MultHyFuel

Deliverable 1.4

Permitting requirements and risk assessment methodologies for HRS in the EU (final version)

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Clean Hydrogen Partnership

Contents

Acronyms

HRS	Hydrogen Refuelling Station
ALARP	As Low as Reasonably Practicable
EU	European Union
AFID	Alternative Fuels Infrastructure Directive
AFIR	Alternative Fuels Infrastructure Regulation
SEA	Strategic Environmental Assessment
CNG	Compressed Natural Gas
LPG	Liquefied Petroleum Gas
CGH2	Compressed Gaseous Hydrogen
LH2	Liquid Hydrogen (cryogenic)
FCEV	Fuel Cell Electric Vehicle
QRA	Quantitative Risk Assessment
ATEX	ATmosphere EXplosible
EIA	Environmental Impact Assessment
SIA	Strategic Impact Assessment
NPF	National Policy Framework
DSB	Directorate for Civil Protection
MSB	Swedish Civil Contingencies Agency

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Executive Summary

Clean hydrogen and fuel cell electric vehicles (FCEV) have developed significantly in the past years in order to respond appropriately to the challenges associated with the transition to a net zero carbon economy.

Associated infrastructure, in particular, hydrogen refuelling stations (HRS) have also developed to respond to the increasing needs for hydrogen in the mobility sector. The need to mainstream hydrogen in the mobility sector requires higher levels of accessibility of HRS in the public environment.

In response to these challenges, the MultHyFuel project proposes to study how HRS can be relevantly and safely integrated in close proximity, alongside other conventional and alternative fuels for hydrogen mobility.

Deliverable 1.4 contains a comparative cross-country assessment of permitting requirements and public guidance on risk assessment methodologies covering HRS permitting across **14 European countries**, providing a **comprehensive cross-country review** of these elements and **gap analysis**. A strong network of national experts was involved in the process of gathering information from the different countries analysed (Austria, Belgium, Bulgaria, Finland, France, Germany, Hungary, Italy, the Netherlands, Norway, Poland, Spain, Sweden and the United Kingdom). In this report, an overview of the commonalities and gaps observed in the administrative framework is presented, alongside relevant examples in the approach adopted by the different Member States.

This report focuses mainly on permitting requirements, risk assessment methodologies commonly used, safety distances prescribed in legislation, equipment maintenance rules and mandatory/common practice mitigation measures applied.

Some countries where HRS is deployed, including Germany, France, Italy and the Netherlands already have hydrogen specific regulations in place. However, these regulations differ between countries, with risk assessment strategies and safety distances differing between the four countries. For example, the distance between the hydrogen dispenser and other fuels in Germany is prescribed as 15m, whereas in Italy it is 3m. In contrast, France prescribes safety distances dependant on dispenser flowrate. In most countries, the approach is to interpret industrial hydrogen, CNG or conventional fuel station rules and use them for the dispensing of hydrogen. This, combined with the fact that many countries leave it up to the operator to come up with their own safety distances for their own "engineering approach", makes it so that different safety distances will be allowed in different countries. This report also highlights knowledge gaps in relation to hydrogen storage equipment, the production of hydrogen on-site and the handling of liquid hydrogen. Finally, in countries where HRS is not deployed, the most pressing challenge is identified as the lack of experience that permitting authorities have in the field of hydrogen, which makes the process more difficult and time consuming, thus creating a barrier to HRS deployment. Thus, there is a need for harmonisation of regulation across all EU member states to facilitate the deployment of HRS.

1 Introduction

MultHyFuel's goal is to bridge the current gap in knowledge when it comes to safety in hydrogen dispensing around other fuels. This will be made through the acquisition of data regarding leakage characteristics, explosions and fire consequences, both on a theoretical and experimental point of view. The data acquired will help the Consortium to develop a more detailed risk analysis on HRS and come up with concrete guidelines that can be used by policy makers when designing the permitting and risk assessment requirements in their countries.

As it stands, the distribution of hydrogen is subject to a significant number of requirements, most of which can be traced back to EU law and more specifically directives in various fields which have been transposed in national legislation. Whilst this provides a common framework of requirements across all partner countries, these requirements need to be transposed in different national legal system, leaving significant differences in transposition, interpretation and implementation as the different administrations adjust the rules to their own legal systems, practice, while also trying to fill in the gaps in the regulatory framework.

In particular, the approach taken for the co-location of hydrogen with other fuels is left to be defined on a national basis. This leads to significant differences between countries as in some cases it is straight-forward to co-locate hydrogen with other fuels and integrate hydrogen into a conventional forecourt. In other countries, there can be significant minimum separation distances imposed between hydrogen and from other fuels, with a hydrogen dispenser needing to be either on an 'island' on its own or located away from the forecourt (or even not be permitted at all).

Deliverable 1.4 is a continuation of deliverables 1.2 and 1.3. Deliverable 1.2 aimed to contribute to the identification of relevant gaps in the current legal and administrative framework in the EU. Such a report was important to identify areas where relevant knowledge is still missing and guide the way for the other work packages within the project. It also helped to identify areas that go beyond the scope of the project but are worth exploring in the future. Deliverable 1.3 provided an update to the same report, improving its structure and understandability. Deliverable 1.4 stands as the final version of this report, which mention to any legislative updates that might have happened since the first publication of deliverable 1.2 in 2021. These updates will be highlighted throughout the text but it should be noted that the core research was performed in 2021

To develop 1.2, a research framework was created and distributed among different national experts to collect as much information about the permitting and risk assessment requirements at the national level as possible.

The report begins with a description of the methodology in the next chapter. To provide the basis for the analysis, chapter 3 provides a summarised description of the applicable EU legislation when hydrogen applications are concerned. Chapter 4, 5 and 6 present the outcomes of the analysis across the different countries, depending on whether they have legislation in place and whether public HRS have been deployed in those countries. Lastly, before drawing the main conclusions from the report in chapter 8, chapter 7 look at the deployment of HRS in multi-fuel scenarios.

2 Methodology

The purpose of the present report is to provide an overview of the practices in different Member States concerning the permitting of hydrogen refuelling stations, highlighting common practices and knowledge gaps with an emphasis on those where hydrogen is deployed next to other conventional fuels.

As the point was to understand the gaps in knowledge and difficulties regarding permitting across Europe, the selection of the **14 European countries** to analyse was focused to ensure a representative sample on the de facto situation regarding the topic. Thus, the selection of countries comprises those which have already deployed hydrogen refuelling infrastructure and those that are yet to do so. The final selection of countries includes Austria, Belgium, Bulgaria, Finland, France, Germany, Hungary, Italy, the Netherlands, Poland, Spain, Sweden, the United Kingdom and Norway.

The main method for data collection was expert survey, whereby national experts from their respective countries were sub-contracted to carry out in-depth research based on a questionnaire provided by the Consortium. The experts conducting the research were selected based on their experience analysing national regulation in the field of hydrogen. Some of the experts had already been involved in similar projects, namely the HyLaw project in 2018 which identified the legislation and regulations relevant to fuel cell and hydrogen applications and legal barriers to their commercialisation. The list of organizations from which national experts contracted can be found in Table 1.

Table 1 - Network of national experts to be involved in WP1.

COUNTRY	ORGANIZATION	EU COVERAGE & REPRESENTATIVENESS
AT	Austrian Energy Agency	
BE	WaterstofNet vzw	
BG	Bulgarian Hydrogen, Fuel Cell and Energy Storage Association	
FI	VTT Technical Research Centre of Finland LTD	
FR	France Hydrogene	
DE	ZSW Center for Solar Energy and Hydrogen Research	
HU	Hungarian Hydrogen & Fuel Cell Association	
IT	H2IT - Italian Hydrogen and Fuel Cell Association	
NL	NEN	
PL	NEXUS Consultants	
ES	Aragon Hydrogen Foundation	
SE	Hydrogen Sweden	
UK	ITM Power	
NO	Greenstat	

The questionnaire provided by the Consortium was prepared by Hydrogen Europe and ZSW, counting with the feedback of the remaining partners. The intention of such questionnaire was to provide the national experts with a common framework that would clearly set the expectations in terms of type of information needed without limiting the flexibility to build upon the questions and to provide more concrete information. The Questionnaire can be seen in Annex I.

The research framework was created to define the scope of the analysis and provide structure to the national experts‘ research. Specific questions were provided so that the real expectations of such analysis could be well understood by all participants. The scope of research on regulations, codes and standards for this framework included permitting requirements and, where applicable, public guidance on risk assessment methodologies for public outdoor HRS for mobile applications with the focus on road vehicles (trucks, buses, FCEV). The aggregate state of refuelled hydrogen could have been gaseous or liquid, which means that both compressed hydrogen (CGH2) in different pressure levels and LH2 were included. To keep the scope within an efficient frame, the focus of this framework was limited to <5.000kg H2-storage on-site, presenting the lower threshold of the Seveso III Directive. Topics like land use and planning fall outside of the scope of the analysis. On-site production of hydrogen fuel is also not included.

As countries will have different approaches in many of the points of research, it was obvious from the start that a very stringent framework would be too limiting for certain countries. The research framework included questions that tackled the following main topics:

- Permitting requirements;
- Risk assessment methodologies;
- Required safety distances;
- Equipment maintenance rules.

The national experts conducted their research independently, using methods such as analysis of relevant legislation and interviews with HRS operators and relevant public authorities. This report aggregates the research's key findings, highlighting the main commonalities and gaps found amongst the different countries.

Once the information was collected from all 14 national experts, a comparative analysis was carried out based on categories of countries with similar characteristics. The three categories, and corresponding sections below, are:

- Countries with public refuelling stations deployed and specific and hydrogen-specific regulation in place;
- Countries with public refuelling stations deployed but no hydrogen-specific regulation in place.
- Countries with almost no public refuelling stations deployed at the time of research;

Through this categorisation, the goal is to be able to compare the regulatory framework between similar countries, enabling the search for more general conclusions that are beyond any specific country.

For each of these sections, the main differences and commonalities in approach and the common gaps will be presented for the countries that belong to the specific group. At the end of the report, further conclusions with be drawn having a look at the 14 countries as a whole. Due to the qualitative nature of the data provided, most of the report will also present a qualitative approach on comparison for the most part.

3 Relevant European legislation

Despite the existence or lack of HRS specific regulation at the national level, different European directives and standards must be complied with by the countries. Before diving deep into the different national laws and procedures, it is useful to consider what are the provisions at the European level that define the framework. In the case of building an HRS, the most relevant directives can be seen in Table 2.

