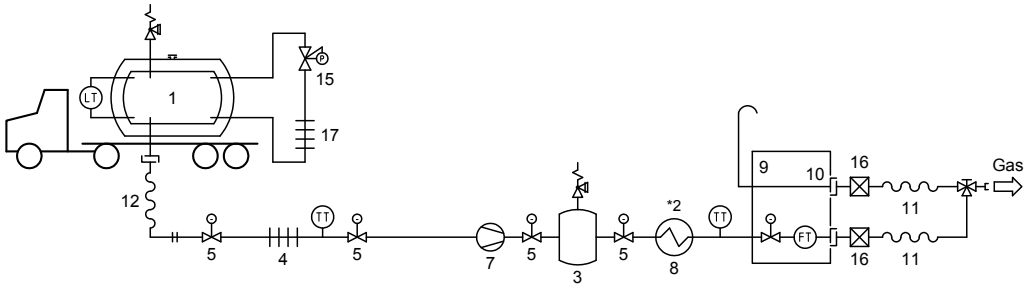
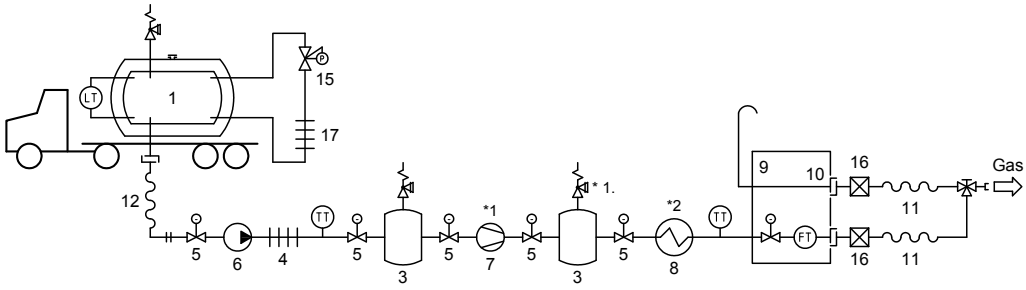


Figure 2.4 alternative option – Liquid hydrogen (excluding a pump): supply through a tanker



Key

1 hydrogen storage unit (liquid)	8 chiller	15 pressure regulator
2 hydrogen storage unit (gas)	9 dispenser	16 breakaway coupling
3 intermediate storage	10 safety valve	17 pressure build-up evaporator
4 evaporator	11 delivery hose	LT level measurement
5 emergency shutdown facility (esd)	12 offloading hose	FT flow measurement
6 pump	13 / ⇒ fill	TT temperature measurement
7 compressor	14 purifier	

*1. Optional

*2. Application depending on delivery pressure and requirements (filling speed)

A hydrogen delivery installation, as shown in the above figures, usually consists of a number of characteristic parts and components. These are described in more detail, for information, below.

1 Liquid hydrogen storage unit

The liquid hydrogen storage unit consists of pressure vessels with an operating pressure that may vary, for example, from 4 bar to 8 bar (from 400 kPa to 800 kPa). Special pressure vessels will be applied since the temperature of the liquid hydrogen delivered is very low and in order to prevent heat input from the surroundings as far as possible. These pressure vessels are double-walled, creating an almost complete vacuum in the space between the walls. In addition, the vacuum space between the walls can be filled, e.g. with perlite, to reduce any heat input. This minimizes the loss of insulation if the vacuum decreases. Nevertheless, the evaporation of liquid hydrogen shall be taken into account. The design of a pressure vessel for storage may be upright or horizontal. Mobile storage is also possible, using a tanker.

The pressure in the pressure vessel is usually measured inside the pressure vessel, at the top. The pressure vessel is filled from a tanker, using an offloading hose or a filling arm. This filling can take place by means of a difference in pressure or by a pump.

2 Gaseous hydrogen storage units

The gaseous hydrogen storage medium consists of pressure vessels with an operating pressure that may vary from 200 bar to 1 000 bar. For example, such a hydrogen storage unit has a volume of 1 000 l to 10 000 l (water capacity). Mobile storage is also possible.

Note:
Tube or cylinder trailers are examples of mobile storage units.

3 Intermediate storage

Intermediate storage can be used for various purposes, e.g. to shorten the time needed for filling up. This type of storage can also consist of several pressure vessels (tanks) that are interconnected by pipes. If the intermediate storage is empty, or if there is no intermediate storage, the road vehicle will be filled through the compressor. In general, the capacity of the compressor connected to an intermediate storage facility will be smaller than where there is no intermediate storage. The filling time then directly depends on the compressor´s capacity.

4 Evaporator

To produce gaseous hydrogen from liquid hydrogen, liquid hydrogen is gasified by means of an evaporator and then it is brought to the desired pressure using a compressor. Another option is to first bring the liquid hydrogen to the desired pressure using a pump and to then gasify it using an evaporator.

5 Emergency shutdown facility (ESD shut-off valve)

The installation components feature shut-off valves to lock down the installation components in the event of a disaster. These shut-off valves can have a dual function, firstly as a process shut-off valve and secondly as a safety shut-off valve. In addition there are manually operated shut-off valves for maintenance purposes.

6 Pump

The pump supplies liquid hydrogen to the evaporator.

7 Compressor

Filling a vehicle from a hydrogen delivery installation is done at a pressure of 350 bar or 700 bar. The delivery pressure depends on the specifications of the road vehicle that is being filled up. This delivery pressure is generated by a compressor. Hydrogen can also be compressed in stages, using several smaller compressors and possibly using intermediate storage.

8 Chiller

In order to quickly pump gaseous hydrogen into the road vehicle under the desired pressure, the hydrogen gas is cooled by a chiller. Temperature compensation is carried out using a temperature sensor immediately upstream of the delivery hose of the delivery hose, coupled to the chiller control system.

9 Dispenser

The dispenser features delivery hoses, start and stop buttons, any flow meter gauges and other components as relevant. A bypass can also be fitted in the dispenser to enable the piping to be pre-cooled before delivering hydrogen to the road vehicle.

10 Safety valve

A safety valve or fail safe spring is a valve that is opened or opens automatically as soon as the maximum pressure or temperature value is exceeded.

11 Delivery hose

The delivery hose shall be connected to the road vehicle by a nozzle valve. When the hose is disconnected, the nozzle valve shuts off the hydrogen gas flow. The delivery hose is fitted with a filler connection that can only be opened after connection to the road vehicle.

12 Offloading hose

A delivery tanker, tube or cylinder trailer from which the hydrogen storage unit is filled will have been provided with an offloading hose.

13 Tanker, tube or cylinder trailer

Fill/supply.

14 Purifier

The gaseous hydrogen that is supplied can contain impurities. A purifier can be used to clean the gaseous hydrogen to the required degree of purity. If gas is generated from a local liquid hydrogen storage unit, hydrogen gas with the required purity can be produced.

15 Pressure regulator

A pressure regulator is a control valve that regulates the pressure to a preset value.

16 Breakaway coupling

A breakaway coupling is a device that automatically interrupts the hydrogen flow in a situation where the road vehicle drives away with the delivery hose still connected.

17 Pressure build-up evaporator

A pressure build-up evaporator is often fitted to a liquid hydrogen storage unit. The evaporator converts liquid from the tank into hydrogen gas and then returns it to the hydrogen storage unit. This enables the pressure in the tank to be regulated. A pressure regulator automatically regulates the pressure in the hydrogen storage unit. An automatic valve, controlled by a pressure switch, can be used as an alternative.

LT level measurement

The level measurement in the liquid tank is usually based on measuring the pressure difference. Due to the slight pressure difference in horizontal tanks, calibrating the level measurement requires extra attention.

FT flow measurement

The objective of flow measurement is to determine how much hydrogen has been delivered and to activate an Emergency Shut Down Facility (ESD shut-off valve) to stop the delivery if the discharge rate is too high.

TT temperature measurement

The temperature measurement gives an indication that the gas temperature of the hydrogen in the dispenser is not being exceeded. Safe deactivation is ensured if the preset limit is exceeded. Safe deactivation can for example be ensured for an evaporator if the temperatures that occur are too low and in order to prevent liquid hydrogen causing damage downstream in the process.

2.2 Construction requirements for the hydrogen delivery installation

2.2.1 Introduction

This subclause describes requirements that apply to all three hydrogen supply methods (see Figures 2.1 to 2.4).

2.2.2 General description of the assembly

An assembly is the fitting together of several pieces of pressure equipment into an integrated and functional whole. The term ‘assembly’ has been taken from the Dutch Pressure Equipment (Commodities Act) Decree (Warenwetbesluit drukapparatuur).

Note:
Analogous with the Dutch Pressure Equipment (Commodities Act) Decree), an ‘assembly’ in the context of the Machine Directive consists of ‘machines’ and/or ‘incomplete machines’ joined together for a specific application. According to the Machine Directive, the assembly shall always bear a CE marking.

The term 'pressure system' comes from the Dutch Pressure Equipment (Commodities Act) Decree where it is defined as follows: A pressure system is a system of several pieces of pressure equipment or assemblies that are assembled into an integrated and functional whole under the responsibility of the manager on its industrial site. A hydrogen delivery installation is also considered to be a pressure system. This subclause contains regulations specifically for a hydrogen delivery installation and it includes various explanations that provide information about regulations from the Pressure Equipment (Commodities Act) Decree, that also apply to hydrogen delivery installations.

Note:
Pressure systems as referred to in the Dutch Pressure Equipment (Commodities Act) Decree do not bear a CE marking, while the separate components may bear a CE marking.

Pressure relief valves, vent channels and corresponding discharge pipes

reg. 2.2.1 Pressure relief valves and their discharge pipes shall be positioned in such a way that they can vent into the open air without being hindered.

The pressure relief valves must be easily accessible for maintenance and inspection.

Liquid or gaseous hydrogen shall be prevented from impinging onto the hydrogen storage unit and on adjoining plots or people.

Pressure relief valves or vent stacks shall be positioned in such a way that no moisture can accumulate (which might result in freezing).

reg. 2.2.2 All vent channels may be connected to a collective channel or exhaust specifically for that purpose if it is demonstrated that the individual vent channels continue to work.

Note:
Moisture accumulating at pressure relief valves can lead to incorrect functioning (due to freezing).

Data plate

Stating the statutorily required technical data, in keeping with the applicable guidelines, can result in a cluttered data plate on complex hydrogen delivery installations. The pressure-related elements of the data plate of the assembly or pressure system on this type of hydrogen delivery installation may refer to a summary document. This is often called a classification list. This list gives a summary of the pressure equipment that comprises the assembly or pressure system.

Note:
The contact details of the fabricator of the assembly, in accordance with the Machine Directive, as well as the year of manufacture and the series/ type number can be stated on the data plate besides the obligatory application of CE marking.

General design limits

reg. 2.2.3 Subjecting the parts and components used in the hydrogen delivery installation to loads exceeding their design limits is not allowed during normal operation.

In a situation where the design limits are exceeded, the hydrogen delivery installation shall be made safe automatically.

2.2.3 Spatial aspect of assembly

reg. 2.2.4 The necessary space to allow safe access to road vehicles, vehicles that supply hydrogen and emergency service vehicles shall be taken into account.

reg. 2.2.5 There shall also be sufficient room to enable systems and subsystems to be replaced.

reg. 2.2.6 When replacing systems or subsystems, it shall be heeded that safety devices, such as sensors, buttons, emergency pushbuttons, fire fighting equipment and escape routes are positioned in logical locations.

reg. 2.2.7 When replacing systems or subsystems, the parking space for vehicles that supply fuel (hydrogen) and for vehicles that come to take hydrogen gas shall be marked.

Preventing damage due to vibrations

reg. 2.2.8 Measures to prevent any harmful effects of vibrations shall have been taken at all relevant points of the hydrogen delivery installation.

Preventing subsidence

reg. 2.2.9 Any parts of the hydrogen delivery installation where there is a risk of subsidence shall have efficient foundations.

Protection against the effects of the weather

reg. 2.2.10 Any parts of the hydrogen delivery installation that are installed outdoors shall be efficiently protected against the effects of the weather.

reg. 2.2.11 The hydrogen delivery installation shall be fitted with lightning protection in accordance with the NEN-EN-IEC 62305 series.

Anti-collision protection

reg. 2.2.12 There must be sufficient room for (a) tanker(s), cylinder or tube trailer(s) to deliver the liquid or gaseous hydrogen. This also applies to a tanker, cylinder or tube trailer that is temporarily connected to the hydrogen delivery installation. This room comprises the access roads, exits and the room necessary to be able to manoeuvre and park the tanker, cylinder or tube trailer on the site.

reg. 2.2.13 Where necessary, the installation components shall be efficiently protected against collision.

Protecting the soil

The Dutch guideline on business operations and soil protection (Nederlandse richtlijn bodembescherming bedrijfsmatige activiteiten (NRB)) features combinations of facilities and measures that are applied to achieve a negligible risk to the soil.

2.2.4 Safety aspects

reg. 2.2.14 The dispenser shall be switched off automatically in an emergency. To ensure this, the hydrogen delivery installation shall have an emergency shutdown (ESD) facility (including an ESD shut-off valve).

The ESD facility ensures that:

- the delivery of hydrogen gas is stopped immediately by the automatic closure of the supply valve in the dispenser, and
- the compressor and the corresponding pipes to the dispenser are shut off.

reg. 2.2.15 All shut-off valves must have an open/closed position indicator.

The safety shut-off valves close within a maximum of 5 s after they stop being energised or after activation of the ESD facility.

reg. 2.2.16 The hydrogen delivery installation shall remain switched off if the protective devices have been in operation and the reason for this has not been rectified.

Protection against overpressure

reg. 2.2.17 The delivery pressure that occurs in the road vehicle's tank during supply must not exceed the pressure appropriate to the hydrogen storage tank in the road vehicle.

The filler coupling shall be constructed such that an excessively high delivery pressure is prevented.

Note:
See also: Draft Regulation on hydrogen and fuel cell vehicles, Economic Commission for Europe Inland Transport Committee (2014).

Note:
The Dutch Pressure Equipment (Commodities Act) Decree states that the installation

components in which gas pressure can occur that exceeds the design pressure of those components, shall be fitted with an overpressure protection with assured operation.

Safety aspects of hydrogen storage

The site where the hydrogen delivery installations are located may contain storage vessels for both liquid and gaseous hydrogen.

reg. 2.2.18 The manually operable shut-off valves and/or controlled shut-off valves installed in the supply pipe and on the connections of the hydrogen storage unit shall be fitted at as short a distance from the hydrogen storage unit as possible. This does not apply to pressure relief equipment and level measurement.

Note:
Safety shut-off valves or safety valves that close following a sensor signal are the subject of the safety-related control system. Further information can be found in the NEN-EN-IEC 61511 series. The design requirements and methods of verification/validation for a safety-related reliability level have been laid down in NEN-EN-ISO 13849-1 (Performance Level (PL) or NEN-EN 62061 (Safety Integrity Level (SIL). Safety-related reliability levels are indicated there.

2.2.5 Construction requirements for the base and the load-bearing structure

The following provisions apply to the foundation and the load-bearing structure.

reg. 2.2.19 The hydrogen delivery installation shall be positioned on a base that is made of non-flammable material.

Note:
When selecting the surface on which a liquid hydrogen tank is installed, the probability of condensed oxygen ending up on the base during the venting and/or filling process should be taken into account. Since there can be oxygen enriched air near this surface, it is possible that material which is considered to be non-flammable under normal circumstances can ignite and/or that metals can be affected severely. Further information on liquid oxygen can be found in PSG 9.

reg. 2.2.20 The load-bearing structure of the hydrogen storage unit shall continue to function for at least 60 minutes in the event of a fire, in accordance with R 60 (NEN-EN 1363-1).

Note:
The fire safety aspects of building products are classified by the letter R followed by a value (e.g. for steel structures). A value of R60 means that the resistance to fire at a temperature of 500 °C is 60 minutes.

2.2.6 Air entry at the compressor

Air entering at a compressor leads to a high-risk situation. Provisions how to prevent this are stated below.

reg. 2.2.21 The hydrogen delivery installation shall be constructed in such a way that air cannot penetrate hydrogen-carrying components. For this purpose, the compressor shall feature a device that cuts out the compressor as soon as the overpressure on the suction side drops to below the minimum supply pressure.

reg. 2.2.22 A device shall be fitted that ensures that hydrogen pressure between the inlet shut-off

valve and the suction side of the compressor is maintained which is higher than the atmospheric pressure during the start procedure, the stop procedure, under normal operating conditions and during the stand-by setup. The compressor shall be stopped automatically if the supply pressure is too low.

2.2.7 Safety and environmental aspects of compressors

The following aspects shall be taken into account when selecting a compressor.

reg. 2.2.23 Compressors shall comply with NEN-EN 1012-3: 2013.