Table 2 - Relevant European legislation for HRS

Colloquial Name	Legislation
Alternative Fuels Directive	Directive 2014/94/EU on the deployment of alternative fuels infrastructure [1]
Alternative Fuels Regulation	Regulation (EU) 2023/1804 on the deployment of alternative fuels infrastructure [2]
Seveso III Directive	Directive 2012/18/EU on the control of major-accident hazards involving dangerous substances [3]
ATEX Workplace Directive	Directive 1999/92/EC on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres [4]
ATEX Equipment/Products Directive	Directive 2014/34/EU on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres [5]
Pressure Equipment Directive	Directive 2014/68/EU on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment [6]
Strategic Environmental Assessment Directive	Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment [7]
Environmental Impact Assessment Directive	Directive 2011/92 on the assessment of the effects of certain public and private projects on the environment [8]

While permitting remains a very localised process, the existence of directives presented in table 2, provides for minimum harmonising standards in every country. Yet, as the directives do not prescribe specific risk assessment methodologies, different approaches have been developed nationally.

Approaches to compliance also differ, as in some countries, the compliance with the Directives mentioned above is not actively checked during the permitting process, but fines may be applied if the operator does not comply with them.

3.1 Alternative Fuels Infrastructure Directive and Regulation

The Alternative Fuels Infrastructure Directive established a framework of measures for the deployment of alternative fuels infrastructure in the EU in order to minimize dependence on oil and to mitigate the environmental impact of transport. It required countries to develop national policy frameworks (NPFs) for publicly available refuelling and recharging points for alternative fuels deployment for electricity, natural gas (LNG & CNG) and hydrogen. It also included technical specifications for such recharging and refuelling points, and user information requirements.

The Directive was repealed in April 2024, by the Alternative Fuels Infrastructure Regulation [9], which further develops the common framework and sets out minimum requirements for the build-up of alternative fuels infrastructure. While it sets binding targets on recharging points and refuelling stations for hydrogen and liquefied methane, these are still to be implemented by means of Member States' national policy frameworks. It also contains provisions on common technical specifications and user information requirements.

Articles 6 and 7 detail the requirements for the deployment of hydrogen refuelling infrastructure:

- One HRS every 200km on the TEN-T Core network by the end of 2030. HRS along the network must be designed for a cumulative daily capacity of one tonne, with at least a 700bar dispenser;
- At least one HRS in every urban node by the end of 2030;
- Member States to set out a clear deployment trajectory that includes an indicative target for 2027 that is in line with market demand and ensures sufficient coverage;
- Daily capacity of HRS can be halved on roads whose average daily heavy-duty traffic is below 2000 vehicles and in case of justified socio-economic cost-benefit terms. Outermost regions and islands can also be exempted under certain conditions.

Annex II contains technical specifications for hydrogen supply for road transport, however these are not completely and comprehensively defined, and this responsibility is transferred to standardization bodies:

- Outdoor hydrogen refuelling points dispensing gaseous hydrogen used as fuel on board motor vehicles shall comply with the interoperability requirements described in standard EN 17127:2020;
- The quality characteristics of hydrogen dispensed by hydrogen refuelling points for motor vehicles shall comply with the requirements described in standard EN 17124:2022;
- The fuelling algorithm shall comply with the requirements of EN 17127:2020;
- Once connectors for the refuelling of vehicles with gaseous hydrogen that are certificated against the standard EN ISO 17268:2020 become available on the market, refuelling points shall be required to use connectors that comply with this standard.

Note 1: These dated references are anticipated to be updated periodically by delegated acts in accordance with Article 21 as revised versions of the standards referenced are published, for example EN 17127: 2024.

Note 2: EN 17127:2020 (contains 19 pages) refers within the scope to ISO 19880-1:2020 (contains 182 pages) The EN 17127 defines in 6.1 "Inspection prior putting into service and periodical inspection" which shall be covered by a Table of minimum Site Acceptance Tests (SAT) and Factory acceptance tests (FAT) which could be based on ISO 19880-1:2020, Annex C.

3.2 ATEX Directives

The two ATEX Directives [10] aim to control the risks caused by explosive atmospheres. The ATEX Workplace directive lays down minimum requirements on employers for protecting health and safety at work for employees in workplaces potentially at risk from explosive atmospheres.

Employers must take appropriate technical and/or organisational measures for the prevention of the formation of explosive atmospheres, or where the nature of the activity does not allow that, take measures to avoid the ignition of explosive atmospheres and reduce the effects of an explosion in such a way that the health of workers is not at risk.

One of the key features of the regime is the classification of hazardous areas in zones where explosive atmospheres might occur. The classification given to a particular zone, and its size and location, depends on the likelihood of an explosive atmosphere occurring and its persistence if it does. The main purpose is to facilitate the proper selection and installation of apparatus to be used safely in that environment, taking into account the properties of the flammable materials that will be present. Hazardous areas are classified into zones based on an assessment of the frequency of the occurrence and duration of an explosive gas atmosphere, as follows:

- **Zone 0:** An area in which an explosive gas atmosphere is present continuously or for long periods;
- **Zone 1:** An area in which an explosive gas atmosphere is likely to occur in normal operation;
- **Zone 2:** An area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it occurs, will only exist for a short time.

The ATEX Products Directive applies to manufacturers, importers and distributors who place on the market equipment or protective systems intended for use in potentially explosive atmospheres. It harmonises essential health and safety requirements to be complied with by manufacturers of ATEX equipment, including instructions for equipment categorisation, conformity assessment procedures and CE- and Ex-marking. The directive is supported by harmonized standards, compliance with which provides the presumption of conformity with the directive.

In general, while the workplace directive is not directly supported by standards, there are three standards, the compliance with which helps justify compliance with the directive:

- **EN 1127-1**: Explosive atmospheres. Explosion prevention and protection - Basic concepts and methodology;
- **EN 60079-10-1**: Explosive atmospheres Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas atmospheres;
- **EN 60079-10-2**: Explosive atmospheres Explosive atmospheres - Part 10-2: Classification of areas - Explosive dust atmospheres.

3.3 Seveso-III Directive

The current Seveso directive [11] is designed to prevent major accident involving dangerous substances through control measures and in case that an accident occurs, limit the consequences of it for humans and the environment. It provides the framework on risk management measures to prevent major accidents and to limit their consequences. The directive covers more than 12 000 industrial installations across the EU.

The Directive recommends that hydrogen storage on-site is limited to 5 tonnes, which is why the scope of the research carried out for the writing of this reports is also limited to this amount of storage.

Different regimes apply, depending on the amount of dangerous substances present, with stricter legal requirements applying to installations handling high amounts. Industrial plants are classified according to two categories: lower-tier establishments and upper-tier establishments. Lower-tier establishments have to report their activities to competent authorities and must create and implement a major accident prevention policy. The upper-tier establishments have additional obligations and are also required to prepare a risk report and emergency plans.

Additionally, the last revision of the directive also improved provisions on giving the public better access to information and better involvement in decision-making.

3.4 EIA & SIA Directives

The Environmental Impact Assessment (EIA) Directive [12] requires that major building or development projects in the EU must first be assessed for their impact on the environment before the project starts. The EIA assesses the direct and indirect significant impact of a project based on a wide range of environmental factors, including: population and human health, biodiversity, land, soil, water, air, climate, landscape, material assets, cultural heritage. With its wide scope and broad purpose, the EIA aims to ensure that environmental concerns are considered from the very beginning of new projects, or their changes or extensions.

While an EIA is mandatory for certain listed projects, for other urban or industrial projects it is up to countries to decide. Member States can decide an EIA will be necessary either on a case-by-case basis or by setting specific criteria (such as the location, size or type of project).

In cases where an EIA has to be carried, the project developer must provide the approval authority with a report containing the following information: description of the project (location, design, size); potential significant effects; reasonable alternatives; features of the project and/or measures to avoid, prevent, reduce or offset likely significant impacts on the environment.

There are also strict rules about how the public is informed of the project and the EIA procedure in order to guarantee transparency with regard to the decision-making process. The procedure allows the public to actively engage in the EIA procedure, especially so that those affected by the project participate in the decision-making process. The public is also informed of the final decision and can then challenge it before the courts.

The objectives of the Strategic Environmental Assessment Directive are to provide a high level of protection to the environment and contribute to integrating environmental considerations into the preparation, adoption and implementation of plans and programmes to promote sustainable development. To achieve this, an environmental assessment must be carried out according to the Directive's provisions for plans and programmes identified as likely to have significant effects on the environment.

The SEA Directive applies to a wide range of public plans and programmes, including land use, transport, energy, waste, agriculture. To decide whether a plan and programme falls under the scope of the SEA Directive, the following four criteria should all be met: be subject to preparation and/or adoption by an authority at national, regional or local level, required by legislative, regulatory or administrative provisions, prepared by any of the sectors listed in Article 3(2)(a) of the Directive, sets the framework for future development consent of projects listed in Annex I and II to the EIA Directive. [13]

3.5 Pressure equipment directive

The Pressure Equipment Directive (PED) [14]. applies to the design, manufacture and conformity assessment of stationary pressure equipment with a maximum allowable pressure greater than 0,5 bar. It ensures the free movement of pressure equipment within the EU by harmonising the national safety and health protection requirements to which they are subject. Pressure equipment according to the Directive are vessels, piping, safety accessories and pressure accessories. It determines the objectives or "essential requirements" which the above-mentioned equipment must satisfy at the time of manufacture and before it is placed on the market.

3.6 International Standards

There are also International standards specific to hydrogen refuelling stations, such as ISO 19880-1:2020 [15] that are frequently referenced by the Member States in their methodology for assessing compliance of hydrogen refuelling stations. AFIR, Regulation 2023/1804[1], which prescribes compliance of the standard EN17127 for technical specifications in HRS and ISO 19880-1:2020 for safety related issues.

ISO 19880-1:2020 defines the minimum design, installation, commissioning, operation, inspection and maintenance requirements, for the safety, and, where appropriate, for the performance of public and non-public fuelling stations that dispense gaseous hydrogen to light duty road vehicles (e.g. fuel cell electric vehicles). Since this document is intended to provide minimum requirements for fuelling stations, manufacturers can take additional safety precautions as determined by a risk management methodology to address potential safety risks of specific designs and applications.
Note: ISO 19880-1 is under the responsibility of ISO/TC 197 – Standardization in the field of systems and devices for the production, storage, transport, measurement and use of hydrogen.
ISO 19880-1:2020 applies the following definition for risk assessment: "Risk assessment is the overall process of risk identification, risk analysis, risk evaluation, and risk mitigation. Use of risk assessment may allow station owners and designers to flexibly define station-specific mitigations that achieve an equal or better level of risk to those of prescriptive recommendations or to relax existing prescriptive mitigation measures as long as the total system risk remains below the selected tolerability threshold (risk acceptance criteria). (…) **The risk assessment should demonstrate that the mitigation measures employed are appropriate to achieve the desired level of risk of the station**."

- Chapter 5.1 lists the elements of a hydrogen fuelling station to be considered potential hazard sources.
- Chapter 5.2 specifies to carry out a quantitative and/or semi-quantitative risk assessment instead of prescriptive requirements. According to this, risk management should consider (i) the nature of the hazards, (ii) the behaviour of hydrogen under the design and operating conditions, (iii) equipment design and operating conditions, (iv) installation design and location, including protection measures as well as (v) specific targets (e.g., person, property, equipment) which are being protected from effects of potential hazards. More details are given in the annex to ISO 19880 [30].
- Chapter 5.3 explains mitigation measures. This includes e.g. pressure relief devices or the mitigation for the formation of a flammable mixture in enclosures.

In Annex A3.1, A3.2, ISO 19880-1:2020 standards also add: **"It may be possible to use quantitative risk assessment (QRA) and/or semi-quantitative (e.g., consequence-only) analysis instead of prescriptive requirements to allow the hydrogen fuelling station to use alternative methods which are of an equivalent, or higher, level of safety to the prescriptive requirements. Using**

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R1804

QRA may allow (for instance using mitigation measures) for shorter safety distances and/or simplified station layout. (…) A semi-quantitative risk assessment provides an intermediary level between the textual evaluations of qualitative risk assessment and the numerical evaluation of quantitative risk assessment, by evaluating risks with a score. Semi-quantitative risk assessment provides a structured way to rank risks (…) Risk assessment provides a framework to establish a common understanding of the system safety level based on robust science and engineering models."

4 Countries with HRS deployed and hydrogen specific regulations

The most advanced countries within the scope of the study having both HRS specific guidelines or legislation and already deployed HRS are Germany with 96 stations, France with 27, the Netherlands with 24, Sweden with four and Italy with one [16].

At the time of research and release of the first version of this report back in 2021, the currently existing guidelines for Sweden were just under development but not published yet. These guidelines were published in 2023. While this final version of the report intends to mention any market and legislative updates that have happened since the first publication in 2021, it does not intend to carry another in-depth research on new methodologies. For this reason, Sweden's case is still detailed in the next chapter of this report together with the countries that had no HRS specific guidelines at the time of research.

4.1 Available guidance and legislation for the deployment of HRS

	Country	Main guidance documents (HRS-specific)
HRS guidelines	Sweden	Instructions - refueling stations for hydrogen-powered vehicles, H2-TSA 2023
	Netherlands	Permitting Process on Hydrogen Refuelling Stations (English)
HRS legislation	Germany	TRBS 3151 Prevention of fire, explosion and pressure hazards at petrol stations and gas filling stations for filling land vehicles (German)
	France	Practical guidelines from regulation n° 1416 by France Hydrogene (French)
	Italy	Fire prevention technical rule for the design, construction and operation of hydrogen distribution systems for motor vehicles (Italian)

4.2 Permitting requirements

In relation to permitting requirements, in **Germany**, the current version of the Technical Rule for operational safety TRBS 3151 [17] from 02/2024 provides as a refinement of the Ordinance on Industrial Safety and Health (german BetrSichV) [18] detailed requirements for HRS. TRBS 3151 gives in Section 3 instructions on how risk assessment shall be done to the specific topic (fuelling stations) and references for methodology in general to:

- TRBS 1111 "Hazard assessment and safety assessment";
- TRGS 400 "Risk Assessment for Activities involving Hazardous Substances".

In the **Netherlands**, the Hazardous Substances Publication Series (Publicatiereeks gevaarlijke stiffen - PGS) [19] provides the guidelines for managing hazardous substances. Depending on the amount of hazardous substances, to be stored, compliance with additional regulations might be required from the obligations under the Major Accidents Risks Decree 2015 (Besluit risico's zware ongevallen 2015) [20]. Thus, it is recommended that project initiators contact the Directorate-General for Public Works and Water Management on whether the Decree applies to the project.

As for PGS, the publication represents guidelines for companies that produce, transport, store or use hazardous substances and for the governmental entities tasked with the supervision and licensing of those activities. They are guideline documents about specific activities, which comprehensively describe the main risks associated with those activities in relation to environmental safety, fire safety and the safety of employees. They are formulated under a management organization, placed under the Dutch institute for standardization, in a process of mutual consultation between business and authorities.

At the moment, the only guideline in relation to hydrogen refuelling under the PGS is PGS 35:2021 on Hydrogen installations for delivering hydrogen to vehicles and equipment (Waterstofinstallaties voor het afleveren van waterstof aan voertuigen en werktuigen). It is the basis for the technical configuration of the HRS and is used in the permitting process.

In **France**, the operation of hydrogen gas distribution stations falls under item n°1416 (Stockage ou emploi d'hydrogène) [21] of the ICPE nomenclature, which covers all “refuelling stations, open or not to public, where gaseous hydrogen is transferred into vehicle tanks and where the daily distributed quantity is superior or equal to 2 kg/day”. Since such station will often be accompanied by storage of hydrogen, the amount of hydrogen to be stored will play an important role in the determination of which regime is applicable.

Italy has a significantly prescriptive permitting procedure for the deployment of HRS, which gives more guidance to the operator, but also less flexibility. Even in this case, however, there are exceptions where the operator can opt for an “engineering approach” (i.e. perform its own analysis), which enables for a degree of subjectivity. Moreover, local authorities may require additional fire protection measures to what is required in regulation.

Even in countries where hydrogen-specific regulation is in place, the responsibility for the correct assessment of risk is transferred to the operator and rules can be open to interpretation.

4.2.1 Different criteria

Within each country, the type of procedure to follow may differ according to different criteria such as the amount of hydrogen stored on-site, the openness of the refilling station to the public, and others. **In some cases, a permit may not even be needed and can be replaced by a simple notification procedure.**

In **France**, the procedure and regulation that apply depend on the size of the refuelling station:

- A station which **does not distribute more than 2 kg** of hydrogen per day, and which can store less than 100 kg of hydrogen will not require any formality, except build permit if build area is more than 20 m².
- A station that can distribute **over 2 kg** of hydrogen per day and which can store less than 100 kg of hydrogen must be declared to the prefecture of its location under heading n°1416 and periodically checked must be performed.
- A station that can distribute more than 2 kg per day and which can store **over 100 kg**, but less than 1 ton of hydrogen will have to be declared under heading n°1416 [21] and heading n°4715 [22] simultaneously, and periodically checked must be performed.
- A station that can distribute more than 2 kg per day and which can store **over 1 tonne** of hydrogen must be declared under heading n°1416 and authorized under heading n°4715.

In **Germany**, the amount of hydrogen stored on-site will change the regulations that must be followed in the permitting procedure:

- Storage **below 3 tonnes** will require a procedure according to the Ordinance of Industrial Safety and Health for construction and operation permit, as well as a building permit according to Federal State Building Regulations [23];
- Storage **over 3 tonnes** will involve a simplified permit procedure according to the Federal Immission Control Act [24] for granting construction an operation permit (includes the building permit as well) Formal permit procedure with the environmental impact assessment is only needed when storage exceeds 30 tonnes of hydrogen, which is out of scope of this research).

Still in Germany, private stations do not need as many approvals before getting their permit. Some safety distances may also be different. There is also a limit in quantity of different fuels in a station. Therefore, if the station includes fuels like LPG, CNG or LNG, the capacity of hydrogen storage will consequently be added to the total amount. The sum of these fuels is then limited to the 3 or 30t as described above.

In many countries, adding specific barriers, such as fire safety walls, allow for a decrease in safety distances around the different equipment. In fact, fire walls are a common mitigation measure applied during the construction of HRS. Another important feature mentioned by most of the countries was the mandatory emergency shutdown that is activated both through gas detection and manually.

4.3 Risk assessment methodologies

Regarding risk assessment methodologies, different common standards are usually followed by the countries. The most relevant is ISO 19980-1:2020 concerning Gaseous Hydrogen – Fuelling Stations. This document defines the minimum design, installation, commissioning, operation, inspection and maintenance requirements, for the safety, and, where appropriate, for the performance of public and non-public fuelling stations that dispense gaseous hydrogen to light duty road vehicles (e.g. fuel cell electric vehicles).

Despite this common standard, in most countries different non-HRS-specific ordinances must be considered while performing the risk assessment to ensure that the requirements concerning explosive atmospheres and safety with hazardous substances are met. Overall, the operator usually has a high degree of freedom in terms of the risk assessment methodology applied, as long as risks are kept to a minimum. In some countries, however, common practices exist.

In the **Netherlands**, it is necessary to perform a Quantitative Risk Assessment (QRA) to get the permit to operate. The QRA guidelines are provided under SAFETI-NL documentation with specific frequencies of failure for different scenarios. For the QRA, threshold values method is used, with specific acceptance criteria in place: vulnerable objects cannot be present within a “10-6 contour”: zone where the chance of a fatal accident to occur is 1 in 1,000,000 per year. An Hazard and Operability (HAZOP) study is not required to get the permit but must be performed before the HRS initiates operation.

Risk assessment in **Germany** follows guidelines provided in EN ISO 12100-1 (german version DIN EN ISO 12100-1) for machinery (now supplemented, for HRS, by ISO 19880-1:2020), EN 61511 (functional safety), EN 1127-1 (Explosive atmospheres) and other relevant national regulations such as the

Ordinance on Industrial Safety and Health [18], Hazardous Substances Ordinance [25] and Workplace Ordinance. Under this legislative framework, the HRS operator is required to carry out a risk assessment before selecting and procuring work equipment, carrying out activities with hazardous substances and setting up and operating workplace for the first time. Different materials exist to assist the operator in carrying out the risk assessment in conformity with the relevant ordinances.

In **Italy,** a full risk assessment analysis is only needed if the operator wishes to apply different requirements (for example, different safety distances) than the ones prescribed by Ministerial Decree 7/8/2018 [26]. In this case, the operator opts for the engineering approach, where different requirements exist for different components, and they follow a specific national directive.

In **France**, risk analysis is only necessary for installations storing more than 1 tonne of hydrogen. For HRS that store more than 1 tonne of hydrogen, the operator can follow the methodology proposed by the 2010 circular [27] (although only the piping methodologies are applicable for hydrogen) but can also use its own methodology as long as he is able to justify that the scope and the completeness of the study are adequate. A risk ranking matrix is usually the method used. The critical scenarios are evaluated in terms of probability and severity (based on people exposed, not fatality), and a matrix such as the one presented in Figure 1 is developed. If at the end of the risk analysis one of the scenarios is in the red zone, the authorization will be refused. In addition, there must be no more than 2 scenarios in the orange zone otherwise the authorization will also be refused.