The noise produced by the compressor may be a reason to implement noise-limiting measures.

2.2.8 Safety and environmental aspects of hydrogen purification

If necessary, the hydrogen gas is cleaned by a purifier on site.

Note:
The filter can be checked by means of fixed, regular operational inspection rounds or by inspection equipment.

Inspection equipment records an alarm value at a pressure that is lower than the maximum value specified by the filter supplier.

2.2.9 Dispenser

Dispenser and filler coupling

reg. 2.2.24 The connected filler coupling of the filling station shall allow potential equalisation between the road vehicle and the hydrogen delivery installation. This potential equalisation must take place as soon as the filler coupling is connected to the tank of the road vehicle. This potential equalisation shall also be assured continuously during the filling process.

reg. 2.2.25 The delivery hose shall be fitted with a filler connection that can only be opened after connecting the hose to the vehicle's tank.

When disconnecting the hose, the gas supply shall stop automatically and immediately or the connection shall be depressurised before the delivery hose can be disconnected.

reg. 2.2.26 The hydrogen delivery installation shall feature an independently operating mechanical or electronic system to protect against overpressure. This system shall ensure that the delivery pressure of hydrogen to the road vehicle does not exceed the temperature-corrected equivalent of 700 bar overpressure and 15 °C gas temperature in accordance with figure 2.5, or 350 bar overpressure and 15 °C gas temperature in accordance with figure 2.6. There shall be communication between the road vehicle and the dispenser, so that the maximum allowed temperature of the vehicle tank is not exceeded while delivering hydrogen.

The dispenser shall be fitted with a device that terminates the delivery when the maximum fill rate in the vehicle's tank has been reached.

When quickly filling a tank with gaseous hydrogen at a pressure of 700 bar, the temperature of the gaseous hydrogen will increase to high levels (see figure 2.5). This situation does not apply to a pressure of 350 bar.

reg. 2.2.27 When filling a road vehicle that is suitable for 700 bar, the maximum temperature of the hydrogen delivered must not exceed 85 °C.

Note:
The maximum allowed tank temperature is 85 °C.

Note:
The maximum admissible pressures differ; see the table in SAE J2601.

reg. 2.2.28 Electrical, electronic, mechanical, pneumatic, or hydraulically controlled protective systems shall be configured in accordance with NEN-EN-ISO 13849-1.
The protection class for electrical and electronic control systems shall be laid down in accordance with the requirements of NEN-EN-IEC 62061 or NEN-EN-ISO 13849-1 (and NEN-EN-ISO 13849-2. These standards prescribe that it shall be demonstrated that the components used and the design comply with this protection class.

Delivery hose and breakaway coupling

reg. 2.2.29 A delivery hose shall at least comply with the requirements contained in NEN-ISO 15500-17.

reg. 2.2.30 The delivery hose:

- must not be longer than 5 m;
- shall be suitable for transporting hydrogen;
- shall have a bursting pressure of at least three times the operating pressure;
- shall feature reliable, robust connections to the other parts of the installation;
- shall be featured with a printed label stating at least the following information:
  - the maximum permissible pressure;
  - the date of manufacture;
  - the producer's name or company logo;
  - the latest test date;
  - the flexible part of the hose shall feature a printed label that enables its properties and diameter to be derived.
- shall have a device that automatically interrupts the flow of hydrogen in a situation where a road vehicle drives off with the delivery hose still connected (breakaway coupling or breakaway device), see reg. 02/02/1931;
- if reinforced, shall be corrosion resistant;
- shall be made of a material that is resistant to hydrogen brittleness;
- shall be configured such that wear is prevented;
- shall be configured in such way that any coils or kinks in the delivery hose are prevented;
- shall be configured to prevent the delivery hose from lying on the ground or scraping over the ground as much as possible;
- can be returned, together with the filler connection, to a holder provided for that purpose which ensures that the filler connection and the delivery hose cannot be damaged.

Note:
In practice, 'roof mounted' delivery hoses can also be applied. In this case, the maximum hose length shall be 5 m from the breakaway coupling to the dispenser and the filler coupling.

reg. 2.2.31 The breakaway coupling shall comply with the following requirements:

- The electrical resistance between the parts of the breakaway coupling when coupled must not exceed 1 000 ohms.
- The tensile force necessary to activate the breakaway coupling may be a maximum of 500 N (50 kg), measured at the most unfavourable angle, and in all possible directions, at which this force can act on the filling hose. The minimum tensile force is 250 N (25 kg).
- The filling hose and the hose connections shall have a minimum tensile force in a longitudinal direction of at least three times the break force of the breakaway coupling.
- If the breakaway coupling has been broken, it may only be connected again by personnel nominated and instructed for this purpose.

Note:
The delivery hose (and vapour return hose) should comply with NEN-EN 12434 or NEN-EN 13766.

Accessibility for authorized personnel and others

Storage rooms or storage areas of the hydrogen delivery installation may not be accessible to unauthorised persons, except the dispenser(s) for delivering hydrogen to the customer/consumer.

reg. 2.2.32 The components of the hydrogen delivery installation that are not accessible to unauthorised persons shall be easily accessible to authorised personnel who carry out maintenance and/or inspection work.

reg. 2.2.33 The accessible components of the installation on the outdoor grounds shall be illuminated in accordance with the illumination values stated in NEN-EN 12464-2.

If the inspection or maintenance activities so require, the accessible components of the internal installation shall be illuminated according to the illumination values stated in NEN-EN 12464-1.

Housing

IP class can ensure efficient protection of internal electrical components against weather conditions, e.g. IP 66 according to NEN-EN 10529. Several dispensers can be placed in one housing.

Operation/display/pictograms

reg. 2.2.34 Every individual dispenser shall have its own start/stop button, emergency stop button (in accordance with NEN-EN-ISO 13850) and a .display.

Furthermore, the hydrogen installation has several emergency stop buttons where intervention is possible, such as at the filling point and other points of the installation.

Note:
The amount of hydrogen gas delivered, the cost price per kg and the total amount can be shown on the display.

reg. 2.2.35 The dispenser shall be marked with operating instructions.

These operating instructions are affixed in a permanent, clearly visible and legible way.

The operating instructions shall be given in a way that is understandable for the customer, with pictograms and/or text in at least Dutch.

Note:
Depending on the location in the Netherlands (e.g. in an area near the German or Belgian border), operating instructions in German or French may also be available.

reg. 2.2.36 The prohibitions and warnings are applied in a clearly visible and legible manner, on a sign on or near the hydrogen dispenser, and pictograms have been applied regarding:

- smoking prohibition: smoking is not allowed near the delivery device;
- prohibition of naked flames: there must not be any naked flames near the delivery device;
- prohibition of the use of electronic devices: electronic devices such as a mobile phone, PDA, radio, photo camera are not allowed;
- switching off the motor: when delivering hydrogen gas to the road vehicle, the road vehicle's motor must not be running.

Note:
Applying pictograms according to - for example - NEN-EN-ISO 7010, NEN-ISO 3864:series or NEN 3011 is recommended.

reg. 2.2.37 The emergency stop button(s) must be linked to the ESD shut-off valves, so that the shut-off valves are closed in their fail-safe position upon being activated. The installation must not be re-started by merely manually releasing the emergency stop.

2.2.10 Delivering hydrogen to the customer (consumer)

The hydrogen delivery installation shall be designed and constructed in such a way that the gas delivered to the vehicle does not exceed the temperature specifications stated in the graphs below for 350 bar and 700 bar. When hydrogen is being delivered to the vehicle, filling in the shaded ranges indicated in these figures is not permitted.

Figure 2.5 – Permitted filling range for 700 bar

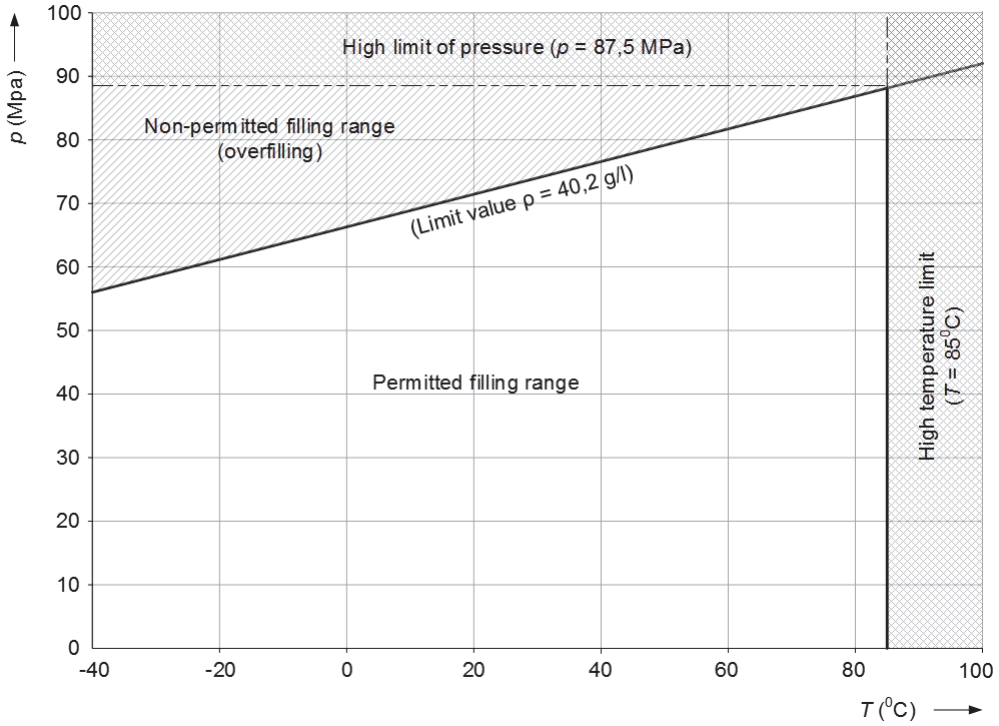
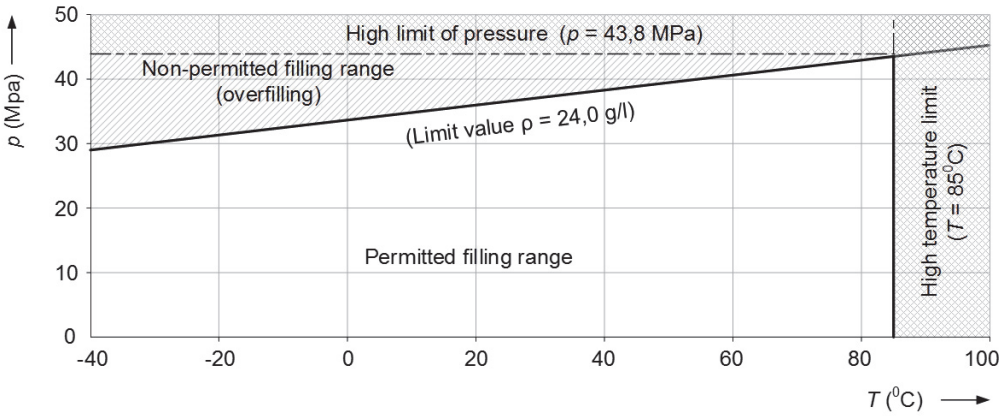


Figure 2.6 – Permitted filling range for 350 bar



The following facilities are required for delivering hydrogen.

Situation

reg. 2.2.38 The dispenser shall be located in a non-hazardous area as defined in NPR 7910-1.

reg. 2.2.39 When delivering hydrogen, the hydrogen delivery installation shall be fitted with the following facilities:

- a facility that releases the installation for use or that makes delivery possible only after the coupling to the road vehicle has been effected;
- a facility that records the delivery data, as described elsewhere in this PGS;
- a call button, emergency telephone or equivalent other device that enables calling, and communicating with, the manager, or a person appointed and instructed by the manager. This device shall be installed near the dispenser in a clearly visible place. The organisation of the reporting system shall be clearly and visibly determined by the manager;
- an emergency shutdown device shall be installed in the vicinity of the delivery installation and in a readily accessible place. This shall be taken into account when organizing the reporting system.

Lighting

reg. 2.2.40 The delivery device shall be illuminated during operation such that sufficient visibility is ensured.

Any artificial light used shall only be electric light. Any lights in a zoned area shall be of an explosion safe design.

Access doors or hatches

reg. 2.2.41 Access doors or hatches in the housing shall have special locks to prevent unauthorised access from outside.

If any people can be locked in, the door/hatch shall feature a panic lock that enables the door/hatch to be opened in all circumstances. Such doors shall feature signs stating ‘Emergency exit - keep clear’ in accordance with NEN 3011.

Note:
Emergency doors and hatches in the building, as well as various other components, such as sprinkler systems, concrete, steel and mastic sealant needed for the construction of this room, are covered by the Construction Products Regulation. This regulation sets both safety and environmental requirements on the building products. The Dutch Building Decree 2012 applies to the room/building (see annex C).

Facilities for switching off the installation

reg. 2.2.42 When the hydrogen delivery installation is switched off, the electronic control and protection system shall be switched in such a way that delivery of hydrogen is not possible.

However, the protection and alarm equipment shall continue to be ready for immediate use.

2.2.11 Hydrogen accumulation and ventilation

Preventing hydrogen from accumulating

reg. 2.2.43 Hydrogen shall be prevented from accumulating and forming an explosive mixture . The relevant methods are described in NPR 7910-1.

Dispenser in relationship to roof

reg. 2.2.44 The dispenser is installed in open air.

If a roof has been applied over a dispenser, it will be constructed such that hydrogen gas is prevented from accumulating under the roof.

Note:
Canopies at existing filling stations have been designed to offer protection against the weather, but they have not always been designed to prevent gas accumulating (e.g. under canopies or process components).

reg. 2.2.45 Any accumulation of gas that has leaked away shall be prevented.

The dispenser shall be fitted with two ventilation openings located opposite one another, both at the bottom and at the top of the dispenser. Their total passage must not be less than 50 cm^2.

The ventilation openings shall be constructed in such a way that they cannot easily be sealed.

When the tank fill level calculated by the maximum fill rate control is reached, the filling cycle will be ended automatically. This also occurs when the stop button is pressed (or the second time that the combined start/stop button is pressed).

reg. 2.2.46 A clearly recognisable emergency stop switch shall be installed in an easily accessible location at a distance of a maximum of 10 metres from a delivery device.

2.2.12 Detection and actions in the event of detection

Detection equipment and sensors

reg. 2.2.47 To signal any inadmissible hydrogen gas concentrations, the gas detectors shall be permanently active.

Note:
Depending on the design, other gases, such as carbon dioxide (CO_2) or nitrogen (N_2) can also be released. They can also lead to hazardous concentrations requiring detection.

reg. 2.2.48 Gas detection equipment shall be positioned in locations where the probability of a gas leak is the greatest, such as when disconnecting and connecting vehicles.

Note:
As a rule they are the locations where the probability of a gas leak is the greatest, such as couplings, dispenser, filling point, pump.

reg. 2.2.49 Continuous temperature measurements shall at least be carried out at those locations where high temperatures can be expected, e.g. due to burning hydrogen gas leaks or fire in the direct vicinity.

If temperatures of over 70°C are measured, the following action will have to be taken:

- automatic ESD activation;
- immediate discontinuation of the delivery of hydrogen;
- acoustic and optical signalling and automatic reporting to the establishment manager;

The manager or a person nominated and instructed for this purpose by the manager shall also be immediately alerted automatically.

Note:
Annex D contains further information about the flammability of hydrogen in the form of jet flames and micro-flames.

reg. 2.2.50 The detection equipment shall be set up in such a way that its functioning can be inspected easily.

This detection equipment shall be connected to the ESD device so that the shut-off valves, when activated, will be switched to their harmless positions at all times and a failure alarm is generated.

reg. 2.2.51 There shall be a scheme stating the locations of the detectors.

Note:
NEN-EN-IEC 60079-10-1 describes the locations where the probability of a gas leak is the greatest.

reg. 2.2.52 At least two gas detectors shall be present, one of which is near the dispenser and one is in the dispenser.

At 10% LEL, an automatic preliminary warning shall be sent to the manager of the installation.

At 20 % LEL, the emergency shutdown circuit (ESD facility) shall be activated.

reg. 2.2.53 There shall be at least two temperature detectors, i.e.:

- one near the dispenser;
- and one or more near the hydrogen storage unit.

Note:
The detection can, for example, activate a fan or close a main shut-off valve to prevent a concentration higher than the LEL occurring.
Passive detection, e.g. the paint layer on a pipe changing colour, can also indicate a leak. Such forms of detection can only work properly if routine inspections of these pipes are carried out.

Inspection

reg. 2.2.54 Instructions on how to act in the event of a possible leak shall be provided in the user information of the hydrogen delivery installation. Inspections of pipes for leaks and any action taken shall be recorded in a logbook.