Figure 1: Rapid Risk matrix used in France.

		PROBABILITY (per year)				
		A (<0.001)	B (0.01-0.001)	C (0.1-0.01)	D (1-0.1)	E (10-1)
Consequence severity	1 (Catastrophic)	H	H	H	H	H
	2(Severe loss)	M	H	H	H	H
	3 (Major damage)	M	M	H	H	H
	4 (Damage)	L	L	M	M	H
	5 (Minor damage)	L	L	L	L	M

As is seen from the previous paragraphs, despite some harmonisation at the EU level through the directives, **risk assessment European methodologies used in Europe are different from country to country.** Both the Netherlands and France have prescribed acceptance criteria, but they are different as one is based on a threshold for the probability of a fatal accident to occur while the other is based on the number of people exposed regardless of fatality. The overall methodology is also different and pulls from different databases to assess the frequency of failure of different scenarios.

4.4 Safety distances

In **Italy**, specific safety distances between hydrogen equipment and other elements of the station are prescribed in legislation. Alternatively, the operator can opt for the "engineering approach" where a dedicated safety and risk analysis study is carried out and the professional person conducting it becomes directly responsible.

The **Netherlands** has a similar approach where safety distances are prescribed but may be reduced if relevant mitigation measures (such as the additional of a fire wall) are in place. Correct mitigation measures should be discussed between the authorities and safety experts.

In **Germany**, recommended safety distances for HRS exist mainly in the TRBS 3151 [17]. However, they are often defined by the manufacturer in their own way, typically based on regulations of their country of origin or international documents. If the operator opts for shorter distances than the ones recommended in the guidelines TRBS 3151, he does it on his own risk. The manufacturer is open to liability claims.

In **France**, distances depend greatly on the dispenser flowrate. A triple distinction is made between dispenser with a maximum flow rate per design of 20 g/s, 60 g/s and 120 g/s as seen in the table below. Distances can be reduced if relevant mitigation measures are in place, which are described in the legislation. The safety distances applicable to the storage area may vary if the installations contain more than 1 ton of hydrogen. The prefect may ask in his authorisation order for more restrictive measures than the general prescription orders initially provided to control the risks of installation. In fact, these safety distances were adopted at the beginning of the hydrogen mobility applications and efforts to update them are currently being made.

It can be concluded that, for this group of countries where hydrogen refuelling specific legislation exists, safety distances are prescribed but flexible. For most of them, there is one single safety distance independently of the type of station. An outlier to this is France, where safety distances depend greatly on the dispenser flowrate.

What becomes obvious is that, even for these more experienced countries, safety distances are still very unharmonized. Italy stands out as the country where distances are, in general, larger. It should be noted that, among these countries, Italy is the one with only one refuelling station currently operational. During research it was not possible to fully understand how these safety distances were defined in Italy. One should not exclude the possibility that lack of data may have pushed the authorities to adopt more conservative prescribed distances.

Table 3 – Ranges of safety distances in countries with deployed HRS and specific legislative framework.

	Italy	The Netherlands	Germany	France
Between the hydrogen dispenser and CNG/LNG dispenser	12 m	5-15 m	No distance	14 m (120 g/s), 10 m (60 g/s) or 2 m (20 g/s)
Between the hydrogen dispenser and other fuels dispensers	15 m	2.5-8.5 m	No distance[2]	14 m (120 g/s), 10 m (60 g/s) or 2 m (20 g/s)

[2] In the case of a combination of a dispenser for hydrogen with other dispensers, all parts of the system must be designed for explosion group IIC (or IIB+H2) and for temperature class T3, as defined in Directive 2014/34/EU. The possible release quantity in the event of leaks from refuelling hose lines for gaseous fuels shall be limited to a harmless level. This is fulfilled for hydrogen if a) there is an automatic check of the

Between hydrogen dispensers and other non-H2-equipment except vehicles	12 m	2.5-3.5 m (shop)	2 m	14 m (120 g/s), 10 m (60 g/s) or 2 m (20 g/s)
Between hydrogen storage and other equipment	15 m	2.4-5 m (pipeline, tube trailers)	5 m	8 m open air 5 m closed
Between hydrogen compressors and other equipment	15 m	2.4-5 m (pipeline, tube trailers)	3 m	No specific distance

4.5 Regulated mitigation measures

Additionally, to the application of adequate protection distances surrounding the installation's equipment, other mitigation measures can be put in place with the goal of limiting the impacts of hazards. Mitigation measures to improve system safety are included in ISO 19880-1:2020 to be complied with by all Member States. Additionally, all ATEX zones must be well ventilated.
A common practice is also to add fire protection walls which allow to reduce safety distances, and buildings inclosing and surrounding possibly explosive atmosphere must be made of non-combustible materials.

Despite some common approaches, most countries will define their own mitigation measures. The sections below show some examples for specific countries.

4.5.1 Measures against fire and domino effects

In **Italy**, operators are asked to co-locate all dangerous elements (in practice all elements of an HRS) in "boxes", that is, at least two sides must be protected with walls of steel reinforced concrete or other materials with similar mechanical properties. Specific measures for the different pieces of equipment are also found in national guidelines:

- The areas in which the dangerous elements of the plant are placed, with the exception of the supply units, must be fenced for a height of not less than 1.8 m so that such elements are inaccessible, and tampering can be prevented. This fence must be placed at a distance from the elements of the system that allows safe operation.

- **Compressor:** The compressor must have an emergency shut-off device that stops its operation when the pressure on the suction side drops below the minimum supply pressure. Each compressor must be equipped with a safety system to prevent overpressure as well as a system of relief valves for emergency depressurization. The compressors must be placed in boxes with walls in concrete or other non-combustible material with adequate mechanical resistance such as to ensure the containment of any splinters projected towards external buildings.

connection of the refuelling hose to the refuelling connection of the motor vehicle so that refuelling is not started in the event of a leak, b) there is automatic monitoring of the refuelling so that refuelling is stopped immediately in the event of a leak, (c) the hose is safely depressurised via a blow-off line by discharging the hydraulic fluid via the vent mast/chimney; and d) after refuelling, the refuelling hose is pressure-free;

- **Storage unit**: Each gaseous hydrogen storage unit must have the following safety requirements: the support structure, if present, must be incombustible and have at least R60 fire resistance characteristics or be protected in order to guarantee performance equivalent to R60; have safety devices that prevent the pressure from exceeding the design value, regardless of the storage temperature; have a safety device, thermally activated, which intervenes in case of exceeding the design temperature of the shell; each storage unit must be isolated from the rest of the system by means of emergency shut-off valves. The storage units must be placed in a special box as for the compressors. If the total volume of the deposit is greater than 6000 Nm^3, the box must be divided into portions delimited by walls built in reinforced concrete, or in other non-combustible material of adequate mechanical resistance, with construction characteristics of the artefacts such as to guarantee mitigation only perimeter. The storage units must be arranged inside each box in such a way as to limit the risks of direct impact of a possible release from one unit to the adjacent one. The storage units must be positioned at such a distance from each other and from the walls of the box as to guarantee the carrying out of surveillance and maintenance operations.

4.5.2 Barriers to the process flow

In **Germany**, the maximum flowrate is dependent on the used refuelling protocol. For SAE J2601-HRS it is limited to 60 g/s. For HD refuelling protocol currently under development by CEP, to 120 g/s. Higher flows will be allowed with new protocols, e.g. the SAE J 2601-5 or upcoming within the ISO 19885-3.

Other measures required in **France** include:

- On the compressor:
  - A pressure measurement device must be linked to an automatic shutdown system in case of overpressure or low pressure at suction.
  - A valve is positioned at the exhaust with a venting placed high up.
  - A temperature measurement device should ensure that the compressor is working properly.

- The distribution line must be equipped with:
  - A flow regulator to limit the rise in temperature in the vehicle's tank.
  - A positive isolation valve.
  - A safety valve.
  - A hydrogen detector in the distribution unit and a detection system that detects any abnormal pressure drop or rise and triggers an emergency shutdown.

- The distribution connector must be:
  - Specific to a given flow and pressure.
  - Equipped with a check valve or equivalent device preventing any air entrance.

In **the Netherlands**, HRS specific guidelines state that in case of power cut, all valves are in safe mode. Moreover, specific technical safety measures for hydrogen installations are also mentioned. It is stated that burdening of the installation is turned to safe mode when it overpowers the design limits. Oxygen should not be able to penetrate the hydrogen-carrying parts of the installation. Hydrogen should not be able to accumulate in any part of the installation.

4.5.3 Protection from collision

To protect the hydrogen equipment from collision, some countries rely solely on safety distances, while others add some collision barriers as a way to mitigate effects of future accidents.

In **France**, specific measures must be taken to protect the hoses from physical damage. It must be:

- Equipped with an anti-snatching out system.
- Equipped with a safety device in case of snatching or bursting.
- Protected from abrasion and folding.
- Installed in such a way that no vehicle can ride on it.
- Installed so that it does not touch the ground.
- Changed in case of deterioration.

In many countries, all the equipment except the dispenser (which needs to be used by the consumer) must have restricted access to personnel only. It is also common practice to have a fence 1.8 m high surrounding the areas where this equipment is installed.

4.6 Equipment maintenance

In the **Netherlands**, hydrogen equipment needs to be inspected every year by an accredited mechanic. An inspection by the dedicated authority (CBI) needs to be performed in year 1, 4 and 10.

In **Italy**, the interval varies greatly on the type of hydrogen component. Dispensers, hoses, cooling equipment will have to be inspected every year, while the storage system can be verified only once every 2 years. For the compressor every year the check valves, piston rings and guide ring should be checked, while the piston set, and the drive set can be verified every two years. Still in the compressor, the crankshaft bearings must be replaced every 8 years. Safety valves must be checked twice a year.

In **Germany**, the inspection period for the pressure equipment is determined during the risk assessment. Maximum intervals are defined within the Ordinance on Industrial Safety and Health [18]. Pressure vessels shall be inspected externally in 2 years , internally every 5 years with strength testing every 10 years maximum. Piping system must be checked every 5 years maximum. Safety valves must be checked with every external inspection of the system, which means that safety relief valve of a pressure system will be checked every 2 years in maximum.

In **France**, pressure system must be checked every 4 years (but 3 years after being commissioned). Safety valves must be calibrated on a regular basis to the manufacturer's recommendations, at least once a year.