2.2.13 Electrical aspects of the installation

Electrical devices

reg. 2.2.55 Every hydrogen delivery installation shall be fitted with a switch that enables the electrical installation of the hydrogen delivery installation to be switched off and electrically disconnected.

The electrical installation of the hydrogen delivery installation shall comply with the provisions stated in NEN-EN-IEC 60079-14 (in ATEX zones) or NEN-EN-IEC 60204-1.

Potential equalisation

reg. 2.2.56 The piping, the hydrogen storage unit, the pressure relief equipment and the vent stacks shall be earthed.

Electric and electronic equipment

reg. 2.2.57 In places where an explosion hazard may prevail, the general provisions for electrical equipment according to NEN-EN-IEC 60079-14 shall be respected.

Note:
Electric(al) and electronic equipment in a zoned area shall be of an explosion safe design. This equipment has an EC declaration of conformity and a regulation stating that the material used is suitable for use in rooms where there can be an explosion hazard.

reg. 2.2.58 The hydrogen storage unit and the other components of the hydrogen delivery installation shall feature a connection point for an equalisation conductor in accordance with NPR-IEC/TS 60079-32-1.

Components of the hydrogen delivery installation shall be fitted with potential equalisation to prevent static electricity or stray currents in accordance with NEN-EN-IEC 60079-14.

2.3 Construction requirements for supplying hydrogen through piping

The following requirements **specifically** apply to the supply of hydrogen through piping.

reg. 2.3.1 A device that fully disconnects the delivery installation from the piping shall have been installed upstream or downstream of the main shut-off valve.

This device shall be connected to the ESD circuit and it shall also allow manual shutting and locking.

The disconnection shall be controlled from the hydrogen delivery installation.

2.4 Construction requirements for supplying gaseous hydrogen

The following requirements **specifically** apply to the supply of gaseous hydrogen.

Filling point

reg. 2.4.1 Filling the hydrogen storage tank is not allowed before the connection has been made between the controls of the shut-off valves of the tube or cylinder trailer to be offloaded and the emergency shutdown device of the shut-off valves of the hydrogen storage unit. The remotely operable shut-off valve present in the filling line may only be opened during the filling process.

reg. 2.4.2 There must not be any barriers between the filling point and the cylinder or tube trailer that may hinder offloading.

The maximum hose length between the filling point and the connection to the cylinder or tube trailer is 5 m.

Vent stack

reg. 2.4.3 The outlet of the vent stack of gaseous hydrogen shall:

- have a diameter that is sufficient to enable the required volume to be vented at the maximum design pressure;
- be protected against rain entering it;
- feature an option enabling condensed water to be drained;
- have a vertical end on its outlet side that is constructed in such a way that it is long enough to prevent any influx of air;
- be fitted with proper lightning protection.

Note:
Requirements and guidelines on lightning protection can be found in the NEN-EN 62305 series and NPR 1014.

reg. 2.4.4 The vent outlet of hydrogen gas shall be designed such that:

- the heat radiation of the flare/vent stack onto neighbouring objects has been taken into account;
- the mouth of the vent stack is at least 3 m above ground level;
- the heat radiation at ground level is lower than 3 kW/m^2 within the establishment limit and lower than 1 kW/m^2 outside the establishment limit;
- the heat radiation intensity from a flare from the central vent stack on the gaseous hydrogen storage unit is less than 10 kW/$m^{2;}$
- the flare material can withstand the high temperatures at the exhaust.

Note:
Further information can be found in clause 5.

Safety aspects of chiller

To prevent the tank of the road vehicle from overheating during the filling process and because of this becoming overloaded, the gaseous hydrogen is pre-cooled by a chiller.
The temperature of the pre-cooled hydrogen gas should comply with SAE J2601.

reg. 2.4.5 The chiller shall feature a shut-off valve that shuts off the hydrogen gas flow if the temperature is outside of the permissible temperature range for filling.

Note:
Depending on the cooling capacity, a special cooling installation featuring special cooling gases can be used. The cooling gases used shall comply with the regulations and the installation shall be leak-tight so that no cooling liquid can escape. The cooling unit can be subject to the European directives and regulations, such as EC no. 842/2006.

Hydrogen storage

Gaseous hydrogen can be supplied by a tube or cylinder trailer that can also be used as a mobile storage unit on the grounds.

reg. 2.4.6 The following requirements are laid down for a gaseous hydrogen storage unit:

- the floor and the support structure of the storage unit or the intermediate storage shall be fire-resistant for 60 minutes according to NEN 6069;
- shall feature a safety device that prevents the pressure in the hydrogen storage unit from exceeding the design pressure of the hydrogen storage unit. This system shall function irrespective of the prevailing temperature;
- it shall feature emergency shut-off valves in the supply and discharge pipes;
- it shall feature a pressure gauge.

2.5 Construction requirements for supplying liquid hydrogen

The following requirements apply **specifically** to liquid hydrogen that has been supplied.

Filling point

reg. 2.5.1 There must not be any barriers between the filling point and the tanker that may hinder offloading.

The maximum hose length between the filling point and the connection to the tanker is 5 m. If the offloading hoses stay on the ground, they shall be stowed away such that no dirt can penetrate them.

reg. 2.5.2 Filling the liquid hydrogen storage tank is not allowed before the connection has been made between the controls of the shut-off valves of the tankers to be offloaded and the emergency shutdown device of the shut-off valves of the liquid hydrogen storage tank. The remotely operable shut-off valve present in the filling line may only be opened during the filling process (e.g. see annex F).

Vent stack

reg. 2.5.3 The outlet of the vent stack of liquid hydrogen shall:

- be positioned on or near the vent stack;
- have a diameter that is sufficient to enable the required volume to be vented at the maximum design pressure;
- be protected against rain entering it;
- feature an option enabling condensed water to be drained;
- have a vertical end on its outlet side that is constructed in such a way that it is long enough to prevent any influx of air;
- be fitted with proper earthing.

The contours of the installation, objects in the direct vicinity (such as buildings), the most regular wind directions and the expected wind speeds shall also be taken into account.

Note:
Further information about hydrogen can be found in Annex D.

Note:
While venting liquid hydrogen, the venting systems cools down, causing cold air to flow downwards. This air will also freeze and flow downwards. Here, the drops, resembling water, are frozen oxygen (further information can be found in Annex D).

Note:
Regulations about earthing can be found in the NEN-EN 62305 series and NPR 1014.

While venting, there is a risk that the liquid hydrogen will ignite, causing the vent stack to act like a flare.

reg. 2.5.4 The outlet of liquid hydrogen shall be designed in such a way that:

- the heat radiation from a flare from the central vent stack onto neighbouring objects has been taken into account;
- this source is at least 3 m above ground level;
- the heat radiation at ground level is lower than 3 kW/m^2 within the establishment limit and lower than 1 kW/m^2 outside the establishment limit in order to protect people;
- the heat radiation intensity from a flare from the central vent stack on the gaseous hydrogen storage unit is less than 10 kW/$m^{2;}$
- the heat radiation intensity from a flare on the liquid hydrogen storage unit is less than 35 kW/$m^{2';}$
- the material of the flare can withstand the high temperatures at the exhaust (and for liquid hydrogen it can also withstand low temperatures at the intake).

Evaporator safety aspects

Hydrogen storage units are often combined with evaporators to convert the liquid hydrogen into a gas.

reg. 2.5.5 The measures for the safe use of evaporators as prescribed by the fabricator shall be complied with when integrating them into the hydrogen delivery installation.

Note:
The requirements of the Pressure Equipment (Commodities Act) Decree) apply to such evaporators.

reg. 2.5.6 The pressure build-up evaporator shall be fitted with a pressure regulator that regulates the pressure in the hydrogen storage unit.

An automatic valve, controlled by a pressure switch, can also be used.

Hydrogen storage

reg. 2.5.7 The hydrogen storage unit shall feature a device to prevent liquid hydrogen that has expanded due to an increase in temperature from escaping through the fail safe spring.

Note:
The hydrogen storage unit can therefore be fitted with an 'economizer system' to ensure that no hydrogen gas is spilled. However, this system cannot be used to lower the pressure in the event of a fire.

The liquid hydrogen is evaporated in order to produce gaseous hydrogen.
Before the gaseous hydrogen is transferred to storage, a number of regulations shall be complied with.

reg. 2.5.8 Before the hydrogen gas is delivered to the hydrogen storage unit, its temperature shall be such that it does not exceed the design limits of the downstream installation.

Note:
Hydrogen gas of a lower temperature that is delivered to a hydrogen storage unit can weaken the material of installation components causing such material to fail.

Liquid hydrogen that is delivered by a tanker is stored below or above ground in a cryogenic storage vessel near the hydrogen delivery installation. This tanker can also be placed on the grounds as a mobile supply unit.

reg. 2.5.9 A liquid hydrogen storage unit shall feature:

- an installation with which the inner vessel can be emptied;
- a display showing the maximum filling capacity;
- a level gauge, which continuously and visibly indicates the filling capacity;
- a safety device that prevents the tank exceeding the maximum filling capacity;
- a pressure gauge, which has a measuring and indication range of at least the design pressure of the hydrogen storage unit;
- emergency shutdown facilities in the supply and discharge pipes.

reg. 2.5.10 If the vessel contains a vacuum space for the insulation:

- the vessel shall feature an inspection point that enables the current vacuum to be checked;
- the vessel shall have a connection option to evacuate the space;
- the vessel shall have a device that compensates the overpressure that occurs if there is no longer a vacuum.

reg. 2.5.11 Measures to avoid the negative consequences of expansion or shrinking shall be taken for all the relevant points of the installation, specifically pipes that carry liquid hydrogen.

Installation components that can be closed in shall have overpressure protection.

Note:
The expanding from liquid into gaseous hydrogen plays a role in the process. Further information can be found in annex D. An example of a device that compensates overpressure if there is no longer a vacuum is a sealing disk.

2.6 Safety aspects of the piping

Some of the piping of the hydrogen delivery installation is covered by the Dutch Pressure Equipment (Commodities Act) Decree. This paragraph also contains regulations that depend on the locations of the pipes: lying freely above ground, laid in a channel or dug into the ground.

Note:
The Dutch Pressure Equipment (Commodities Act) Decree does not apply to equipment in which the pressure is less than 0.5 bar. The Decree does not apply to pipes of a diameter < DN 25 either, irrespective of pressure. In such cases, article 3.3 of the European Pressure Equipment Directive (PED) refers to sound engineering practice. When carrying out a test or a reassessment, the notified inspection body (AKI) will also assess pipes and fittings.

The following rules also apply to pipes.

reg. 2.6.1 The pipes of a hydrogen delivery installation under high pressure shall preferably be laid above ground. If this is not possible, these pipes may be laid in a dry, preferably completely or partially open channel, or they may be laid below ground, provided they are protected.

Note:
The requirements for pipes included below apply both to above-ground and underground pipes.

reg. 2.6.2 The pipe materials used shall be suitable for hydrogen.

Note:
Some materials, such as cast iron, are not suitable for use as material for pipes. Minor leaks will lead to virtually invisible micro-flames. If there is a major leak in a pressure vessel or in a pipe, at a pressure of 700 bar, and fire breaks out, virtually invisible and powerful jet flames with a reach of more than 1 metre can occur.

reg. 2.6.3 Leak tightness shall be demonstrated by means of a helium leak test or using a gas mixture of hydrogen and nitrogen.

Note:
If an inert gas (e.g. nitrogen) is used for performing a leak test on cryogenic piping, there is a risk of the inert gas freezing. Such freezing can lead to the piping getting blocked and/or being exposed to additional mechanical strain.

Instructions for the supplier and installer of the piping

reg. 2.6.4 The instructions provided by the supplier of the piping and the connecting elements shall be observed.

To minimize the probability of leaks, the following requirements also apply:

- The piping shall be seamless and shall not let any hydrogen gas pass through.
- Pipe connections shall be welded where possible.

The welding procedures to be applied shall take into account the possibility of hydrogen brittleness and/or cracking occurring.

reg. 2.6.5 The piping and connecting elements shall be protected in such a way that mechanical or thermal damage is prevented.

Note:
Points for attention are protection against chemical, thermal/electrical (stray currents), radiation (UV, electromagnetic, or heat) and mechanical influences.

reg. 2.6.6 Pipes and bends shall be free from cracks, creases, swelling, coils, kinks and other defects.

The maximum out-of-roundness shall be less than 8 % of the nominal outer diameter of the pipe.

reg. 2.6.7 Any compression fittings used shall be suitable for the application in question. They shall also be hydrogen leak-tight.

Screw connections may only be used with special equipment where such connections are prescribed.

Note:
If there is a minor leak in the piping, any hydrogen that has escaped can lead to jet flames or micro-flames in the event of a fire, depending on the pressure and the mass flow. Such a (usually invisible) hydrogen fire can severely affect the local temperature (see annex D).

According to European Directive 92/58/EEC, pipes shall be marked subject to the minimum requirements that the product to be transported and the direction of flow are indicated in a clearly legible form (this Directive was incorporated into the Dutch Working Conditions Regulation (Arbeidsomstandighedenregeling)). Also reference is made to NEN 3050.

Further regulations for pipes in a dry channel

reg. 2.6.8 When using a dry channel it shall be demonstrated that this structure will not subside.

Note:
The calculation of the construction should be based on the results of a soil mechanics survey, see NEN 3680.

reg. 2.6.9 The piping in the channel shall be of one piece or of a welded design.

Note:
The piping may be of various insulation designs (for example cryogenic or vacuum insulation).

reg. 2.6.10 If the piping has been laid in a channel, the design and the installation of the channel shall be such that it is dry under normal climatological conditions.

Furthermore, the piping shall be designed such that no gas can accumulate in the channel or can move freely through the channel. The channel shall be easily accessible for visual inspection.

Further regulations for underground piping

reg. 2.6.11 No underground piping is allowed for the transport of liquid hydrogen.

The underground piping for transporting hydrogen gas shall be constructed in a protective pipe sleeve that is groundwater-tight. The ends of this pipe sleeve are open and rain-resistant.

Underground piping for transporting hydrogen gas shall be installed in sucha way that no material stresses can arise as a result of mounting, settlement or temperature differences.

Note:
For underground piping it is possible that freezing phenomena of the soil may have an effect on limiting the thermal shrinkage of the piping. This shall be taken into account in the design.

reg. 2.6.12 Underground piping (for transporting gaseous hydrogen) for hydrogen delivery installations shall be laid in a layer of clean sand at least 0.1 m thick laid all round. This sand shall be cleaned of stones and other hard objects.

Underground piping shall be buried sufficiently deeply to withstand the mechanical loads expected. The ground covering shall be at least 0.6 m.

The locations of such piping shall also be indicated aboveground and it shall be ensured that the local load caused by the soil itself and/or by any masses placed on it is not such that the piping is exposed to mechanical stresses.

Note:
Examples of masses that can be placed on underground pipes are cars or the struts of a mobile cranes.

Note:
The above regulation is complied with if the following measures have been taken: the underground piping is installed according to BRL K901. During filling of the piping trenches the external cladding shall be checked with an ammeter according to BRL K901.

Detection chamber of twin-walled underground piping

reg. 2.6.13 The detection chamber shall be checked for tightness. It shall be possible to provide written evidence of the correct adjustment for inspection.

reg. 2.6.14 The detection system shall be resistant to the hydrogen gas, and the accompanying pressure and temperature conditions.

3 The hydrogen delivery installation in operation

3.1 Introduction

A number of specific subjects relating to operational management are explained further in this clause. Additional regulations have been included for matters that are not laid down in legislation, but which are essential for safe operational management.

It is essential here that responsibilities prior to the hydrogen delivery installation being put into operation are laid down. As a rule the following people are stakeholders in a hydrogen delivery installation:

- the manager (the person who is responsible for the operation of the filling station and has an agreement with the user/owner, where the user can also be the manager);
- the user (pursuant to the Dutch Pressure Equipment (Commodities Act) Decree) is the person who will use the installation and shall comply with the licence and Dutch legislation);
- the installer;
- the owner (see user);
- the hydrogen supplier;
- the customer for the hydrogen is the customer who comes to fill up their vehicle tank with hydrogen (they are not the same person as the user).

Each of the stakeholders has their own responsibilities with respect to the operation of the hydrogen delivery installation. This is discussed in more detail in annex J. Furthermore, the following matters are relevant to safe operation:

- the management of the hydrogen delivery installation;
- execution of periodic inspections;
- supervision of the hydrogen delivery installation;
- filling the hydrogen storage unit (if applicable);
- carrying out work on the hydrogen delivery installation.

3.2 General regulations

The following general regulations apply:

reg. 3.2.1 The user of the establishment or a person appointed and instructed by the user of the establishment is responsible for the management of the entire hydrogen delivery installation.

reg. 3.2.2 If the establishment is not open for the delivery of hydrogen, all shut-off valves shall be in the safe position.

Note:
A shut-off valve can be fail-safe both when it is open or when it is closed, depending on the function of the shut-off valve.

3.3 Supplying hydrogen

3.3.1 Introduction

This paragraph addresses the supply of hydrogen (general), supply from local production or pipes, supply of gaseous hydrogen and supply of liquid hydrogen.

3.3.2 Supplying hydrogen, general

As described in 1.3, hydrogen can be supplied in several ways, i.e. in the form of:

- gaseous hydrogen through piping (regulations for the operational installation are described in 2.3.1);
- gaseous hydrogen through mobile units (regulations for the operational installation are described in 2.3.2);
  liquid hydrogen through mobile units (regulations for the operational installation are described in 2.3.3);

Note:
Local production is not covered by PGS 35. However, this PGS 35 does cover taking the safety distances into account and stopping such production in case an emergence situation occurs.

Note:
If liquid hydrogen is supplied using a tanker, intermediate storage may be used for various reasons, e.g. for logistic reasons.

3.3.3 Supply from local production or pipes

The requirements from 1.3 of this PGS apply from the supply pipe to the shut-off valve which forms the boundary of the hydrogen delivery installation.

reg. 3.3.1 The hydrogen delivery installation shall comply with the connection conditions of the gas supply company/the pipe network operator or any conditions derived from local production.

3.3.4 Supply of gaseous hydrogen

3.3.4.1 General

Two situations can be differentiated for hydrogen delivery installations where supply is in the form of gaseous hydrogen:

- mobile storage, see 3.3.4.2 (with the tractor unit driving off and the tube or cylinder trailer being left behind);
- intermediate storage that is restocked from a tube or cylinder trailer (with the trailer being emptied into the hydrogen delivery installation).

Note:
The requirements of the Pressure Equipment (Commodities Act) Decree) apply to intermediate storage.

reg. 3.3.2 Before the filling of the hydrogen storage tank is started, the operating staff shall assure themselves that the situation in the vicinity is sufficiently safe. While filling the hydrogen storage tank, the operating staff shall be able to operate the controls of the tube or cylinder trailer and check, from their location, that the maximum permissible filling capacity of the hydrogen storage tank is not exceeded.

3.3.4.2 Mobile storage units

The mobile storage unit shall comply with the ADR regulations, with the user being responsible. When offloading gaseous hydrogen, the offloading hoses are part of the installation, unless otherwise arranged. In addition, the ease of access of the reservoir and the filling point, and the accessibility of the parking space for the tube or cylinder trailer must be considered. The tube or cylinder trailer shall be able to reach and leave the offloading point without hindrance. These spatial aspects and the minimum distances to be observed from the tube or cylinder trailer to objects within the establishment are described in clause 5.

This PGS poses some additional safety requirements to those in the ADR, which are needed in the Dutch situation to enable hydrogen storage units to be filled safely.

Because a tube or cylinder trailer forms part of the establishment while loading or offloading hydrogen, some of these safety devices may be required on the basis of the license or general rules applicable to these establishments.

reg. 3.3.3 The offloading of hydrogen tube or cylinder trailers shall have been laid down in a procedure (e.g. see annex F).

reg. 3.3.4 The tube or cylinder trailer to be offloaded shall be parked in the direction of driving away so that in an emergency it can drive away to the public road without manoeuvring. This route shall be kept clear.

reg. 3.3.5 When hydrogen is being delivered to the hydrogen storage unit, the driver shall be present at the tube or cylinder trailer during the filling process to press the emergency stop button in the event of an emergency situation. To ensure this, the hydrogen delivery installation shall feature an emergency stop device that stops the hydrogen delivery as soon as the emergency stop button is pressed.

reg. 3.3.6 When the offloading hose is disconnected, any gaseous hydrogen released shall be discharged through a safe vent stack.

reg. 3.3.7 Tankers, tubes or cylinder trailers must not be offloaded at the same time as another tanker, tube or cylinder trailer with fuels or substances other than hydrogen is being offloaded within the same establishment, if such other tanker, tube or cylinder trailer is located within 25 m from the first tanker, tube or cylinder trailer.

reg. 3.3.8 The mechanical brake of the tanker, tube or cylinder trailer shall be applied during delivery to the hydrogen storage unit.

The engine of the tanker, tube or cylinder trailer may only be running if this is necessary for filling the hydrogen storage unit.

reg. 3.3.9 Filling the hydrogen storage tank is not allowed before the connection has been made between the controls of the shut-off valves of the tanker to be offloaded and the emergency shutdown device of the shut-off valves of the hydrogen storage tank.

The remotely operable shut-off valve present in the supply line may only be opened during the filling process.

3.3.5 Supplying liquid hydrogen

3.3.5.1 General

Filling the hydrogen storage tank is the activity with the greatest risk associated with hydrogen delivery installations. In this respect spatial aspects such as the location of the parking space for the tanker and the internal distances are very important. In addition there is also the ease of access of the reservoir, the filling point and the accessibility of the parking space for the hydrogen tanker. The hydrogen tanker shall be able to reach and leave the offloading point without hindrance. These spatial aspects and the minimum distances to be observed from the tanker to objects within the establishment are described in clause 5.

reg. 3.3.10 Before starting to fill the liquid hydrogen storage tank, the operating staff shall assure themselves that the situation in the vicinity is sufficiently safe. While filling the hydrogen storage tank with liquid hydrogen, the staff shall be able to operate the controls of the tanker and check from there that the maximum permissible filling capacity of the hydrogen storage tank is not exceeded.

Requirements for delivery by a hydrogen tanker

The safety requirements for a hydrogen tanker are laid down in the ADR.
This PGS however contains a few additional safety requirements that are necessary for the safe filling of the hydrogen storage tank of a hydrogen delivery installation. Because a hydrogen tanker forms part of the establishment while loading or offloading hydrogen, some of these safety devices may be required on the basis of the license or general rules applicable to these establishments. Where possible and relevant, regulations on this are included in this PGS with regard to:

- requirements relating to the offloading hose;
- a procedure for offloading from the hydrogen tanker (e.g. see annex F).

Two situations can be differentiated for hydrogen delivery installations that use liquid hydrogen as their source:

- mobile storage;
- intermediate storage that is restocked from a hydrogen tanker.

Note:
Tankers that are parked temporarily form a part of the installation, but the emergency stop for the tanker is not connected to the delivery installation.

reg. 3.3.11 It shall be clearly indicated at the filling point what the maximum filling capacity and the filling pressure of the hydrogen storage tank is.

reg. 3.3.12 The offloading of the hydrogen tanker shall have been laid down in a procedure (e.g. see annex F).

reg. 3.3.13 During the work for delivering the product and filling the liquid hydrogen storage tank, smoking, naked flames and the presence of other ignition sources are not permitted. A clearly visible prohibition sign shall be affixed. Inspection during the phase of use

Note:
Reference is made to NEN-EN-ISO 7010 and NEN 3011.

3.3.5.2 Filling the hydrogen storage unit

According to the ADR, it is essential that the hydrogen storage unit is filled exclusively by, and under the responsibility of, the driver of the hydrogen tanker, after the driver has been given the relevant permission by the manager responsible for the hydrogen delivery installation.

Note:
This does not mean that the responsible manager shall be present during offloading. In some cases night-time offloading, for example in case of applicable window times, is in fact desirable. There will not always be staff present at these times.

When offloading, a fixed procedure shall be followed. In addition to technical indications this procedure also includes conditions for the tanker driver, such as:

– while filling the hydrogen storage unit, the driver shall be able to operate the controls of the tanker and check that the maximum permissible filling capacity of the reservoir is not exceeded.

reg. 3.3.14 The maximum liquid volume in a hydrogen storage unit must not exceed 95% of the actual tank volume. The expansion of the liquid while filling shall be taken into account here.

Note:
If no measures are taken to ensure this, the maximum filling capacity shall be determined based on the ADR.

reg. 3.3.15 As soon as the maximum permissible filling level is reached, the filling shall be stopped automatically.

reg. 3.3.16 The procedure for filling a hydrogen storage unit at a hydrogen delivery installation for motor vehicles shall have been laid down. Annex F states the minimum actions that shall be carried out.

reg. 3.3.17 When disconnecting the offloading hose virtually no liquid or gaseous hydrogen may escape. Any liquid or gaseous hydrogen that has escaped shall be safely removed.

Note:
The testing of the offloading hoses and coupling has been regulated in the ADR.

reg. 3.3.18 The liquid line intended for filling the hydrogen storage unit shall be fitted with one or more shut-off valves at the hydrogen filling point. This/these shut-off valve(s) shall be properly supported and must not be operated by unauthorised persons.

reg. 3.3.19 The engine of the tanker, tube or cylinder trailer must not be running while connecting and disconnecting the offloading hose required for the filling.

reg. 3.3.20 The mechanical brake of the tanker, tube or cylinder trailer shall be applied during delivery to the hydrogen storage unit.

reg. 3.3.21 Filling the hydrogen storage unit is not allowed before the connection between the controls of the shut-off valves of the tanker to be offloaded and the emergency shutdown device of the shut-off valves of the hydrogen storage unit has been made. It is only permitted to open the remotely operable shut-off valve present in the supply line during the filling process.

3.4 Delivering hydrogen

3.4.1 Regulations for delivery to motor vehicles

General

reg. 3.4.1 When delivering to a road vehicle, the road vehicle's motor must not be running, and it must not be switched on before the delivery hose has been disconnected.

3.4.2 Regulations for supervision at hydrogen delivery installations and dispensers

The Working Conditions Act states that employees aged under 18 may only carry out hazardous work under expert supervision. The supervision of the delivery of hydrogen may therefore only be carried out by persons aged 18 years and older.

reg. 3.4.2 If the hydrogen gas delivered does not comply with the preconditions for temperature and pressure, the delivery to the hydrogen delivery installation shall be stopped automatically, in accordance with SAE J2601.

reg. 3.4.3 Only the establishment manager or a person appointed and instructed by the establishment manager may start up the hydrogen delivery installation and remove the lock after the protection system has been started up.

3.5 Working activities on the hydrogen delivery installation

3.5.1 Regulations applicable while working on the hydrogen delivery installation

reg. 3.5.1 To avoid any deforming of and damage to the material, safety measures shall be laid down in procedures.

Note:
Damage can be caused by, e.g., pressure surges or thermal shock.

reg. 3.5.2 When carrying out work on a hydrogen delivery installation on the site of use, the checklist from Annex G, or a similar document, shall be filled in. The checklist or a similar document shall be available to be shown during the work. Any resulting measures, to be taken in advance or afterwards, to promote safety shall be taken.

Information on the work carried out and on any faults shall also be included in the log book.

Note:
A example of a document similar to the checklist in annex G would be a Task Risk Analysis (TRA).

Note:
Filling in a checklist is in any case important when carrying out work such as filling an empty hydrogen delivery installation and removing all gas, replacing pumps/shut-off valves or replacing the safety vent stack. However, it is also possible that hydrogen is released while other work is carried out on the hydrogen delivery installation; this checklist can then be used. The purpose of this checklist is to ensure a safe situation while work is being carried out during which hydrogen may be released. This checklist does not contain any technical information on the work carried out. For this reason it is not necessary to keep the checklists in the installation log book.

reg. 3.5.3 A specific safety procedure shall be drawn up for:

- filling an empty hydrogen delivery installation;
- purging a hydrogen delivery installation;
- replacing a pump in a hydrogen storage unit;
- placing, relocating or removing a hydrogen storage unit.

3.5.2 Work on the hydrogen storage unit

reg. 3.5.4 Prior to the work the installer assesses whether the hydrogen storage unit shall be made completely inert and free from gas, shall only be depressurised or whether the work can be carried out with a hydrogen storage unit under pressure.

Note:
A hydrogen storage unit should only be depressurised and made free from gas when maintenance or repair work is being carried out on the hydrogen storage unit itself or on the pipework and shut-off valves and components that are connected directly to the hydrogen storage unit.

Inspection and testing of larger hydrogen storage units should be carried out on-site. The first filling after installation should also be carried out on-site, as should maintenance and degassing prior to carrying out maintenance.

A liquid hydrogen storage unit may only be removed or moved when all the liquid has been removed from the reservoir. This shall be carried out on the installation site by a company specialising in this. Since the way in which working activities on the hydrogen storage unit shall be carried out safely is not embodied in legislation, regulations for this are included in the following paragraph.

3.6 Monitoring the hydrogen delivery installation

If process disruptions occur, intervention may be necessary for example to prevent the installation emitting (venting) hydrogen gas to the atmosphere for an unnecessarily long time. The failure of various process components to function (for example the delivery pump) may also be caused by process conditions and not simply by the mechanical failure of the process component.

reg. 3.6.1 Every hydrogen delivery installation shall have a system with which disruptions can be notified through an alarm or notification system to a manager.

reg. 3.6.2 A manager (or a person nominated and instructed by the manager) shall be nominated for every station. The manager or person in question shall have the required competencies to be able to interpret and possibly to rectify any malfunctions that can occur while the hydrogen delivery installation is in operation. Monitoring may be done locally or remotely.

reg. 3.6.3 Only the manager (or a person appointed and instructed by the manager) may restart the delivery device after checking it.

reg. 3.6.4 The level of knowledge required for the manager is at least Dutch VAPRO A (crebo level 2) or an equivalent level of knowledge demonstrated by internal training.

Note:
A diploma or any other proof of an employee's level of knowledge can be included or recorded in the personnel file.

4 Testing, maintenance, inspection, registration, documentation and enforcement

4.1 Introduction

This clause describes the requirements on testing, maintenance and inspection of hydrogen delivery installations [i.e. pressure equipment according to the Pressure Equipment (Commodities Act) Decree]. It also contains the requirements relating to the registration, documentation and enforcement of these aspects.

Not all aspects important for safety relating to maintenance and inspection of a hydrogen delivery installation are set down in legislation. For this reason this PGS contains additional regulations. This clause includes the additional regulations for mandatory testing, maintenance and inspections that are carried out by external parties.

The European Pressure Equipment Directive 97/23/EC (PED) regulates only the assessment of the new build phase and inspection of the assembly of stationary pressure equipment. Inspection before putting into service (keuring voor ingebruikneming – KvI) and re-testing are regulated at national level in the Pressure Equipment (Commodities Act) Decree. This aims as far as possible to comply with the European Directive. Testing during the new-build phase shall be carried out by notified bodies (NOBO). Testing during the usage phase shall be carried out by the relevant notified inspection body (aangewezen keuringsinstelling - AKI), or authorised user inspectorate (keuringsdienst van gebruikers – KVG).

Mixtures of hydrogen gas with air can form an explosive atmosphere that can be ignited by heat sources e.g. sparks and so on. A hydrogen delivery installation and its direct vicinity shall for this reason comply with requirements relating to explosion safety. ATEX 95[2] and clause 3 on Equipment of Workplaces of the Working Conditions Decree are relevant in this regard. This is the Dutch implementation of ATEX 137.

ATEX 95 relates to technical integrity and contains target regulations for equipment and protective systems that are used in potentially explosive atmospheres. The requirements are primarily important for fabricators and importers of explosion-safe equipment. In the Netherlands ATEX 95 is transposed in the Explosion-safe equipment (Commodities Act) Decree (*Warenwetbesluit explosieveilig materieel*); this is explained in more detail in annex H.

ATEX 137 was implemented in the Netherlands in section 2a *Explosive atmospheres* that are part of clause 3 on *Equipment of Workplaces* of the Working Conditions Decree. Section 2a of the Working Conditions Decree describes how to work safely in an environment where there is an explosion hazard. Among other things this includes the following obligations for employers:

[2] 2014/68/EU (PED, European implementation before 19 July 2016) and 2014/34/EU (ATEX 95, European implementation on 20 April 2016).

- the assessment of explosion risks (risk inventory and evaluation);
- the classification of areas where explosive atmospheres may occur in hazard zones;
- the taking of both technical and organisational measures in hazard zones;
- informing employees and
- recording the above in an explosion safety document.

Rules for drawing up an explosion safety document and how an employer shall handle explosion safety can be found in the section *Safe working in case of an explosion hazard*, see http://www.arboportaal.nl/onderwerpen/veilig-werken/inrichting-werkvloer/explosieve-atmosfeer.html.

4.2 Testing

4.2.1 Introduction

An assembly shall comply with Articles 12 and 12a of the Pressure Equipment (Commodities Act) Decree which means that the assessments and testing that shall be carried out on an assembly (checking against the essential safety requirements) also apply to a pressure system.

Note:
Assessments and testing should be carried out by the NOBO, AKI or KVG.

After assessing the conformity of the installation, consideration is given to whether the total assembly or the separate pieces of pressure equipment (subassemblies/lines) shall undergo an testing before being put into service (KvI).

Note:
Testing covers new build, testing before putting into service and testing during the phase of use (periodic reassessment, interim inspections, modifications and repairs). The user and/or the fabricator is responsible for all these testing.