Table 4 – Maintenance periods for different equipment in observed countries.

	Piping	Storage	Pressure system	Safety valves
France	Flexible	4	4	1
The Netherlands	1	1	1	1
Germany	5	max. 5 years	2	2
Italy	10	2	1	0.5

5 Countries with public HRS deployed but no hydrogen fuel specific regulations

The second group of countries assessed, which have deployment of HRS, but no specific regulations to guide permitting, consists of Austria with five refuelling stations, Belgium with nine, Norway with one, Spain with four, Sweden with four and the United Kingdom with seven [9]. Finland does not have any public stations currently operational, but several are at advanced stages of development and permitting, which is why this country is also included in this chapter.

To proceed with permitting in these countries, operators are often engaged from the very early stages of the process with the responsible authorities in order to be aware of the procedures and rules to be followed to obtain all relevant permits.

Once again, it should be noted that Sweden stands out among these countries as the only one with a current set of guidelines that summarizes the main rules for deployment of HRS, published in 2023 and in Swedish [28]. This set of guidelines is not free of charge and is not a piece of legislation but it helps the operator navigate through the different requirements and provides enough recommendations to have a successful permitting application. At the time of the research, such guidelines were still under development, therefore the processes here described are not using these guidelines as a source, something that the reader should bear in mind.

5.1 Permitting requirements

Within each country, the type of procedure to follow may differ according to different criteria such as the amount of hydrogen stored on-site, whether the stations is open to the general public or it is intended for private use, among others. **In some cases, a permit may not even be necessary and the permitting procedure is replaced by a simpler notification procedure.**

As there is no specific regulation for the refuelling of hydrogen, industry regulation for hydrogen or conventional fuel regulations are used as a basis instead.

For example, in the **UK**, the Petroleum Agency is normally the Authority involved in the permitting process. The British Compressed Gases Association has specific guidelines for the design, construction, maintenance and operation of refuelling stations dispensing gaseous fuels, but no standard procedure for the permitting of hydrogen refuelling stations is yet in place.

In **Spain**, no procedures have been designed specifically for HRS. The commissioning communication procedure for "Gas Vehicle Service Stations: Communication for Commissioning" is the same communication permit to be notified by CNG stations of which some are already in operation and other multifuel stations.

In **Norway**, the Directorate for Civil Protection (DSB) handles the „ Act relating to the prevention of fire, explosion and accidents involving hazardous substances and the fire service Directorate of Civil Protection and Emergency Planning “. The Act is not hydrogen-specific, but more broadly applied to dangerous goods, pressurized equipment, etc. There are guidelines with pre-accepted solutions, but it is up to the operator to decide how to organise the layout as long as sufficient evidence is presented to prove that the safety requirements are met. Normally, the station only needs a thorough permitting procedure if the storage capacity is over 5 tonnes, or the supply of hydrogen is done through pipeline with pressure over 16 bar. However, DSB is free to request permitting requirements for any other station, if they determine that it requires special attention.

As for **Sweden**, it is the municipality that handles the process for permitting, but usually delegates the tasks regarding flammable and explosive goods to the emergency services. These emergency services are supervised on a national level by the Swedish Civil Contingencies Agency (MSB). These authorities have experience with hydrogen use in industry. Municipalities with less experience may refer to the MSB for advice. The regulation does not prescribe specified safety measures, but rather requires that the safety measures in place are “adequate”, “done in a safe manner” or “satisfactory safe”. What might be considered adequately safe is generally decided by the administrator handling the permit request. The regulation provides a recommended interpretation, but also clearly states that there may be situations where the conditions deviate from what the tables assumes, which may lead to other safety distances.

In **Belgium**, a permit is necessary. Despite the existence of a general framework for permitting an HRS as part of multifuel refuelling stations, there is limited practical experience among permitting authorities. There are currently nine HRS that are part of a multifuel refuelling stations, that have successfully completed the permitting process, however since they are located in different provinces with different permitting authorities involved, generalisations are difficult to make. The Flemish Regulations on Environment Permitting (VLAREM) specify the application permitting conditions for class-I installations, but fail to provide specific guidelines for hydrogen like they do for LPG or CNG. **There is, however, a Best Available Technologies (BAT)** [29] **report in Belgium specifically for hydrogen refuelling stations that serves as a guideline for operators and authorities and tries to fill in the gap.** Additionally, the Dutch PGS35 and the EIGA Doc 15/06 are often consulted for the same reason.

A key goal of the BAT study is to provide well-founded recommendations for a specific VLAREM framework of conditions. The study emphasizes the measures required to operate a hydrogen refueling station safely and in an environmentally friendly manner. Due to factors like high storage and compression pressures, the study includes specific measures to mitigate associated risks, such as calculating internal separation and risk distances. The scope of the study covers stationary hydrogen refueling stations that:

- Receive hydrogen from local production, pipelines, or delivery by tube trailers or battery vehicles (where the trailer is either unloaded or remains full);
- Include a compressor to increase pressure to 450 and 950 bar for dispensing hydrogen at 350 and 700 bar, respectively;
- Can deliver gaseous hydrogen to vehicles at pressures of 350 and 700 bar.

The requirements and the permitting process in **Finland** concern to the handling and storage of hydrogen in general, with no specific rules targeting HRS. Usually the requirements for permitting of CNG and CBG (Compressed Biogas) refuelling stations are referred to. Permit is necessary from the Finnish Safety and Chemicals Agency (Tukes), only if the station stores over 2 tonnes of H_2. Although the correspondent for Finland has indicated that there is no room for interpretation of the rules, the lack of hydrogen specific rules enables that some interpretation is possible.

In **Austria**, the permitting process for public HRSs is consent-based due to the Austrian Trade, Commerce and Industry Regulation Act [30], which stipulates that the district administrative authority acts as a one-stop-shop for permitting HRS, based on the ordinance of equipment for filling stations, explosion protection, etc. There are currently no publicly available guidelines for permitting HRS in Austria, so project developers do not have any specific regulatory framework to rely on. The relevant public experts in the permission process have great discretion in the permitting process. Some of them have been reported to use existing German norms, others draw analogies with other permitting procedures such as refuelling stations for gaseous fuels. Permitting is required, but the different levels depend on the decision of the authorities.

5.1.1 Different rules according to different criteria

Generally, the process to be followed and the rules for permitting can may change according to whether the refuelling station is open to the general public or not. HRSs open to the public will normally involve competent authorities in the permitting process and be guided by more stringent permitting processes compared to those which are intended for private use.

Another important criterion which will determine the ease of permitting is the amount of hydrogen stored on-site. Different countries apply different thresholds in this regard and table below provides examples where the size of hydrogen storage will lead to different permitting requirements. It shows that, in some countries, the process can be rather simple for stations with a storage of less than 2 tonnes of hydrogen on-site. For example, in **Norway**, the rules applicable to those stations require a formal permit from the authorities and this is followed even in cases where such permit is not formally required (as the station is still eligible to be inspected).

In **Austria**, different volumes of hydrogen stored on-site will result in different safety distances.

Table 5 – Thresholds of hydrogen storage on-site which determine permitting procedure

Country	Range where additional rules apply	Rules that apply
United Kingdom.1	> 2 tonnes	Assessment is required from the Hazardous Substances Agency.
United Kingdom.2	> 5 tonnes (or less when there is the storage of other dangerous substances, such as LPG)	HRS 2falls within the scope of COMAH regulation and more stringent rules apply.
Finland	> 2 tonnes	Permitting is required and falls in the scope of Tukes.
Norway	> 5 tonnes	Permitting is required.

Another important criterion is whether hydrogen is produced on-site or not. If production takes place on site, it can easily change the process of permitting, making it significantly more onerous for operators. For the sake of simplicity, this analysis does not include production of hydrogen on-site, but it is an important factor to be aware of.

5.2 Risk assessment methodologies

In **Austria**, all five public HRS had to submit a Hazard and operability study (HAZOP) as described in ISO 19880-1, which included a description of when and how safety valves or emergency stop switches react in case of risks or events and what their state is following the reaction. It also includes information and instructions on who and what actions must be taken in the event of damage.

In **Belgium**, there are standardised methodologies and guidelines, but they are based on historical industrial data which is not hydrogen specific. HRS multi-element components such as the electrolysers or steam reformers, are represented as a combination of standardized components (see file for details on what the risk assessment looks like).

As for **Spain,** there is no prescribed methodology to be followed. It is up to the engineers who will design the infrastructure and to select and specify the measures and the risk evaluation that are to be followed and under which conditions are to be followed.

In **Finland**, the legislation does not set requirements for qualitative risk assessment or use of certain risk-analysis methods. Neither an acceptable risk level has been set. However, for the permitting process a summary of the hazards identification and risk assessment results are required. The results must describe the typical and maximum possible accidents of the plant, as well as their consequences inside the plant, and the effects outside it. In addition, the causes of the accidents, their probability or the circumstances and situations in which they may occur must be reported. According to the guidelines provided by Tukes, risk assessment must include:

- detailed (verbal) description of possible accidents, including causes of accidents, progress of the events (accident scenario) and the possible consequences (e.g. toxic release, fire, explosion)
- estimates of the accident probabilities or the circumstances in which accidents are assumed to be possible (no numerical probabilities are required)
- extent and severity of the effects of the accidents (for example, the distance at which thermal radiation, pressure effects or concentrations of hazardous substances may cause danger or damage).

In **Norway**, the QRA guideline [31] (only for HRS over 5 tonnes of storage) is described in detail, the main details of which are:

- **Identification of hazards** and unwanted events. All possible events at the facility should be assessed, including leaks and incidents related to the equipment listed. A detailed HAZID sheet with key words/lead words is given in Appendix A to the guideline. Based on the HAZID a list of top events is established for further assessment
- **Assessment of consequences** of all top events. For every scenario the consequences in terms of fatality for humans are assessed based on harm criteria for radiation and explosion pressure.
    - Harm criteria for radiation is given in guidelines
    - Harm criteria for explosion pressure was on hearing at the time of the research. The suggested harm criterion is 400 mbar representing 50% probability of fatality for people inside a building

  General guidelines are given for the use of empirical tools and CFD tools, but there are no requirements for use of different tools in specific scenarios.
- **Assessment of the leak frequency**, ignition probability and hence fire and explosion frequencies:
    - Leak frequencies are suggested estimated based on HyRAM-model, with an exception for filters.
    - The ignition probabilities suggested are given in the guidelines.
- **Establishment of risk picture** in terms of 10^{-5}, 10^{-6} and 10^{-7} iso-contours for individual fatality risk per annum

- **Comparison with risk acceptance criteria.** The risk tolerance criteria applicable for QRAs are described in Table 6.
- **Identification of possible risk reducing measures**

Table 6 - Definition of consideration zones (safety zones around a facility) in Norway as described in the document [31].