4.2.2 New build

The assembly of all the components of a hydrogen delivery installation shall be approved by a notified body (NOBO) according to the Pressure Equipment (Commodities Act) Decree. All the components shall comply with the European Pressure Equipment Directive and on this basis shall bear a CE marking with the NOBO number of the NOBO that has carried out monitoring.

The assessment of the assembly into an installation is described in PRD Section 2-1 and is carried out by considering seven steps, namely:

1. Basic design of the installation.
2. Basic design of the assembly.
3. Determination of design conditions for each piece of pressure equipment.
4. Design of the pressure equipment.
5. Fabrication and final inspection of the pressure equipment.
6. Detailed design of the assembly.
7. Fabrication and final inspection of the assembly.
8. Handing over of the assembly for testing before putting into service (*KvI*).

4.2.3 Testing before putting into service

When putting the installation into service, the fabricator shall take the following into account:

- Pressure Equipment (Commodities Act) Decree (*Warenwetbesluit drukapparatuur – Wbda*);
- Explosion-safe equipment Commodities Act (*Warenwet explosieveilig materieel* - ATEX 95);
- Working Conditions Decree (*Arbeidsomstandighedenbesluit* - ATEX 137).

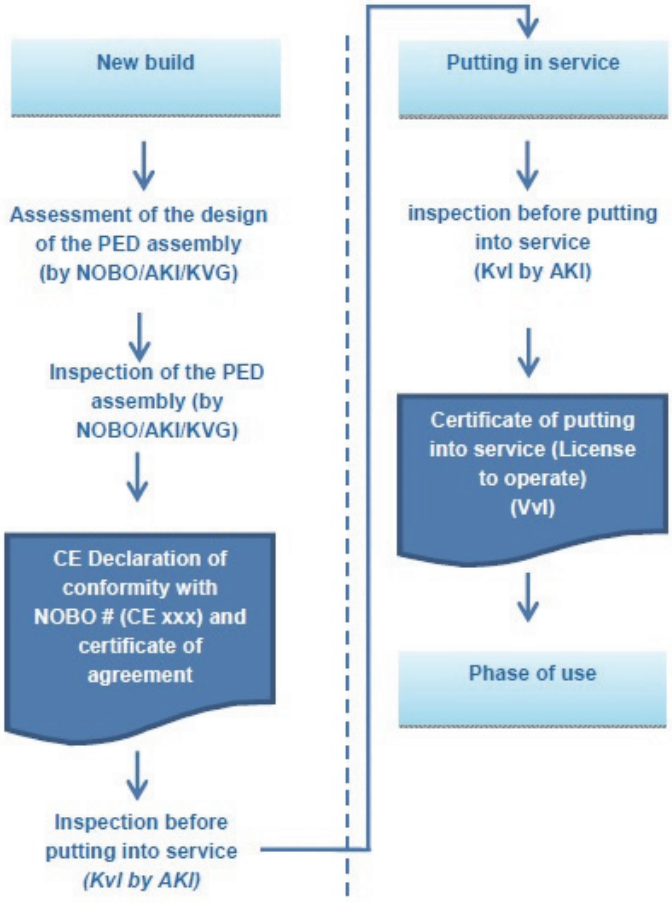
4.2.3.1 Pressure Equipment (Commodities Act) Decree (*Warenwetbesluit drukapparatuur – Wbda*)

Before a new hydrogen delivery installation is put into service, it shall be inspected according to the Pressure Equipment (Commodities Act) Decree by an AKI authorised to do so. The testing before putting into service (*Kvl*) shall be carried out according to PRD Section 2-2 and includes the following verifications and checks:

- verification of the pressure equipment in the light of the instructions for use, manufacturing book and markings;
- checking the external condition of the pressure equipment;
- checking the operation of the safety accessories and pressurised accessories; checking the set-up of the pressure equipment.

Upon approval a certificate of taking into service (*verklaring van ingebruikneming - Vvl*) is issued.

Figure 4.1 – Testing documents for new build and putting into service



As stated above in this PGS, the Pressure Equipment (Commodities Act) Decree does not apply to equipment in which the pressure is less than or equal to 0.5 bar positive pressure with respect to atmospheric pressure. For pressure equipment which does not fall under PED, the duty of care according to the Working Conditions Decree applies. The user is responsible for this.

4.2.3.2 Explosion-safe equipment Commodities Act (*Warenwet explosieveilig materieel* - ATEX 95)

It is preferable to install the hydrogen delivery installation in the open air.

Note:
Requirements placed on all electrical equipment used in a zoned area have been included in ATEX 95 according to product specifications and European Directives. The zones are described in NPR 7910-1. The fabricator shall include this in the declaration of conformity.

If parts of the hydrogen delivery installation are located in places where no open air conditions prevail, the zoning as indicated in NPR 7910-1 applies, see also regulations in clause 5.

4.2.3.3 Working Conditions Decree (*Arbeidsomstandighedenbesluit* - ATEX 137)

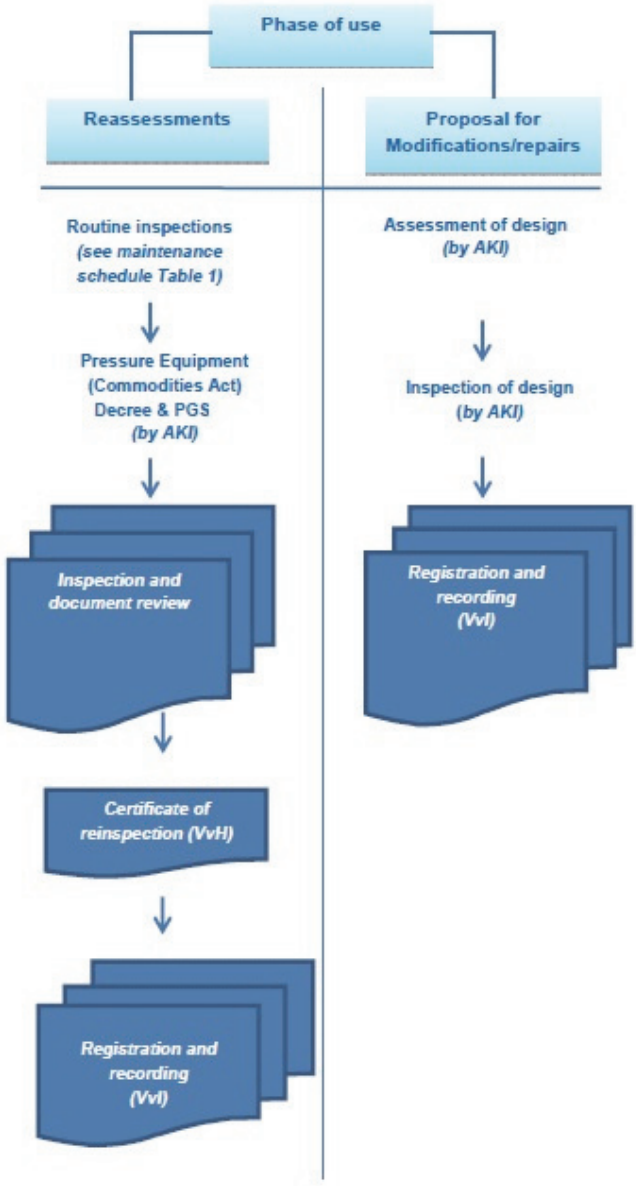
Note:
The Working Conditions Decree requires an explosion safety document to be drawn up.

4.2.4 Testing during a phase of use

Testing during a phase of use (see also figure 4.2) covers:

- periodic reassessment;
- routine inspections;
- modifications and repairs.

Figure 4.2 – Testing documents for the phase of use



4.2.4.1 Periodic reassessment

The Pressure Equipment (Commodities Act) Decree also includes requirements for the phase of use, including requirements relating to periodic retesting and reassessment. Reassessment of installations is carried out by the AKI or KVG, based on the requirements in this PGS and the Pressure Equipment (Commodities Act) Decree according to PRD Section 2-3.

4.2.4.2 Repairs and modifications

Note:
The requirements relating to repairs and modifications are set out in Article 14 of the Pressure Equipment (Commodities Act) Decree (see PRD Section 2-5).

Note:
AKI or KVG provides regulations for carrying out the assessment and inspection of installations, such as hydrogen delivery installations.

4.2.4.3 Periodic inspections

Routine inspection, maintenance and overhaul of hydrogen delivery installations is reserved only for expert and competent staff. Requirements regarding expertise and competence of staff are included in the authorisation regulations drawn up for this or are at the discretion of the AKI. Maintenance shall also be carried out in accordance with the fabricator's instructions.

Annex M provides an informative list of testing periods and also includes a practical maintenance schedule.

4.3 Acceptance regulations for installers

Note:
The installation of pressure equipment that is within the scope of the Pressure Equipment (Commodities Act) Decree may only be carried out by approved installers, see annex D of NPR 2578.

4.4 Maintenance and registration

4.4.1 Maintenance and inspection

The whole installation shall always be in a good state of maintenance and the installation is the responsibility of the user (duty of care).

On starting work on the hydrogen delivery installation the required safety measures shall be set down by the user in writing (work permit).

Additional requirements to the Pressure Equipment (Commodities Act) Decree relate to:

- the delivery hose;
- the fire extinguishers;
- the high-level alert for the liquid level;
- the overfilling protection devices (independent of the high level alarm).

The user takes care of the maintenance, checking and inspection of the hydrogen delivery installation.

reg. 4.4.1 Maintenance shall be carried out by an installer whose level of knowledge is at least Dutch VAPRO A (crebo level 2) or an equivalent level of knowledge demonstrated by internal training.

Note:
As there are no acceptance regulations for installers for hydrogen available yet, NPR 2578 can be used until there are such acceptance regulations.

reg. 4.4.2 The hydrogen delivery installation shall be taken into/out of service according to the instructions of the supplier/fabricator of the hydrogen delivery installation in the operating instructions.

4.4.2 Registration

4.4.2.1 General

A hydrogen delivery installation is supplied with an installation book.

4.4.2.2 Installation book

reg. 4.4.3 Every hydrogen delivery installation is supplied with an installation book that contains at least the following basic information:

- description of the installation (process and installation diagrams);
- operating instructions;
- log book.

These documents may also form part of or be included in a central computerised information system.

reg. 4.4.4 The operating instructions together with the description of the hydrogen delivery installation shall provide information on the way the hydrogen storage unit is installed, the location of the hydrogen piping, the place, function and operation of the accessories included in the installation and the method of operation.

reg. 4.4.5 The installation book also contains a log book, which among other things includes information on work, maintenance, testing and inspections carried out and any malfunctions and irregularities.

reg. 4.4.6 The current situation of the installation shall be set out in the installation book. Certificates, measurement and test reports and other records shall be present, such as:

- the certificate of putting into service (*Vvl*), reports of the AKI or KVG of the periodic testing, repairs and modifications;
- any installation certificates for modifications or repair work;
- any additional certificates, for example for a leak detection system or application of internal cladding;
- the two-yearly certification of the inspection of fire extinguishers (for fire extinguisher present);
- any report(s) of retesting; any report of tightness test(s);
- a report of the two-yearly check on the operation of the temperature detection system in the delivery installation;
- a drawing on which the location of the tank(s), piping and accessories is indicated;
- any modifications shall be directly updated on this drawing and dated;
- a hydrogen safety information sheet;
- a copy shall be included in the installation book of all testing, inspections and checks that are applicable;
- all reports relating to inspections, testing and checks indicating date and results. If

these reports are filed at a central point, the report numbers and their date shall be indicated in the installation book. This indication shall bear the signature of the person who has carried out the inspections;
- a plan drawing indicating the installation and the corresponding hazard zones;
- official documents (or a copy of these), including:
  - certificates of materials, components and accessories used;
  - declaration of verification of the installation;
  - licenses;
  - an emergency plan;
- particulars:
  - deviation from the normal operation laid down in the operating manual;
  - hazardous situations that have occurred;
- other particulars.

4.4.3 Storage periods

(Re)testing data shall be stored, such that the full period between (re)testing is covered. After this a new interval begins with the result of the last retesting as starting document. The inspection body notes all special events such as testing and repairs on the installation on the notes page accompanying the certificate of taking into service. The notes page remains present in the installation as long as the installation is in use or is ready for use. As a result the history of the installation can always be checked.

4.5 Enforcement

Enforcement based on the Pressure Equipment (Commodities Act) Decree requires the following documents:

- valid *VvI*;
- certificate of retesting with validity date;
- modifications to AKI reports relating to repairs and modifications.

The following documents shall be present at the hydrogen delivery station for the licensor:

- valid *VvI* or certificate of retesting according to WBDA;
- documents relating to periodic maintenance;
- incident report;
- installation book (log book).

5 Safety measures

5.1 Introduction

This clause features additional safety measures that apply besides the general safety and general installation requirements which have already been described in the previous clauses of this PGS publication.

This clause features the requirements placed on:

- internal safety distances;
- the electrical installation (and preventing and reducing the risk of fire and explosion);
- other aspects.

5.1.1 General

reg. 5.1.1 The general layout of installations for the storage and delivery of hydrogen shall be as clear as possible, both from the point of view of unhindered access and exit for customers and suppliers (annex H) of liquid or gaseous hydrogen, and from the point of view of safety. Attention shall be paid to:

- good overview of the installation for the operating staff both from the operating building (if applicable) and from the hydrogen delivery installations;
- clear arrangement of access roads, exits and site surfacing with a view to collision hazard;
- accessibility to the installation in case of fighting any fire;
- evacuation facilities in case of incidents.

5.2 Internal safety distances

reg. 5.2.1 The internal safety distances to be complied with shall be determined using radiation calculations.

5.3 Fire

For an extensive description of the hazard characteristics of hydrogen, is referred to Annex D.

Hydrogen has an almost invisible flame and this seriously hinders effective fighting of a hydrogen fire.

A hydrogen fire can also be accompanied by a very narrow flame (e.g. a vertical flame can be approached from the side).

Extinguishing a hydrogen fire may be undesirable as after extinguishing an explosive gas cloud may occur that may ignite again, with all that this entails.

This does not however take away the fact that the presence of an extinguishing water supply is necessary for example to extinguish a vehicle fire or a fire in the filling station shop (if present) or to cool the objects on which the fire has radiated.

Note:
Furthermore, subjecting a hydrogen fire to a curtain of extinguishing water is an ideal way to make the flame visible (it will turn orange under a water curtain). Articles 6.27 and 6.30 of the Dutch Building Decree 2012 describe the requirement that a building shall have a sufficient extinguishing water facility. Since a hydrogen delivery station is a building, a sufficient extinguishing water supply shall be determined in agreement with the competent authority and depending on the situation.

6 Incidents and disasters

6.1 Introduction

This clause covers regulations to limit incidents and disasters. The Working Conditions Act and regulations serve to protect employees, enabling them to work safely and without jeopardising their good health. As part of this, the employer shall ensure that effective measures are taken as regards first aid, fighting fires and evacuating any employees and other people present, and that effective communications are maintained with the external emergency services. To this effect, the Act features provisions on in-company emergency response and first aid in the event of accidents. The measures in the event of an emergency shall be described in the emergency plan. The following and other scenarios can occur.

6.1.1 Hydrogen fire

It does not take much for hydrogen gas to ignite. Depending on where the leak is located and how extensive it is, very small flames or large flare fires can occur. The flame is colourless but it can be made visible by means of a thermal imaging camera or a jet of atomized water. The jet of atomized water will cause the flame to turn orange. Putting out a gas fire can lead to the undesirable situation of a flammable gas cloud occurring.

6.1.2 A hydrogen gas cloud escaping

Hydrogen gas is colourless and odourless. The escaping gas can be detected near the leak using a thermal imaging camera or stationary gas detection. Any liquid hydrogen that leaks out will evaporate almost immediately.

6.1.3 Fire in the vicinity

reg. 6.1.1 A fire can occur in the vicinity of the hydrogen installation. Firefighting equipment shall be present in order to put out this fire and eliminate any risks for the installation.

Note:
Articles 6.27 and 6.30 of the Building Decree 2012 describe the requirement that a building shall have a sufficient extinguishing water supply.

6.2 Instructions for the manager

6.2.1 Action in case of incidents and disasters

reg. 6.2.1 Attempts shall be made to get any leaks or fire that occur under control as soon as possible. As part of this, an emergency stop device is activated. If necessary, help shall be offered to any people inside the establishment and any people living in the direct vicinity. This can be done by following an emergency plan which shall be drawn up in consultation with the competent authorities. Emergency instructions (arising from the emergency plan) shall be present at the hydrogen delivery installation. Annex I includes an example of emergency instructions.

Note:
These instructions should include the names and telephone numbers of authorities and people who shall be contacted in case of disasters as well as the address of the location.

reg. 6.2.2 Where filling stations are not manned, the manager/user shall ensure the 24/7 availability of the bodies and people identified in the emergency plan.

reg. 6.2.3 The following action shall in any case be taken in case of an incident and/or disaster:

- activate the emergency shutdown device(s) present to stop any loading and lock down the installation;
- notify the emergency services and the user/manager of the hydrogen delivery installation.

reg. 6.2.4 The above actions shall at least be carried out if any of the following incidents and/or disasters occur: fire, leak of hydrogen or another substance (cooling water, refrigerant).

Every fire, hydrogen or other leak (cooling water, refrigerant) shall be notified immediately to the fire service.

reg. 6.2.5
- A fire extinguisher shall be suitable for fire classes B and C according to NEN-EN 2 and also meet the requirements included in NEN-EN 3. The characteristics, performance requirements and test methods for the fire extinguisher are based on NEN-EN 3-7, which shows that it is suitable for fighting fire classes B and C. Fire extinguishers shall have an extinguishing capacity of at least 43A / 233B according to NEN-EN 3-7.
- Fire extinguishers shall be protected from and/or resistant to the effects of the weather.

6.2.2 Emergency plan

In accordance with the occupational health and safety regulations, an emergency plan shall have been drawn up and this shall be present in the establishment.

reg. 6.2.6 An emergency plan shall be kept in a place made known to the staff, which is directly accessible to them without hindrance.

reg. 6.2.7 Personnel working within the establishment shall be informed of the content of the emergency plan and shall be familiar with the use of the available equipment, so that in case of disaster the staff is able to take as effective action as possible.

reg. 6.2.8 The emergency plan shall not be confined to the measures for the scenarios described in 6.1., but it shall also include measures for such events as a collision occurring, the breakaway coupling being activated etc.

6.2.3 Regulations for the operation of hydrogen delivery installations and automatic dispensers

reg. 6.2.9 The installation is switched off and locked automatically as soon as the ESD shut-off device is activated or the automatically operating protective devices, such as the temperature-sensitive elements/gas detection, are triggered.

The manager of the establishment or a person nominated and instructed by the manager of the establishment shall be alerted automatically as soon as the ESD-shut-off valve is activated.

Annexes

Annex A Terms and definitions

350 bar (delivery pressure)
filling a vehicle from a hydrogen delivery installation is done at a temperature-corrected equivalent of 350 bar positive pressure and 288 K

700 bar (delivery pressure)
filling a vehicle from a hydrogen delivery installation is done at a temperature-corrected equivalent of 700 bar positive pressure and 288 K

Note:
For further information is referred to the figures in 2.2.10.

Notified inspection body (AKI)
body authorised by the Minister of Social Affairs and Employment (SZW) that may carry out (re)testing work and/or assessments under the Pressure Equipment Decree

Blow-off line
pipe through which hydrogen can be safely evacuated to the atmosphere

Blow-off safety device
device that prevents the pressure limit value being exceeded by blowing off gas

Delivery hose
flexible hose, including the couplings and the filler connection that forms part of the delivery installation with which liquid or gaseous hydrogen is delivered to the hydrogen storage tank or the vehicle tank

Dispenser
assembly of components through which the hydrogen gas is dispensed to the road vehicle, beginning at the end of the pipe(s) counting from the compressor and/or intermediate storage

Delivery pressure
pressure in the hydrogen delivery installation measured on the discharge side of the delivery installation

Shut-off valve
mechanism to regulate the flow of a medium (gas, solid, slurry, or liquid), by partly or fully opening or closing one or more flow openings; there are manually operated and remotely controlled shut-off valves

Note
The remotely controlled shut-off valves may have a function both for the operation of the installation and also the function of a safety shut-off valve.

Manager
the person who is responsible for the operation of the hydrogen delivery installation and has an agreement with the user/owner; the user may also be the manager

Assessment
assessing the design against the regulations such as MID, EMC, MD, PED, WBD, ATEX, PGS 35

Competent authority
administrative body of a corporate body governed by public law, for example a municipal executive of a municipality that has been given a competence described in a law to take a written, binding decision on a particular subject that has legal consequences for citizens and/or companies

Open air
place in the open air where the air speed is usually higher than 2 m/s and rarely less than 0.5 m/s without mechanical means and where no hindering obstacles are present; a situation with one side wall and a roof is regarded in this guideline as an open air situation

Cylinder trailer or tube trailer
trailer to which cylindrical pressure vessels have been attached along the length of the trailer

cylinder pack trailer
trailer with several packs on it, with every pack containing several cylinders in one bundle

Declaration of conformity
fabricator´s declaration that the equipment/assembly is fabricated according to the code indicated in the design and, if required, that monitoring is carried out by an independent third party (NOBO)

Owner
see user

Operator
see manager

ESD
automatic activation of the Emergency Shutdown Systems (ESD systems) to make the hydrogen installation safe. In addition, these systems ensure the rapid warning of the people present at the installation and alerting of the in-house emergency organisation

Fabricator
the person who manufactures the equipment or the assembly and issues a declaration of conformity for this

User (in line with WBDA)
the person who will use the installation and shall comply with the licence and Dutch legislation

Hazard zone classification
classification of hazardous areas into zones, depending on the probability of the presence of an explosive atmosphere

Lock down system
repression system to isolate all or part of an installation to prevent any or further discharge

Establishment (in line with the Environmental Management Act (Wm))
any business activity undertaken by people as a business or to such an extent that it resembles a business that is done within certain limits

Note
This then means the complete business of which the hydrogen delivery installation is a part.

Testing
statutory obligation to be carried out by an independent body (for example AKI)

Lower Explosive Limit (LEL)
lower explosive limit expressed in volume fraction with respect to the total quantity of air

Emergency shutdown
switching off and/or shutting down an item of equipment, vehicle or installation as quickly as possible in case of an emergency

QRA
Quantitative risk assessment
Quantitative risk analysis
numerical evaluation of the chances, effects and consequences of accidents and the combination of these in risk measurements

SAFETI-NL
software program for performing QRA calculations in the Netherlands

Tanker
trailer to which a cryogenic liquid hydrogen transport vessel has been attached

Intermediate storage
installation intended to store hydrogen gas under high pressure consisting of one or more pressurized storage units

Non-return valve
component in the installation that prevents the return of gas and/or liquid

Supervisor
person who has received instructions about the safe operation of the delivery installation and the execution of the emergency plan in case of disasters, e.g. the establishment manager or a customer, for example a driver

Note:
This must be laid down administratively and be demonstrable.

Note:
If the customer of the liquid hydrogen or gaseous hydrogen or the driver of the road vehicle being refuelled has followed an instruction, specifically for a location, he can be seen as a supervisor. If this person leaves the site, delivery should now no longer be possible without identifying a new supervisor.

Safe position safety shut-off valve
shut-off valve that is designed such that it automatically takes the safe position upon failure of the servo-mechanism

Licensor
see user

Filler connection (nozzle)
part of the delivery hose with which the connection between the delivery hose and the road vehicle can be created

Liquid hydrogen
hydrogen in a liquid state

Hydrogen delivery installation
establishment for delivering hydrogen to a vehicle for which the relevant approval has been granted

Note:
The establishment comprises the hydrogen-related structures intended for the supply, storage, production, compression and the dispenser(s). The establishment may be part of a multi-fuel filling station.

Multi-fuel filling station
filling station where, besides other conventional fuels, such as petrol, diesel and LPG, other fuels such as hydrogen, can also be filled into vehicle tanks

Annex B Standards

[A] NEN 1010:2011, Veiligheidsbepalingen voor laagspanningsinstallaties

[B] NEN 2559:2001, Onderhoud van draagbare blustoestellen

[C] NPR 2578: 2013, Beheer en onderhoud van LPG-, propaan- en butaaninstallaties

[D] NEN 3011:2004, Veiligheidskleuren en -tekens in de werkomgeving en in de openbare ruimte

[E] NEN 6069, Beproeving en klassering van de brandwerendheid van bouwdelen en bouwproducten;

[F] NPR 7910-1, Gevarenzone-indeling met betrekking tot explosiegevaar – Deel 1: Gasexplosiegevaar, gebaseerd op NEN-EN-IEC 60079-10-1:2009

[G] NEN-EN 3-7:2004, Draagbare blustoestellen – Deel 7: Eigenschappen, prestatieeisen en beproevingsmethoden

[H] NEN-EN 1012-3:2008, Compressoren en vacuümpompen – Veiligheidseisen – Deel 3: Procescompressoren

[I] NEN-EN 1363-1, Bepaling van de brandwerendheid - Deel 1: Algemene eisen

[J] NEN-EN 12434: 2000, Cryogene vaten – Slangen voor cryogene toepassing

[K] NPR-IEC/TS 60079-32-1, Explosieve atmosferen - Deel 32-1: Richtlijnen voor elektrostatische risico's

[L] NPR-ISO/TR 15916:2004, Basismetingen voor de veiligheid van waterstofsystemen

[M] NEN-EN 12464-1 Licht en verlichting - Werkplekverlichting - Deel 1: Werkplekken binnen NPR 2578: 2013 Beheer en onderhoud van LPG-, propaan- en butaaninstallaties

[N] NEN-EN 12464-2, Licht- en verlichtingstechniek - Werkplekverlichting - Deel 2: Werkplekken buiten

[O] NEN-EN 13766:2010, Thermoplastische meerlaagse (niet-gevulcaniseerde) slangen en slangassemblages voor het transport van vloeibaar petroleumgas en vloeibaar aardgas - Specificatie

[P] NEN-EN-ISO 7010:2012, Grafische symbolen – Veiligheidskleuren en -tekens Geregistreerde veiligheidstekens

[Q] NEN-EN-ISO 7751:1997, Rubber and plastic hoses and hose assemblies – Ratios of proof and burst pressure to design working pressure

[R] NEN-EN-ISO 10380: 2012, Pijpleidingen – Gegolfde metalen slangen en slangassemblages

[S] NEN-EN-ISO 13849-1, Veiligheid van machines - Onderdelen van besturingssystemen met een veiligheidsfunctie - Deel 1: Algemene regels voor ontwerp

[T] NEN-EN-ISO 13849-2, Veiligheid van machines - Onderdelen van besturingssystemen met een veiligheidsfunctie - Deel 2: Validatie

[U] NEN-EN-ISO 13850 Veiligheid van machines - Noodstop - Ontwerpbeginselen

[V] NEN-EN-ISO 13850 Veiligheid van machines - Noodstop - Ontwerpbeginselen

[W] NEN-EN-ISO 14113:2008, Rubber and plastic hose and hose assemblies for use with industrial gases up to 450 bar

[X] NEN-EN-ISO 15500-17:2001, CNG fuel system components – Part 17: Flexible fuel line

[Y] NEN-ISO 16110-1:2007, Waterstofgeneratoren gebruikmakend van "fuel processing" technologie – Deel 1: Veiligheidseisen

[Z] NEN-ISO 17268:2006, Wegvoertuigen met gecomprimeerd waterstof als motorbrandstofvulsystemen

[AA] ISO/TS 20100:2008, Gaseous hydrogen – Fuelling stations

[BB] NEN-ISO 22734-1:2008, Waterstofgeneratoren gebruikt voor het water elektrolyseproces – Deel 1: Industriële en commerciële toepassingen

[CC] NEN-EN 160529, Beschermingsgraden van omhulsels van elektrisch materieel (IP-codering)

[DD] NEN-EN 50110-1:2005, Bedrijfsvoering van elektrische installaties

[EE] NEN-EN-IEC 60079-10:2008, Explosieve atmosferen – Deel 10-1: Classificatie van gevaarlijke gebieden – Explosieve gasatmosfeer

[FF] NEN-EN-IEC 60079-14, Explosieve atmosferen - Deel 14: Ontwerp, keuze en opstelling van elektrische installaties

[GG] NEN-EN 62061, Veiligheid van machines - Functionele veiligheid van veiligheidsgerelateerde elektrische, elektronische en programmeerbare elektronische besturingssystemen

[HH] NEN-EN-IEC 60204-1:2006, Veiligheid van machines – Elektrische uitrusting van machines – Deel 1: Algemene eisen

[II] NEN-EN-IEC 62305-reeks, Bliksembeveiliging

Annex C Relevant legislation and regulations

C.1 Introduction

A delivery station shall comply with European regulations, transposed into Commodities Acts (warenwetbesluiten) in the Netherlands. When completed/commissioned, the hydrogen delivery installation is provided with the CE marking by the fabricator (or assembler) of the facility, i.e. the party under whose name and responsibility the installation has been manufactured. The CE marking indicates that all the relevant and applicable regulations are complied with. For instance, the Machine Directive, EMC Directive, Measuring Instruments Directive and other directives and/or regulations can apply besides the European Pressure Equipment Directive. If, for example, there is intermediate cooling, legislation on refrigerants, the energy efficiency of motors etcetera might apply. The ATEX Directive, Low Voltage Directive and/or RoHS, as well as the Construction Products Regulation might apply to the components and/or the underlying assemblies.

Documentation (a technical file) shall be assembled to demonstrate that the legislation referred to has been complied with (conformity assessment). Some parts of legislation require a test by an independent body (Notified Body) accredited for this purpose. The certificates issued shall be part of the file. And finally, the fabricator shall sign the EC declaration of conformity and shall apply the CE marking to the installation.

The majority of the requirements or regulations laid down for the use of hazardous substances are laid down in legislation, whether or not based on European Directives, or follow directly from European regulations. The PGS publications aim to give as complete as possible a description of the way in which companies can comply with the requirements arising from legislation and regulations. Further to the legislation drawn up from a European perspective and referred to in this PGS, local legislation is also relevant, including various permits to be allowed to build the hydrogen delivery installation in a certain location.

This summary is broken down into the following categories:

- general;
- requirements for technical integrity;
- operation;
- requirements for spatial context;
- transport.

For the most up-to-date version of the legislation and regulations we advise you to consult the website www.wetten.nl.

C.2 General

Environmental Licensing (General Provisions) Act (Wet algemene bepalingen omgevingsrecht – Wabo)

The Wabo came into effect as of 1 October 2010, with the corresponding Ambient Law Decree (Besluit omgevingsrecht – Bor) and with the corresponding Ministerial Regulation on Ambient Law (Ministeriële regeling omgevingsrecht – Mor). Annex 1 of the Bor indicates the establishments that require an environmental licence.

Best Available Technology (BAT)

According to Article 9.2 of the Mor the competent authority when awarding a license shall take into account the best available technology (BAT) that is suitable for the establishment. The Mor

lists the PGS publications that are considered as Dutch BAT documents. Activities Decree (Activiteitenbesluit)

Activities Decree (*Activiteitenbesluit*)

The Decree on general rules for environmental management of establishments (Barim: Besluit algemene regels voor inrichtingen milieubeheer) or Activities Decree) gives general environmental rules for companies for whom a licence is not compulsory. In addition, for certain activities, the decree contains regulations that may also apply to establishments for which a licence is compulsory. By ministerial regulation or in the license the legislator refers to specific PGS regulations for certain activities.

The Activities Decree makes a distinction between three types of establishments: A, B and C. Type A and B establishments fall fully under the general rules of the Activities Decree, where for type A establishments, because of their low environmental impact, the 'light regime' and noreporting obligation applies. Type B establishments are establishments for which the licence obligation is lifted but who do have a reporting duty. Type C establishments shall have a license, where for certain activities the regulations from clause 3 of the Activities Decree and a few other regulations of the Activities Decree are directly applicable and for this reason may not be included in the license.

C.3 Requirements for technical integrity

Pressure Equipment (Commodities Act) Decree (Warenwetbesluit drukapparatuur – WBDA)

The European Pressure Equipment Directive (PED) has been transposed in the Pressure Equipment (Commodities Act) Decree (WBDA) in the Netherlands. The requirements of the European Directive for design and new build are further interpreted in harmonised European standards.

The Pressure Equipment (Commodities Act) Decree lays down requirements for the technical integrity of installations for the use and storage of pressurised gases or liquids. The requirements focus among other things on the strength of pressure equipment under different conditions, on safe operation, inspection equipment, drain and vent devices, corrosion, wear and tear, assembly of different components, filling devices and overfilling protection devices and safety accessories.

However, certain things are not regulated in the Pressure Equipment (Commodities Act) Decree. For example it does not apply to components of installations with a pressure of 0.5 bar (0.5 atm overpressure with respect to the atmospheric air pressure) or lower. This means that in the Netherlands, the rules of the Health & Safety legislation as regards the employer’s general duty of care and the safety of work equipment and workplaces are applicable. In cases where neither the Pressure Equipment (Commodities Act) Decree nor the Working Conditions Act apply, the product liability a fabricator has towards his customers shall suffice.