Consideration zone (safety zone)	Individual risk of fatality [per year]	Description
Inner	$\geq 10^{-5}$	This is the facilities area. Only short passage for third parties are accepted.
Middle	$10^{-6} – 10^{-5}$	Public road, railway, marina/harbour and similar. Offices and industry may also be located within this zone. No private houses or guest houses for over-night staying should be located within this zone.
Outer	$10^{-7}– 10^{-6}$	Areas for private houses, shops and smaller guest houses for overnight staying.
Outside outer	$< 10^{-7}$	Schools, kindergartens, nursing homes, hospitals and similar institutions, shopping centres, hotels and large public arenas and stadiums should be located outside the outer zone.

Sweden has no national regulations to regulate how risk assessment and risk analysis are performed. MSB has published a guide for Risk assessment for small and medium-sized businesses [32], in which they suggest that the Bow tie method could be used. It is clearly stated in the guide that a more detailed analysis might be required. The guided is primarily intended for businesses handling relatively small amounts of flammable goods.

In the **UK**, operators tend to use different templates, especially where the hazards are very different, and it helps to have different prompts specific to the activity being assessed, or where the expectations and aims are different. When it comes to risk criteria, whilst use of R2P2 is not a legal requirement, it is recognized as best practice, and failure to follow it may lead to some advisory words from the Health and Safety Executive. COMAH installations require risk assessment HAZOP. HAZOP is often used together with a top-down HAZID earlier in the project (flowsheet stage). At the concept stage an inherent safety study is encouraged. A qualitative or semi-quantitative judgement is then made about which hazards can be treated qualitatively and which need quantification, e.g. consequence assessment, frequency assessment, QRA, human factors/human error assessment. The main focus of the risk assessment is to prioritize and find risk reduction measures to reduce the residual risk to an acceptable level. In the UK, this means showing that the risk is not intolerable (against individual risk criteria, and societal risk measures for major hazards) and that it is ALARP (a balance between putting more resources into reducing risk and the benefit gained from further risk reduction measures). This is often demonstrated qualitatively or by approximate and conservative quantification. ALARP requires the balance to err on the side of safety. The starting point for ALARP is that the safety measures required by relevant standards are implemented first. ALARP looks at whether further risk reduction is also needed.

To sum up, for this group of countries, specific risk assessment methodologies are usually not prescribed, and the same for acceptance criteria. This provides the operators with more flexibility but it can pose as a challenge when the operator needs to decide which databases to pick from and which methodology to follow. In any case, it is important to keep good communication with the authorities from the start of the process to make sure that the methods used will be accepted.

5.3 Safety distances

The Directive on Deployment of Alternative Fuels Infrastructure (AFID) was recently revised into the Alternative Fuel Infrastructure Regulation (AFIR), and one of the changes is that the mandatory compliance of ISO/TS 20100 standards is replaced by the mandatory compliance with EN17127, EN 17124 and EN ISO 17268[3]. The latter goes into details on safety requirements, but does not define safety distances on its own, but does prescribe an ATEX zoning approach for their definition.

It is therefore not surprising that none of the countries included in this group include any prescribed safety distance when it comes to hydrogen dispensing equipment. There are some prescribed distances, however, for the storage of flammable gases, in the case of Sweden and Belgium.

There's been some effort, however, from UK's British Compressed Gases Association to standardise the distances used across the different BCGA documents.

In **Sweden**, several rules for the protection of devices containing flammable gas from collisions or other accidents exist. The regulations are interpreted in the "Handbook for Handling of flammable gas for professional use" [32], published by the Swedish MSB, where minimum safety distances are suggested. The handbook gives suggestions for minimum safety distances for storage of flammable gases. The recommended safety distances depend on the amount of gas being stored, which fire barriers are being used (if any) and the flammability of the target as well as the severity of the consequences, should an accident occur (e.g. large amounts of flammable material or if a nearby building is difficult to evacuate, such as an hospital). The handbook notes that classification is usually performed according to EN 60079-10. In the Swedish Electrical Commission (SEK) "Handbook 426", a Swedish translation of the standard is provided. The handbook further explains that if several substances from different explosion groups occur, the substance with the most dangerous properties becomes decisive when choosing equipment. Other guidelines such as "Refuelling station instructions for CNG" [33] and "The handbook for Handling of flammable gases and liquids at gasoline stations" [34] are also relevant.

In **Austria**, LPG regulation applies to HRS, according to involved stakeholders. If the refuelling station has a capacity of less than 3 tonnes storage, they must be at least 10 m away from dispensers of other liquid fuels.

In **Belgium**, prescribed distances are only for storage part of the system. The EIGA Doc 15/21 [35] (from the European Industrial Gases Association) recommends distances that are used by applicants in permits (same in the UK), but these guidelines refer to hydrogen used by industrial consumers and are not specific on hydrogen refueling stations. The Best Available Technologies report suggests distances for filling equipment.

In **Spain** the rules to be followed are the ones for handling of hydrogen in the industrial sector. Their application to HRS is a consequence of a lack of specific legislation of hydrogen as a fuel.

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[3] In alignment with Regulation 2019/1745 (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019R1745)

Table 7 – Ranges of safety distances in countries with deployed HRS, but no specific legislative framework (part 1).

	UK	Norway	Sweden	Austria
Between the hydrogen dispenser and CNG/LNG dispenser	-	-	-	5 m
Between the hydrogen dispenser and other fuels	-	-	CNG rules: depends on the classification of the equipment in terms of suitability with explosive atmospheres	5 m
Between hydrogen dispensers and other equipment	-	-	-	5 m
Between hydrogen storage and other equipment	-	-	0-25 m (flammable gas)	3 m
Between hydrogen compressors and other equipment	-	-	3-12 m (CNG, distance between compressors and storage), or zero if barrier is used	0.2 m (1 m above)

Table 8 – Ranges of safety distances in countries with deployed HRS, but no specific legislative framework (part 2).

	Finland	Belgium	Spain
Between the hydrogen dispenser and CNG/LNG dispenser	-	-	-
Between the hydrogen dispenser and other fuels	-	2-5 m based on gaseous hose assumptions	-
Between hydrogen dispensers and other equipment	-	-	-
Between hydrogen storage and other equipment	-	7-14 m	5-20 m from CNG, gasoline, LPG storage (cryogenic H2)
Between hydrogen compressors and other equipment	-	3-4 m	-

5.4 Equipment maintenance

Most maintenance intervals of a HRS are defined in detail by the technology providers, due to the specific technical solutions they have implemented. Nevertheless, especially for safety of relevant components within the HRS, some maximum intervals can be found in national regulations. From the 14 countries analysed in this report, only Austria has specific maintenance intervals for hydrogen equipment that do not rely solely on supplier's advisory, but rather national legislation. All the others either have no guidance at all or rely on the supplier's advisory on when to perform maintenance on the equipment.

Nevertheless, the range and average maintenance interval for each piece of equipment can be seen in the table below:

Table 9 - Inspection/maintenance intervals for the different hydrogen elements in the HRS.

Equipment	Inspection interval range (years)			
	Belgium	Austria	Sweden	UK
Dispenser	1-3 years	/	Max. 2 years	/
Storage	1 year	1-3 years	Max. interval between inspections: 12 years	5 years
Compressor	5 years	3 years	Max. 1 year	/
Piping and distribution	5 years	2-12 years	Max. 4 years	/
Safety valves	10 years	3 years	Max. 1 year	2-3 years, replacement after 5 years
Hoses	1 year	At least every 3rd month	Max. 1 year	/
Pre-cooling equipment	/	1 year	Max. 1 year	/
Vaporizer	/	1 year	Max. 2 years	/

Spain is following the ISO 19880, in its section 15 „Maintenance of each piece of equipment should follow the manufacturer's instructions". As stated by the ITC ICG 05, from the Royal Decree 919/2006 of 28 July 2006 [36], approving the technical regulation on the distribution and use of gaseous fuels and its complementary technical instructions ICG 01 to 11, in its article 5, the maintenance frequency should follow the recommendations from the ISO specified for the type of refuelling station. For HRS the reference ISO is ISO 19880, thus the recommendation is to follow manufacturer's opinion. This is similar to the **UK**, which relies mostly on manufacturer's guidance.

This is also similar to the approach in **Belgium**, where the maintenance intervals are determined, and maintenance is done, on certain equipment parts, such as dispensers, storage and piping and distribution lines by the "operator or his appointee, installer or specialist company". Other equipment part, such as compressors, safety valves and hoses are to be inspected by an "recognized Environmental Expert". For most HRS equipment, an inspection interval is determined, as shown in the table above.

In **Sweden**, according to MSBFS 2020:1 [37], the retention capability of apparatuses containing flammable gases must be inspected before they are put into operation and thereafter periodic controls are required, as often as necessary to counteract leakage. If the apparatus has been moved a new inspection is required before it begins operation anew. The officially recommended interpretation is to primarily follow the manufacturer recommended intervals between inspections, the recommended secondary interpretation is to inspect the retention every second year.

In **Austria**, regulations concerning intervals and contents of maintenance stem mainly from three sources:

- Ordinance on Explosive Atmosphere [38];
- Pressure Equipment Monitoring Ordinance [39];
- Electrical Protection Ordinance [40].

The Technical Inspection Agency (TUV) must first approve all HRS. This approval includes an installation document that specifies inspection and maintenance intervals. The operator of an HRS must keep records of all maintenance and inspection measures. However, again the surveyed experts highlighted that an analogy is drawn between LPG filling stations and liquid hydrogen, but most of all between CNG filling stations and gaseous hydrogen. It is also worth mentioning that pressure vessels (storage unit) and pipelines are divided into different test levels according to the Pressure Equipment Monitoring Ordinance. Depending on the test level (test level 1 to test level 4), different test intervals are required.

There are no specific requirements on the maintenance intervals in **Norway**. It is up to the operator to assess what is needed in order to maintain the safety level. If the facility complies with a harmonized standard (recognized standard) during commissioning, this should also be followed in operation phase. If maintenance intervals are stated there, this should be adhered to.

In **Finland**, there are no specific requirements for hydrogen as well. For CNG refuelling stations, the operator prepares service and maintenance program, and specifies the activities and maintenance intervals, taking into account the inputs from suppliers.