National inspection bodies are appointed by the Ministry of Social Affairs and Employment (SZW) (so-called 'AKI' in Dutch) to monitor the taking into service of pressure equipment and for periodic retesting under the Pressure Equipment (Commodities Act) Decree,

Legislation on explosive atmospheres (ATEX 95)

ATEX (ATmosphère EXplosible) is the synonym for two European Directives in the field of explosion hazard. ATEX 95 (Directive 94/9/EEC) concerns technical integrity and contains target regulations for equipment and protective systems used in potentially explosive atmospheres. In the Netherlands ATEX 95 is transposed in the Explosion-safe equipment (Commodities Act) Decree.

C.4 Operation

Legislation on explosive atmospheres (ATEX 137)

ATEX (ATmosphère EXplosible) is the designation of two European Directives in the field of explosion hazard. Within businesses where an explosion hazard exists, ATEX 137 (Directive 1999/92/EC) shall be complied with. This obligation is laid down in the Netherlands in the Working Conditions Decree (*Arbeidsomstandighedenbesluit*).

ATEX 137 describes the minimum requirements for creating a safe and healthy work environment for employees potentially at risk from explosive atmospheres. For the Netherlands these guidelines are included in the Health & Safety (*ARBO*) legislation and regulations. Employers are obliged to take measures that:

- as far as possible prevent the occurrence of explosive atmospheres;
- avoid the ignition of explosive atmospheres;
- limit the harmful consequences of an explosion.

The employer shall draw up an explosion safety document describing the risks and the technical and organisational measures taken to minimise such risks. The explosion safety document forms part of the RI&E.

Pressure Equipment (Commodities Act) Decree

In addition to requirements for technical integrity the Pressure Equipment (Commodities Act) Decree also contains a few requirements relating to operation. For example general requirements are laid down regarding the competence of maintenance mechanics relating to pressure equipment. It does not however discuss specific competencies for working on installations with hazardous substances.

Risk inventory and evaluation (Risico-inventarisatie en evaluatie – RI&E)

Every company with staff shall investigate or have investigated whether the work may constitute a hazard or may cause damage to the health of the employees. This investigation is called an RI&E and shall be laid down in writing according to article 5 of the Health and Safety Act.

Working Conditions Act (*Arbeidsomstandighedenwet*)

The Working Conditions Act (*Arbeidsomstandighedenwet*) states the rights and obligations of both employer and employee with regard to working conditions. The Working Conditions Act applies wherever work is carried out, not only in companies, but also in associations or foundations.

The Working Conditions Decree (*Arbeidsomstandighedenbesluit*), which is an elaboration of the Working Conditions Act, sets out further rules with which both employer and employee shall comply to prevent health and safety risks (target regulations). It also contains different and additional rules for a number of sectors and categories of employees.

In the Health and Safety Act, revised in 2007, employers and employees were given more scope and responsibility for putting their own interpretation on the way in which they comply with the law within their own branch. This has the advantage that enterprises can pursue H&S policy that takes into account the specific features of the sector.

The government provides a clear legal framework (target regulations) with as few rules and administrative burdens as possible in the form of the Working Conditions Act. Employers and employees together make agreements about the way in which they can meet the regulations

laid down by the government. These agreements may be laid down in so-called Health & Safety catalogues.

These describe the different methods and solutions that employers and employees have agreed together for meeting the target regulations laid down by the government. They can include, for example, descriptions of techniques and methods, good practice examples, standards and practical guidance.

If an industry does not take the initiative to draw up a Health & Safety catalogue for the relevant industry, the *SZW* (Social Affairs and Employment) Inspectorate can take the initiative to draw up an Industry Health & Safety brochure.

According to the Working Conditions Act and the Working Conditions Decree every organisation shall have an expert in-house emergency organisation.

In-house fire service (*Bedrijfsbrandweer*)

The Safety Regions Act (*Wet veiligheidsregio's*) came into effect on 1 October 2010. After this date, the board of the safety region has the authority to designate which establishments are obliged to have an in-house fire service.

This Act includes the regulations for an in-house fire service organisation in Article 31, as well as in chapter 7 of the Safety Regions Decree (*Besluit veiligheidsregio's*). The new regulations incorporate the results of the 'Updating in-house fire services' project.

The Safety Regions Decree contains a description of the procedure that the government and companies shall follow to arrive at an opinion on any in-house fire service obligation: The decree specifically states which type of establishments are eligible for an assessment into in-house fire service obligation.

The Safety Regions Decree states very specifically which data an in-house fire service report ('*rapport inzake de bedrijfsbrandweer*' – 'report on the in-house fire service') shall contain. According to the Safety Regions Decree the board of the safety region shall only lay down requirements in the designation order on:

- staff;
- provisions;
- equipment;
- protective equipment;
- alarm and cooperation;
- scope of the in-house fire service.

The In-house Fire Service Guide (*werkwijzer Bedrijfsbrandweren*) is an aid in appointing an in-house fire service. This guide covers the following subjects in detail:

- statutory frameworks for in-house fire service provision;
- industrial safety;
- procedure for appointing the in-house fire service;
- scenarios and drawing up the in-house fire service report;
- monitoring and enforcement;
- preparedness for in-house fire services
- training and practices;
- quality requirements of government organisation.

National and international standards for operation

National and international standards have been drawn up that describe a method for a safe operation using a safety management system. Examples are the Occupational Health and Safety Assessment Series (OHSAS) 18001 for OHS management systems and the Dutch Technical Agreement NTA 8620 for safety management systems of Brzo companies.

C.5 Requirements for spatial context

In addition to technical integrity and operation, the spatial context of storage and transfer installations is also important for assessing the hazards relating to such an installation and managing the risks. A distinction is made between three types of distance requirements:

- hazard zones around electrical installations;
- distances between components of an installation, storage and flammable objects on the site;
- distance requirements relating to buildings outside the establishment.

Building Decree (*Bouwbesluit*)

The Building Decree 2012 includes general rules for fire-safe building and use of buildings.

The purpose of the Building Decree 2012 as regards limiting the spread of fire (fire compartmentalisation) is to be able to control a fire so that people can escape safely and the fire does not spread to other buildings. The Building Decree specifies in principle (for new builds) that buildings shall be divided into fire compartments with an area of use of no more than 1 000 m² and in a number of cases – industrial functions – up to 2 500 m² (for storage facilities for packaged hazardous substances PGS 15 has the limit of 1 000 m²). For a larger area of use, equivalent safety shall be demonstrated. This may be done using the survey report Method for Manageability of Fire (Methode Beheersbaarheid van Brand) (edition 2007). Note! In combination with hazardous substances, this requires special attention because there are exclusions in the model, for instance for substances with rapid fire spread.

NEN 6068 states how this resistance to fire breakthrough and fire flashover (*WBDBO*) shall be determined based on the fire resistance and the design of the building.

External Safety (Establishments) Decree (*Besluit externe veiligheid inrichtingen – Bevi*)

Further requirements may be laid down by the Bevi – linked to the Environmental Management Act – for the external safety of establishments with specific risks for people outside the site of the establishment. The purpose of the Bevi is to limit the risks to which citizens are exposed in their living environment due to activities with hazardous substances performed in establishments up to a set limit.

Since October 2004, the Bevi has obliged the competent authority, when granting licences under the Environmental Management Act and for relevant spatial developments (in particular zoning plans), to take into account the external safety (place-related risk and group risk). Based on the Bevi, a ministerial regulation (*REVI*) specifies the distances to be maintained for a number of industrial sectors. For other companies, for example Brzo companies, the distance to be maintained shall be determined by a risk calculation using the calculation rules stated in the Bevi. This indirectly imposes safety standards on companies which form a risk for people outside the industrial site by their use, storage, transport or production of hazardous substances.

The Bevi in outline:

- the Bevi regulates how a municipality or province shall handle risks for people outside a company with hazardous substances;
- the Bevi determines the place-related risk. Municipalities and provinces can use this to determine safety distances around risk companies;

- the *Bevi* imposes an accountability duty for the group risk. Municipalities and provinces can use this to determine safety distances around risk companies;
- when companies are located too close to housing, for example, extra safety measures are necessary. In the most extreme cases, municipalities and provinces can require a company to move or housing to be demolished;
- If an establishment is covered by the Bevi, it is a Type C establishment under the Activities Decree.

C.6 Transport:

Transport is covered by international conventions for the transport of hazardous substances. These regulations and their transposition are embodied in ministerial regulations in the Transport of hazardous substances act (Wet vervoer gevaarlijke stoffen) and in the Ships Act (Schepenwet). The following international conventions are important here:

ADR for road transport

Accord européen relatif au transport international des marchandises Dangereuses par Route. The Regulation on transport of hazardous substance by land (*Regeling vervoer over land van gevaarlijke stoffen – VLG*) contains specific regulations for the transport of hazardous substances by road. Annex 1 to this regulation contains the international rules for the transport of hazardous substances, which come from the ADR convention;

Annex D Information about hydrogen

D.1 Introduction

The use of hydrogen involves risks. Due to the small size of its molecules, hydrogen gas penetrates virtually everything; it is also lighter than air and it is odourless. Furthermore, little energy is required to ignite the gas.

Depending on the pressure and the discharge rate, hydrogen gas can burn in the form of a micro-flame (0.3 mm) or of a jet flame of several metres in size, which flames are virtually invisible.

In liquid form, hydrogen is a cryogenic liquid that is so cold (-252 °C) that, when exposed to the ambient air, the oxygen en nitrogen from the ambient air will condensate.

Knowledge of the characteristic properties of hydrogen helps in order to be able to understand the regulations of this PGS and applying them professionally to the construction of hydrogen delivery installations.

D.2 Some properties of hydrogen

D.2.1 Diffusion

Due to the small size of its molecules, hydrogen can diffuse in or even through materials. Since this increases the probability of leaks, only a few materials are suitable for use in combination with hydrogen.

The number of connections shall be minimised (e.g. welded and screwed connections), and any connection techniques and sealing materials used shall be suitable for this purpose.

Besides this, diffusion of hydrogen in certain materials can lead to negative changes in the material properties. This phenomenon is known as ‘hydrogen embrittlement’. The high coefficient of diffusion in the air also offers a safety advantage. In an open area, the hydrogen gas will mix with air quickly and thus be diluted. The risk of explosion is therefore reduced.

D.2.2 Density

Hydrogen gas is fourteen times lighter than air. If hydrogen is released in a closed room, it will accumulate at the highest point. There is a risk of an accumulation of hydrogen at the top of a closed room. This risk is relevant in service areas of the establishment and under roofs over the hydrogen delivery installation.

Any roof structures under which released hydrogen can accumulate shall be prevented. Sufficient, natural or forced (mechanical), ventilation shall be provided in accordance with NEN-EN-IEC 60079-10-1 or NPR 7910-1.

A detection system shall be installed there where ventilation is difficult or cannot be guaranteed to a sufficient extent.

The location of the hydrogen delivery installation shall be chosen such that any hydrogen that escapes is blown in a safe direction (the prevailing wind direction). An option to ensure this can be a flare.

D.2.3 Boiling point

Liquid hydrogen is a cryogenic liquid. The boiling point of hydrogen is (–252 °C) under atmospheric conditions. The melting point of hydrogen is at (–259 °C).

Note:
The melting point of oxygen is –218 °C and that of nitrogen is –210 °C.
The boiling point of oxygen is –183 °C and that of nitrogen is –195,8 °C.

If 'liquid' drips somewhere while filling a vessel with liquid hydrogen, this will be liquid air (i.e. a mixture of nitrogen and oxygen) with enriched air being created (both in the liquid phase and later also in the gaseous phase) due to distillation with oxygen. If this liquid oxygen transforms back into the gaseous phase upon contact with the relatively warm components, there will be a very high oxygen concentration in that location and an increased probability of fire.

D.2.4 Ignition energy

Hydrogen gas requires very little energy (0,02 mJ) to ignite. Furthermore, a mixture of hydrogen gas and air can be ignited along a very wide area (volume fraction of 4 % to 75 %). To prevent static charges accumulating in the constructions, materials that conduct electricity well are used and potential equalisation shall be ensured.

Note:
Friction of garments can even suffice to generate this small level of energy.

The self-ignition temperature is 585 °C.

D.2.5 Flaming

Since hydrogen has a colourless, hardly visible flame and has hardly any heat radiation a hydrogen fire cannot be easily detected by people. A flame can be detected using special thermal imaging cameras and/or UV measurement. When applying flame detection, external influences on the equipment, such as sunlight or welding activities in the environment, should be taken into account.

Annex E On site hydrogen production

Techniques

The most common techniques for producing hydrogen on site are reforming and electrolysis:

- Reforming uses high-temperature steam (700 °C – 1 100 °C) to convert a fuel (hydrocarbon compounds such as natural gas) into hydrogen and carbon dioxide. NEN-ISO 16110-1 describes requirements that apply to installations that produce hydrogen gas by means of the reforming process.
- Electrolysis is the process of decomposing water into oxygen gas and hydrogen gas. This process can be carried out under atmospheric conditions or under pressure (10 bar - 200 bar) or high temperature (500 °C – 850 °C). NEN-ISO 22734-1 describes requirements that apply to installations that produce hydrogen by means of electrolysis.

Safety aspects of hydrogen production

If applicable, newly built installations for producing hydrogen must comply with European product directives and bear CE marking when commissioned. Which directives apply should be established on a case-by-case basis. Examples of such directives are the ATEX Directive, the Pressure Devices Directive and the Machine Directive. The measures for safe use of the installation described by the fabricator should be followed.

If fuels used during reforming are stored and supplied, this storage shall comply with the relevant safety criteria. The Hazardous Substances Publication Series (PGS) describes measures for the safe storage and delivery of fuels such as for natural gas (PGS 25), LPG (PGS 19) and liquid fuels (PGS 28). In the event of storage under an overpressure of more than 0.5 bar, the Dutch Pressure Equipment (Commodities Act) Decree applies.

It shall be possible to remotely and safely stop the production of hydrogen in the event of a disaster.

The setup of the installation complies with the fabricator's instructions.

This PGS describes measures for setting up hydrogen storage tanks for fuels that can also be used for hydrogen production. If residual products are created while producing hydrogen, they shall be processed or stored according to the applicable legislation and regulations.

Annex F Activities that shall at least be carried out when offloading hydrogen to a hydrogen delivery installation

Part 1 – Procedure(s) for offloading gaseous hydrogen

Hydrogen can be offloaded using either of two methods:

- from the tanker, using a pump;
- based on the pressure difference between the tanker and the storage medium

While offloading, the driver shall wear the prescribed personal protection equipment (PPE).

The tanker driver shall follow a fixed procedure for offloading gaseous hydrogen. This procedure shall contain the following points:

- Parking the tanker in the designated parking space so that it can drive off without having to manoeuvre if a disaster occurs.
- Pulling on the handbrake and switching off the engine of the tractor unit.
- Placing the wheel chocks under the trailer wheels so that they are blocked in both the regular driving direction and in the reversing direction.
- Disconnecting and driving away the tractor unit (if applicable).
- Establishing the filling capacity and the volume in the stationary hydrogen storage tank that is to be topped up.
- Establishing the maximum quantity of hydrogen to be topped up.
- Indicating the conditions under which the offloading hose may be connected and filling may take place (e.g. that offloading activities are forbidden during thunderstorms, or which people to consult before offloading activities take place).
- Opening the doors to the tanker cabinet, enabling the safety facility that prevents the tanker driving off and, if present, the remotely controllable shut-off valves to be activated.
- Connecting the earthing cable to the terminal of the hydrogen storage unit to be filled to prevent a static or other discharge taking place, between the trailer and the hydrogen storage unit, while filling and while connecting and disconnecting the hoses (if applicable, unless the emergency stop circuit is connected to the trailer).
- Connecting the offloading hose between the tanker and the filling point of the hydrogen storage tank.
- Checking that the connections do not leak.
- Indicating how to render the offloading hose inert and how to check that no air (which might form an explosive mixture) is entrapped in the offloading hose. .
- Indicating which shut-off valves shall be operated and how they can be recognised.

  Note:
  The remote-controlled shut-off valves (if present) on the reservoir connections of the tanker may be opened in different ways (there is no standard for this yet).

- If a pump is used for filling, it shall be indicated how to switch this pump on and off and how to act in the event of an emergency stop.
- Stopping filling when the maximum permissible filling capacity is reached.
- Degassing, rendering inert and disconnecting the offloading hose.

  Note:
  When disconnecting the hose a small quantity of hydrogen may be released. Offloading activities during thunderstorms are forbidden.

- Stowing away the offloading hose safely. (In some cases, the offloading hoses may belong to the hydrogen storage tank. How to safely stow away these offloading hoses shall then be indicated.)
- Disconnecting the earthing terminal and the emergency stop circuit if relevant.
- Placing the tractor unit in front of the trailer (if applicable).
- Removing and storing the wheel chocks.
- Checking that the safety facility that prevents the trailer from being driven away has been deactivated.
- Dealing with the delivery note etc. for the offloading that has been carried out.
- Releasing the handbrake and leaving the parking space safely.