6 Countries with no deployment of public HRS at the time of the research

The last chapter focuses on the survey respondents from countries with no public hydrogen refuelling stations deployment at the time during which the analysis was carried out. These are Bulgaria, Hungary and Poland. These countries which have not deployed any public hydrogen refuelling stations have also been included in this analysis in order to determine what kind of permitting barriers operators would have to deal with as front-runners in these countries. In other words, it tells us what happens when authorities have no experience handling hydrogen dispensing permitting.

It should be noted, however, that some of these countries have seen major developments in terms of HRS deployment and regulatory framework since 2021.

In Hungary, a refuelling station was made public in 2023. We chose to insert this country in this category nonetheless, because this station is still inserted inside Linde's production site and requires prior booking before being able to refuel. These are, nevertheless, great market developments for Hungary, and some of the regulatory developments will also be highlighted in the sections below.

Developments in Poland are even more impressive as the country now counts with five operational hydrogen refuelling stations. The procedures described in the sections below refer to the plans followed in 2021 when some of these stations were at the point of asking for a permit. It is possible that the procedures have changed by now.

6.1 Permitting requirements

Although these countries have no deployment of HRS so far, efforts have been made to develop a regulatory framework with a view to come up with specific rules that would guide project developers. As an example, in **Bulgaria** the Ordinance No. RD-02-20-2 of 28/09/2020 [41] on the terms and procedure for the design, construction, commissioning and control of refuelling stations for cars powered by hydrogen fuel is in force since 2020. In **Hungary**, public access HRS must comply with Min. Decr. NGM 2/2016 [42] focusing on the technical safety oversight of pressure equipment, filling equipment, small capacity compressed gas filling equipment and the periodic inspection of automotive gas containers".

These ordinances are still significantly reliant on existing documents for other gases such as natural gas and are waiting for further standardisation of hydrogen safety rules in order to be updated. It is worth mentioning that one of the shortcomings identified at the time of the research (2021) was that Min. Decr. NGM 2/2016 [42] defined the maximum hydrogen storage volume accepted as 2 m^3, with no mention to pressure conditions. This made the deployment of HRS impossible. This legislation was fortunately updated in 2023 and now the maximum allowed storage is one tonne for gaseous hydrogen and five tonnes for liquid hydrogen. Another important development is that hydrogen (fuel) was incorporated explicitly in the long existing "Autogas" definition. "Autogas" is now LPG, CNG/LNG and hydrogen. This finetuning means that now it is unambiguous that hydrogen is under the scope of Min. Decr. NGM 2/2016 [42] and the adequate legislation and permitting procedure to follow is now clear. This decree, however, still does not include any prescribed safety distances for hydrogen as a fuel.

At time of development of the research included in this report, in 2021, **Poland** had no hydrogen-specific rules in place and no HRS deployed yet. In 2024, two public HRS are now available in the country, but public guidance on permitting requirements is still non-existent. Nevertheless, it is good to keep in mind that while the information in this report is still likely to apply today, it is also possible that the experience acquired with the new installations has helped refining some of the procedures in place. In Poland, a few legislation processes regarding alternative fuels and electromobility are in place, which apply to certain extent to the hydrogen vehicles and hydrogen refuelling. However, they are still projects at early stages and thus cannot be fully applied. In practice, EU-wide regulations should be used regarding permitting and construction of HRS and when these regulations are not detailed enough, regulations which apply to CNG or other refuelling stations should be used.

Permitting in this group of countries is heavily relying on EU-wide recommendations and waiting for standards to be updated that will fill-in the current gap where European legislation

is not detailed enough. For the moment, CNG rules are mostly used to cover these gaps. Trying to make this analogy of hydrogen with other gases has already led to some inaccurate definitions in legislation, which is a massive barrier for the efficient deployment of HRS.

6.2 Risk assessment methodologies

Overall, there are no specific risk assessment requirements for the construction of HRS, in Bulgaria and Hungary, in a multifuel context or not, aside from the general requirements provided by ISO/TS 19880, which include performing QRA or semi-quantitative analysis instead of relying on the prescriptive requirements.

In **Bulgaria**, the dedicated ordinance states that risk assessment is at the responsibility of the operator. Since there are no HRS deployed in Bulgaria so far, there are no examples of how this has been carried out in the past. The regulation [41] states that the HRS should be designed, constructed and operated in such a way that intentional or unintentional release of flammable gas during normal operation should prevent, minimize, detect or control the formation of flammable or explosive atmosphere. For this purpose, the following elements of the HRS (i.e. equipment) which are regarded as potential sources of danger, should be checked: on-site hydrogen production facility (not included in the project), hydrogen supply system; compressors; storage containers; pipelines; dosing devices (dispensers).

In Hungary, specific risk assessment methodologies are not prescribed, as long as the planning of the HRS meets the requirements of the Technical Safety Regulation (part of Min. Decr. NGM 2/2016 [42] and which cover technical specifications for pressure and filling equipment).

In **Poland**, at the time of the research, as long as conventional fuelling rules and risk assessments are complied with, no further risk assessment was necessary.

6.3 Safety distances

In Hungary, the abovementioned decree defines technical expressions to all pressure equipment and filling stations including hydrogen refuelling stations, as it transposes AFID. Bulgaria relies heavily on existing rules for CNG. Poland follows the same methodology, combined with safety distances prescribed for conventional fuelling stations.

There are some projects in Poland with the intention of harmonizing hydrogen-specific legislation, and some of the distances in those projects are presented in the table below but can hardly be taken as the rule.

Table 10 – Safety distances for countries without deployed HRS.

	Hungary [43]	Poland	Bulgaria [44]
Between the hydrogen dispenser and CNG/LNG storage	10 m	20-55 m	10 m (LNG storage)
Between the hydrogen dispenser and other fuels	10 m	20-55 m	5 m

Between hydrogen dispensers and other equipment	10 m	2.35 m	5 m
Between hydrogen storage and other equipment	5 m (10 m for other fuel's storage)	80 m	10 m
Between hydrogen compressors and other equipment	5 m	3.1 m	10 m

It should be once again mentioned that, given the lack of clear hydrogen-specific legislation, safety distances reported for this group of countries are based on interpretation of other relevant guidelines. They can only serve as an estimation of what safety distance requirements would the operators be asked to comply with. However, it is useful to analyse these cases and see that this lack of hydrogen-specific legislation can lead to different interpretations from country to country, which is clearly highlighted by the difference in suggested requirements such as the distance between hydrogen dispensers and other equipment.

6.4 Equipment maintenance

When it comes to the amount of time that the equipment can go without inspection or maintenance, in **Bulgaria** there are no specifications because no HRS has been deployed yet. The same is true for Hungary, where it is up to the equipment manufacturers to define the correct maintenance intervals.

In **Poland**, the plans in place for the deployment of the first HRS state a maintenance interval of 1 year for H_2 dispensers, compressors, hoses and pre-cooling equipment and 2 years for H_2 storage.

7 Type of integration in a multifuel context

With increasing demand from AFIR, HRS will be upscaled and deployed to cover the TEN-T Core network and urban nodes across Europe. This will inevitably lead to deployment of HRS alongside conventional fuels possibly in commercial and residential areas. Co-location of hydrogen with different fuels may, however, require specific safety measures.

Generally speaking, the approaches taken by the different countries vary significantly amongst the different countries. Some may be more conservative by not allowing the placement of a hydrogen dispenser in the same island as other fuels, while others do. **This can come up as a challenge for operators who are trying to deploy multifuel HRS in different countries.** With different criteria being applied all over Europe, the operator will not be able to apply the same design to all its stations. Every project will possibly require different layouts.

In most countries there are no rules explicitly stating whether one is allowed or not to place a hydrogen dispenser on the same island as other fuels. In **Spain**, however, legislation clearly forbids this layout. In **Austria**, even though it is not explicitly mentioned in the legislation, placing the hydrogen dispenser on the same island as other fuels has not been allowed so far. In **Germany**, this placement is allowed. In **France**, required safety distances between hydrogen dispensers and other fuels (5 m) may or may not allow you to place the hydrogen dispenser in the same island as other fuels, but they definitely do not allow you to use the same dispenser for different fuels in combination with hydrogen (the same occurs in Hungary and Bulgaria). In most countries, what determines whether the hydrogen dispenser can be placed right next to other fuels is the safety distances prescribed.

In **Belgium**, hydrogen and conventional fuel dispensers can be co-located in the same as long as different hoses are used for the different fuels. The common practice, however, is to have the dispenser of hydrogen under the same island as a conventional fuel dispenser but separated in such a way that it is possible for a FCEV to be refuelled at the same time as a conventional combustion engine vehicle.

The same layout – same island/separate dispenser – is adopted in **Germany**. This is because, in general, combined arrangement of dispensing equipment in a potentially explosive area for fuels requires consideration of carry-over explosive atmospheres. In the case of a combination of a dispenser for hydrogen with other dispensers, all parts of the system must be designed for explosion group IIC (or IIB+H2) and for temperature class T3, as defined in Directive 2014/34/EU. The possible release quantity in the event of leaks from refuelling hose lines for gaseous fuels shall be limited to a harmless level. This is fulfilled for hydrogen if:

a) there is an automatic check of the connection of the refuelling hose to the refuelling connection of the motor vehicle so that refuelling is not started in the event of a leak,
b) there is automatic monitoring of the refuelling so that refuelling is stopped immediately in the event of a leak,
c) the hose is safely depressurised via a blow-off line by discharging the hydraulic fluid via the vent mast/chimney; and
d) after refuelling, the refuelling hose is pressure-free.

8 Conclusions

In this report, an analysis of the current permitting requirements for the deployment of HRS in 14 countries across Europe was carried out, based on surveys answered by a network of national correspondents. The goal was to identify the main commonalities and gaps in knowledge among countries and to map areas where further data needs to be acquired in order to harmonize safety standards.

The first gap identified is that most countries do not have hydrogen-specific regulation in place for the deployment of HRS. Most countries rely on EU-wide recommendations and standards to define their own permitting requirements, but these rules are not detailed enough and there is still significant room for different interpretations or approaches. A common approach taken by most countries is to fill-in the gaps of legislation with CNG-specific rules or rules for the handling of hydrogen as a chemical substance in an industrial context. In some countries, such an approach has already led to the setting of rules that turn out to be unfit for hydrogen or unnecessarily restricting, thereby hindering the deployment of HRS in these countries.

Safety distances are especially unharmonized among Member States. In most countries, the approach is to interpret industrial hydrogen, CNG or conventional fuel station rules and use them for the dispensing of hydrogen as well. This, combined with the fact that many countries leave it up to the operator to come up with their own safety distances for their own "engineering approach", makes it so that different safety distances will be allowed in different countries. More importantly, the safety distances applied today are not based on verified evidence of how hydrogen behaves in multifuel scenarios.