Part 2 – Procedure(s) for offloading hydrogen tube trailers

Hydrogen tube trailers can be offloaded in various ways:

- cascaded offloading for filling a hydrogen storage unit;
- direct offloading to the hydrogen delivery station.

Note:
Both offloading methods have been described in detail in drivers' manuals.

The driver shall follow a fixed procedure for offloading a hydrogen tube trailer. This procedure shall contain the following points:

Disconnecting the trailer

- Closing all the individual valves of the tubes/vessels/packs.
- Closing the dispenser's pressure valve.
- Partly opening the flush valve on the dispenser to release the pressure from the pressure offloading hose.
- Fully closing the flush valve as soon as the offloading hose is no longer under pressure.
- Disconnecting the emergency air hose of the trailer/semi-trailer if present. The emergency shut-off valve on the trailer/semi-trailer then closes.
- Closing the trailer's pressure valve.
- Disconnecting and stowing away the pressure hose.
- Removing the wheel chocks and stowing them away in the storage room designed for this purpose.
- Disconnecting the earthing terminal of the trailer/semi-trailer to be removed and carefully placing it in the location provided for this purpose.
- Attaching the trailer/semi-trailer to the tractor unit and checking the attachment.
- Connecting the brake system and activating the electricity between the tractor unit and the trailer/semi-trailer.
- Removing and storing the wheel chocks.
- Checking that the safety facility that prevents the tanker from driving off has been deactivated.
- Dealing with the delivery note etc. for the offloading that has been carried out.
- Releasing the handbrake and leaving the parking space safely.

Part 3 – Procedure(s) for offloading liquid hydrogen from hydrogen tube trailers

While offloading (supplying), the driver shall wear the prescribed personal protection equipment (PPE).

For offloading liquid hydrogen, the tanker driver shall follow a fixed procedure. This procedure shall contain the following points:

- Parking the tanker in the designated parking space so that it can drive off without having to manoeuvre if a disaster occurs.
- Pulling on the handbrake and switching off the engine of the tractor unit.
- Placing the wheel chocks under the trailer wheels so that they are blocked in both the regular driving direction and in the reversing direction.
- Disconnecting and driving away the tractor unit (if applicable).
- Establishing the filling capacity and the volume in the hydrogen storage unit.
- Establishing the maximum quantity of liquid hydrogen to be supplied.
- Indicating under which conditions supplying is allowed.
- Opening the doors to the tanker cabinet, thus activating the safety facility that prevents the tanker from driving off. If remote-controlled shut-off valves are present, it shall be possible to activate them.
- Connecting the tanker's earthing cable to the hydrogen storage unit to prevent static discharge while supplying liquid hydrogen.
- Connecting an emergency stop circuit (if present) to shut off the tanker in the event of a disaster. This will interrupt the supply of liquid hydrogen from tanker to hydrogen storage unit.
- Removing the blind flanges or blind couplings of the shut-off valves.
- Connecting the offloading hose between the tanker and the filling point of the hydrogen storage unit.
- Checking that the connections do not leak.
- Indicating how to render the internal offloading hose inert. It shall also be indicated how to check that no air is trapped in this offloading hose.
- Checking that the evaporated hydrogen gas can be discharged through the vent unit while the offloading hose is brought to the right temperature.
- Keeping the pressure difference within the limits required in order to have the liquid hydrogen flow to the hydrogen storage unit.
- Indicating which shut-off valves shall be operated and how they can be recognised.
- Stopping the supply of liquid when the maximum filling capacity is reached.
- Degassing, rendering inert and disconnecting the offloading hose.
- Stowing away the offloading hose safely. In some cases, the offloading hose may belong to the hydrogen storage unit. How to safely stow away this offloading hose shall then be indicated.
- Installing the blind flanges or blind couplings of the shut-off valves.
- Disconnecting the earthing terminal and the emergency stop circuit if relevant.
- Placing the tractor unit in front of the trailer (if applicable).
- Removing and storing the wheel chocks.
- Checking that the safety facility that prevents the tanker from driving off has been deactivated.
- Dealing with the delivery note.
- Releasing the handbrake and leaving the parking space safely.

Annex G Example of checklist for work on hydrogen delivery installations

This checklist shall be present at the works and updated during the work.

1. General data

Place and nature of the work:	
Client: name of company: officer: signature of officer:	
Carried out by:	
Name of responsible employee on site:	
Signature of responsible employee:	

2. Part to be filled in daily

General

Date:	
Weather conditions: - windy/windless - clear/misty - temperature (°C)	
Number of people involved in the work:	
Qualifications of the people involved in the work:	

Safety measures

☐	Are no flammable material or ignition sources present within 15 m?
☐	Have warning notices been put up?
☐	Are extinguishers present? type: _____ number: _____ capacity: _____
☐	Explosion meter present and tested?
☐	Oxygen meter present and tested?

3. Progress of the work

A. Gas removal

☐	Have parts 1 and 2 of this checklist been completely filled in?
☐	Has the reservoir been pumped empty as far as possible?
☐	Have any combustion engines been stopped, the electrical installation been turned off, the power been disconnected and naked flames been put out?
☐	Have the reservoir and piping been depressurised?
☐	Have hoses and piping been flushed with inert gas?
☐	Has the reservoir been filled completely with water or flushed efficiently with inert gas?
☐	Has the reservoir been completely ‘vented’?
☐	Measurement of hydrogen in hydrogen storage (reservoir) _____volume fraction of hydrogen
☐	Gas test at pipe outlets _____ LEL (lower explosive limit)
☐	Measurements carried out by: _____
☐	Is the reservoir free for entry of people?

	measurement: _____ volume fraction of hydrogen checked by (name): _____ signature and date: _____

B. Putting into operation

☐	Have all fittings been checked and fitted with new gaskets?
☐	First fill with hydrogen carried out by: name: _____ date: _____
☐	Has the reservoir been pressurised with hydrogen, nitrogen, air or other inert gas?
☐	Has the tightness test been carried out?
☐	Installation released for use for issue (signature + date): for receipt (signature + date):

Annex H Explosion-safe equipment (ATEX 95)

The rules relating to explosion-safe equipment are laid down in the European Directive 94/9/EEC (ATEX 95) (to be amended by 2014/34/EU). This directive relates to technical integrity and contains target regulations for equipment and protective systems used in potentially explosive atmospheres. In the Netherlands, ATEX 95 has been transposed in the Explosion-safe equipment (Commodities Act) Decree (*Warenwetbesluit explosieveilig materieel*), with corresponding Regulation concerning further rules with respect to explosion-safe equipment (*Regeling houdende nadere regels ten aanzien van explosieveilig materieel*) and the Decree on electrical explosion-safe equipment (*Besluit elektrisch explosieveilig materieel*). The requirements are particularly important for fabricators and importers of explosion-safe equipment.

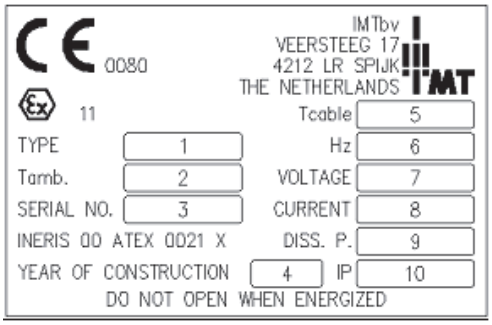
For all people using and/or carrying out activities on a hydrogen delivery installation, it is important that the work equipment and the electrical installation material used within the hazard zones cannot cause ignition.

In concrete terms, this means that material shall be designed according to the requirements of the Explosion-safe equipment (Commodities Act) Decree, and that smoking and naked flames, as well as the presence of objects with a surface temperature higher than 450 °C (the ignition temperature of hydrogen is higher than this maximum for temperature class T1) is not permitted within the zone.

Electrical equipment that meets the standards for explosion safety can be identified by the ‘Єx’ symbol in a regular hexagonal. Should this not be visible, a document shall be present in the log book in which the supplier declares that the electrical equipment meets the normal standards for explosion safety. This then involves a so-called EC declaration of conformity that is accompanied by a CE marking. Cabling is regarded as a fixed electrical connection, free of sparking and is hence exempt from explosion safety criteria.

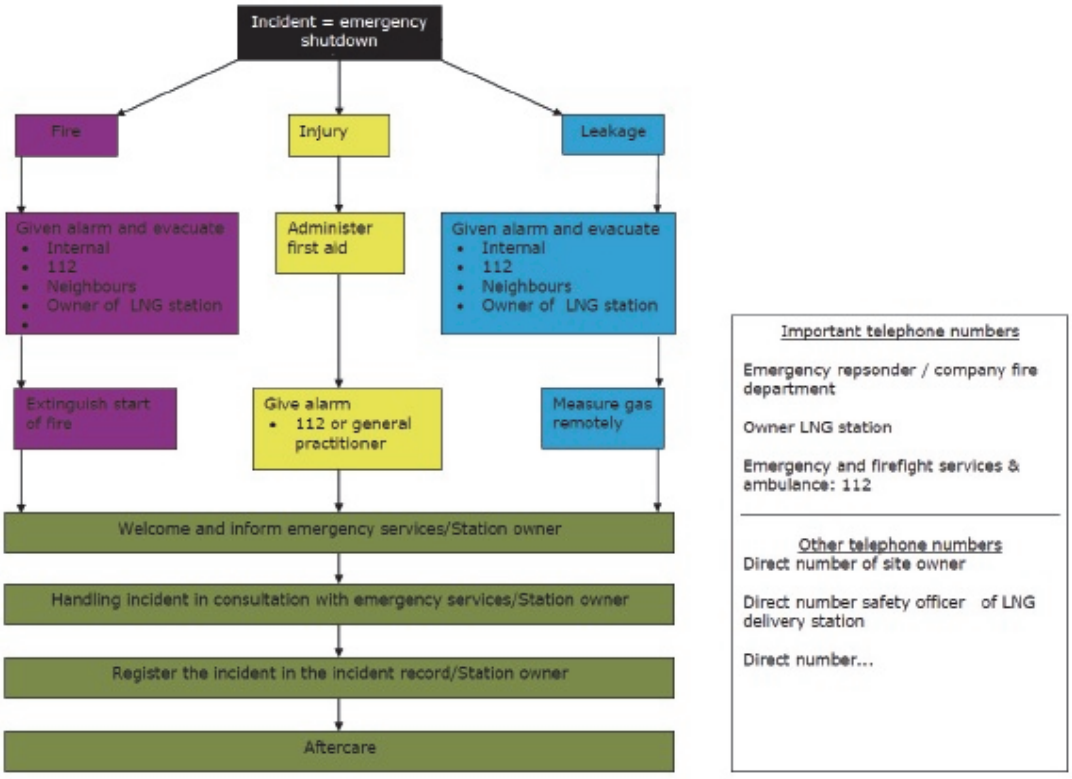
Finally in simple electrical installations cast-in components are often used that thereby meet the explosion safety requirement (and are regarded as compliant) without the housing in which they are placed bearing the ‘Ex’ mark.

Set out below are two examples of images where an ‘Ex’ marking is affixed. In this respect we would point out that the ‘Ex’ marking is not required based on the ATEX Directive, but results from a number of other standards.



Annex I Example of an emergency instruction for a hydrogen delivery installation

Owner = manager



Annex J List of responsibilities and roles

The stakeholders in a hydrogen delivery installation each have their own tasks and responsibilities as regards safety:

- fabricator;
- installer;
- inspection body (AKI);
- user/owner (licensor/owner) of the hydrogen delivery installation;
- manager of the hydrogen delivery installation;
- supervising person;
- liquid or gaseous hydrogen supplier.

The following aspects are important for safe operation of the hydrogen delivery installation:

- design and construction;
- inspection and maintenance;
- use;
- management;
- supervision of the use;
- supply.

The final responsibility for compliance with the regulations always lies with the user of the establishment See Table K.1 for a list of the stakeholders and their responsibilities in which roles.

Table J.1 — List of responsibilities and roles of stakeholders in a hydrogen delivery station

Responsible persons (for definitions see annex A)	Corresponding term	Role(s)
Fabricator		Design and construction
Installer		Installation and maintenance
Inspection body (AKI)		Inspection
User/owner		Licensor
Manager	User/operator	Operation and management
Supervisor	Manager hydrogen customer (e.g. a trained driver)	Supervision of the use of the hydrogen delivery installation
Hydrogen supplier		Filling the hydrogen storage unit

Annex K References

[1] http://www.arboportaal.nl/onderwerpen/veilig-werken/inrichting-werkvloer/explosieve-atmosfeer.html.

[2] QRA rekenmethodiek waterstoftankstations (QRA calculation method hydrogen filling stations) – RIVM – (being prepared).

Annex L Testing

Table L.1 shows the testing periods and also includes a practical maintenance schedule.

Table L.1 — Testing and maintenance schedule for hydrogen delivery installations

Activity (check for:)		Commissioning Testing	Routine inspections			Periodic reassessment	Routine inspections					Periodic reassessment
		Year										
		0	1	2	3	4	5	6	7	8	9	10
1. Leak tightness												
1.1	Before putting into service according to PRD Section 2.2	o										
1.2	Annual visual external inspection for leaks regarding cryogenic components		x	x	x	o	x	x	x	x	x	O
1.3	Gas tightness inspection (reservoir connections, flanged joints and accessories, for	o	x	x	x	o	x	x	x	x	x	O
2. Functional operation of accessories		o	x	x	x	o	x	x	x	x	x	O
3. Visual external inspection												
3.1	Corrosion	o	x	x	x	o	x	x	x	x	x	O
3.2	Damage	o	x	x	x	o	x	x	x	x	x	O
3.3	Contamination	o	x	x	x	o	x	x	x	x	x	O
3.4	Support and foundation for condition and damage	o	x	x	x	o	x	x	x	x	x	O
4. Functional protection												
4.1	Blow-off pressure safety cut-out according to PRD	o				o						O
4.2	Overfilling protection	o	x	x	x	o	x	x	x	x	x	O

Activity (check for:)		Commissioning Testing	Routine inspections			Periodic reassessment	Routine inspections					Periodic reassessment
		Year										
		0	1	2	3	4	5	6	7	8	9	10
4.3	Emergency shutdown devices	o	x	x	x	o	x	x	x	x	x	O
4.4	Gas detection	o	x	x	x	o	x	x	x	x	x	O
4.5	Alarm or notification systems	x	x	x	x	x	x	x	x	x	x	X
5. Documentation												
5.1	Inspection of log book					o						O
5.2	Vvl inspection, AKI reports	o				o						O
5.3	Checking of routine inspection reports		x	x	x	o	x	x	x	x	x	O
5.4	Installation schedule approved by AKI	o				o						O
6. Location												
6.1	See NPR 2578	o	x	x	x	o	x	x	x	x	x	O
7. Other												
7.1	Earthing	o	x	x	x	o	x	x	x	x	x	O
7.2	Warning signs	o	x	x	x	o	x	x	x	x	x	O
o = AKI x = authorised installer												

Annex M Composition of PGS team 35

Members of PGS team 35

Responsible persons (for definitions see annex A)	Corresponding term	Role(s)
Name	**Organisation**	**Sector**
Büthker, Erik	CNG Net	Chairman
Bastiaans, Jeroen	Antea Group	NL Ingenieurs
Bogaers, Pieter H.J.M.	SWING Fuel Stations BV	BOVAG
Bont, de, John	Linde Gas Benelux	VFIG
Boogert, van den, Hans	Lloyd's Register Nederland BV	VFIG
Bout, Peter	Air Products Nederland B.V.	VFIG
Dalhuijsen, Wouter	Hydrogen Efficiency Technologies (HyET)	Nederlandse Waterstof en Brandstofcel Associatie (NWBA)
Dijkhof, Paul	KIWA Nederland BV	NOBO (AKI)
Elliott, Alice	Shell Global Solutions International	VNO-NCW
Hoogerkamp, Paul	MECID BV	Ingehuurd expert (geen lid)
Martens, Hans	Air Liquide Benelux Industrial	VFIG
Matthijsen, Ad	RIVM	RIVM
Pasman, Peter	Omgevingsdienst Regio Arnhem	VNG
Schaap,Dirk	Ministerie I&M	Ministerie I&M
Schouten, Wim	Nederlandse Organisatie Voor de Energiebranche	Nederlandse Organisatie Voor de Energiebranche
Staaveren, van, Marieke	Brandweer Amsterdam-Amstelland	Brandweer Nederland (Dutch Fire Service)
Van den Boogert, Hans	Lloyd's Register Nederland BV	AKI/NOBO
Vijgen, Luc	DCMR Milieudienst Rijnmond	IPO
Vliet, van, Hans	TRIONpartners	Deltalinqs
Ronde, te, Indra	NEN	Projectleider