Countries where HRS have not yet been deployed, face an additional challenge where authorities in charge of permitting are inexperienced and are waiting for additional guidelines to help them establish more clear rules for their operators. In countries such as Italy and Germany, local authorities in regions where HRS have already been deployed will, obviously, have more experience in the process. However, in most cases the deployment of an HRS is a completely new concept. Without failure, all national correspondents agreed that the lack of HRS specific legislation and lack of experience from the authorities usually makes the process more difficult and time consuming, not to mention the level of subjectivity that it enables for the final decision on the permit.

In countries with HRS-specific legislation, required risk assessment methodologies are not the same. Prescribed safety distances are also not harmonised. There are different databases used for the definition of failure frequency for critical scenarios, which could be a reason behind such differences.

This is where projects like MultHyFuel can be of extreme help. MultHyFuel is especially targeting the acquisition of valuable data on the characteristics of hydrogen leakage in hydrogen dispensers and what consequences they can cause in the surrounding equipment, including domino effects. This data will feed back into a detailed risk analysis that will result in some guidelines that will be shared with public authorities and standardisation bodies.

MultHyFuel is, however, restricted within its scope and will mostly focus on safety around the hydrogen dispenser with a special attention to what happens when this is done next to other fuels. What becomes clear through the present report and previous deliverables of the project is that there are gaps in knowledge in other areas of the refuelling station as well, namely when it comes to hydrogen storage equipment, where most safety distances currently applied are not harmonised between the countries, production of hydrogen on-site, and the handling of liquid hydrogen.

This report represents an updated version since the first report was published in September 2021. This final version intended to best compare the methodologies in the different countries in a more systematic way, but it sticks to the information gathered in 2021 about permitting procedures in Europe. It is interesting to see, however, that some of the least experienced countries in 2021 have made impressive progress both in terms of HRS deployment but also development of their regulatory framework. This is the case of Hungary, which updated its legislation, making hydrogen in scope and increase the thresholds of hydrogen storage allowed in refuelling stations. Also in Poland significant progress was made, the country now counting with five publicly available hydrogen refuelling stations.

MultHyFuel

9 References

[1] [Online]. Available: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32014L0094.

[2] „Regulation (EU) 2023/1804 of the European Parliament and of the Council of 13 September 2023 on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU“.

[3] [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32012L0018.

[4] [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31999L0092.

[5] „Directive 2014/34/EU of the European Parliament and of the Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (recast)“.

[6] [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02014L0068-20140717.

[7] [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32001L0042.

[8] „Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment“.

[9] European Hydrogen Observatory, „Alternative Fuels Infrastructure Regulation,“ 8 September 2023. [Online]. Available: https://observatory.clean-hydrogen.europa.eu/eu-policy/alternative-fuels-infrastructure-regulation. [Zugriff am 23 January 2024].

[10] T. Jespen, „ATEX - Explosive Atmospheres: Risk Assessment, Control and Compliance,“ Springer Publishing, Koege, 2016.

[11] I. Gabryelewicz, M. Wędrychowicz, W. Woźniak and P. Besta, “SEVESO III Directive – Information on Establishments with a a High or Increased Risk of a Major Industrial Accident,” *Rocznik Ochrona Środowiska,* vol. 24, pp. 383-392, 2022.

[12] European Commission, “Environmental Impact Assessment,” [Online]. Available: https://environment.ec.europa.eu/law-and-governance/environmental-assessments/environmental-impact-assessment_en. [Accessed 24 01 2024].

[13] European Commission, „Strategic environmental assessment,“ [Online]. Available: https://environment.ec.europa.eu/law-and-governance/environmental-assessments/strategic-environmental-assessment_en. [Zugriff am 24 January 2024].

[14] Health and Safety Executive for Northern Ireland, „Pressure Equipment Directive (PED),“ [Online]. Available: https://www.hseni.gov.uk/pressure-equipment-directive-ped. [Zugriff am 29 January 2024].

[15] [Online]. Available: https://www.iso.org/standard/71940.html.

[16] „European Hydrogen Observatory,“ [Online]. Available: https://observatory.clean-hydrogen.europa.eu/index.php/hydrogen-landscape/distribution-and-storage/hydrogen-refuelling-stations.

[17] „TRBS 3151,“ [Online]. Available: https://www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRBS/TRBS-3151.html.

[18] [Online]. Available: https://www.gesetze-im-internet.de/betrsichv_2015/BetrSichV.pdf.

[19] „Hazardous Substances Publication Series," [Online]. Available: https://publicatiereeksgevaarlijkestoffen.nl/publicaties/.

[20] „Major Accidents Risks Decree 2015," [Online]. Available: https://wetten.overheid.nl/BWBR0036791/2015-07-08.

[21] „Rubrique n°1416," [Online]. Available: https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000037519292.

[22] „Rubrique n°4715," [Online]. Available: https://www.legifrance.gouv.fr/jorf/id/JORFTEXT00003167242.

[23] [Online]. Available: https://germanlawarchive.iuscomp.org/?p=649.

[24] [Online]. Available: https://www.gesetze-im-internet.de/bimschg/BImSchG.pdf.

[25] [Online]. Available: https://www.baua.de/DE/Themen/Arbeitsgestaltung-im-Betrieb/Gefahrstoffe/Arbeiten-mit-Gefahrstoffen/pdf/Gefahrstoffverordnung.pdf?__blob=publicationFile&v=5.

[26] „Ministerial Decree 7/8/2018," [Online]. Available: https://www.gazzettaufficiale.it/eli/id/2018/11/05/18A07049/sg.

[27] „Circulaire du 10 mai 2010," [Online]. Available: https://www.legifrance.gouv.fr/download/pdf/circ?id=31313.

[28] „H2-TSA 2023," [Online]. Available: https://www.energigas.se/publikationer/normer-och-anvisningar/anvisningar-tankstationer-for-vatgasdrivna-fordon-h2-tsa-2023/.

[29] [Online]. Available: https://emis.vito.be/sites/emis/files/study/BBT-studie_Waterstoftankstations_Eindrapport_dec-2020.pdf.

[30] „Austrian Trade, Commerce and Industry Regulation Act," [Online]. Available: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10007517.

[31] „Direktoratet for samfunnssikkerhet og beredskap," [Online]. Available: https://www.dsb.no/globalassets/dokumenter/rapporter/prj11089512_r1_final.pdf.

[32] „Swedish handbook for handling of flammable gas for professional use," [Online]. Available: https://rib.msb.se/filer/pdf/29241.pdf.

[33] „Refueling station instruction for CNG," [Online]. Available: https://www.energigas.se/publikationer/normer-och-anvisningar/anvisningar-tankstationer-for-metangasdrivna-fordon-tsa-2020/.

[34] „Swedish Handbook for handling flammable gases and liquids at gasoline stations," [Online]. Available: https://rib.msb.se/filer/pdf/27549.pdf.

[35] [Online]. Available: https://www.eiga.eu/publications/eiga-documents/doc-1506-gaseous-hydrogen-stations/ .

[36] „Royal Decree 919/2006," [Online]. Available: https://www.boe.es/buscar/pdf/2006/BOE-A-2006-15345-consolidado.pdf.

[37] „Swedish regulations on the handling of flammable gas and flammable aerosols," [Online]. Available: https://www.msb.se/siteassets/dokument/regler/forfattningar/msbfs-2020-1.pdf.

[38] [Online]. Available: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20003475.

[39] „Ordinance on Pressure Equipment Monitoring,“ [Online]. Available: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20000216&FassungVom=2016-07-18.

[40] „Ordinance on Electrical Protection,“ [Online]. Available: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=20007682.

[41] “Ordinance RSHV,” [Online]. Available: https://www.mrrb.bg/bg/naredba-rd-02-20-2-ot-28-09-2020-g-za-usloviyata-i-reda-za-proektirane-izgrajdane-vuvejdane-v-eksploataciya-i-kontrol-na-stancii-za-zarejdane-na-avtomobili-zadvijvani-s-gorivo-vodorod/.

[42] Wolter Kluwers, „2/2016. (I. 5.) NGM rendelet a nyomástartó berendezések, a töltő berendezések, a kisteljesítményű sűrített gáztöltő berendezések műszaki-biztonsági hatósági felügyeletéről és az autógáz tartályok időszakos ellenőrzéséről,“ February 2016. [Online]. Available: https://net.jogtar.hu/jogszabaly?docid=a1600002.ngm. [Zugriff am 2 February 2024].

[43] [Online]. Available: https://www.hse.gov.uk/comah/.

[44] [Online]. Available: https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=Bundesnormen&Gesetzesnummer=10007517.

[45] [Online]. Available: https://shop.austrian-standards.at/action/en/public/details/673300/OENORM_EN_17127_2020_03_15;jsessionid=5F195214F25DEDC4D8B71005CF6A8B04.

[46] [Online]. Available: https://www.h2-genehmigung.de/Index/Index?lang=1.

[47] [Online]. Available: https://www.lex.bg/bg/laws/ldoc/2137206003.

[48] [Online]. Available: https://publicatiereeksgevaarlijkestoffen.nl/publicaties/PGS35.html.

[49] [Online]. Available: https://www.energigas.se/publikationer/normer-och-anvisningar/anvisningar-.

[50] „Guidelines for risk analysis of facilities handling hazardous substances,“ [Online]. Available: https://www.dsb.no/globalassets/dokumenter/rapporter/prj11089512_r1_final.pdf.

[51] „Revised QRA guidelines in Norwegian,“ [Online]. Available: https://www.dsb.no/globalassets/dokumenter/horinger-og-konsekvensutredninger/kvantitative-risikovurderinger/horingsutkast---med-vedlegg.pdf.

[52] „Safety of systems handling flammable, reactive, pressurized and explosive substances,“ [Online]. Available: https://www.dsb.no/rapporter-og-evalueringer/sikkerheten-rundt-anlegg-som-handterer-brannfarlige-reaksjonsfarlige-trykksatte-og-eksplosjonsfarlige-stoffer/.

[53] Federal Institute for Occupational Safety and Health (Bundesanstalt für Arbeitsschutz und Arbeitsmedizin), „Technische Regeln für Betriebssicherheit (TRBS),“ [Online]. Available: https://www.baua.de/DE/Angebote/Regelwerk/TRBS/TRBS.html. [Zugriff am 24 January 2024].

[54] „Handbook on permits for handling flammable gases and liquids,“ [Online]. Available: https://rib.msb.se/filer/pdf/28281.pdf.

10 Annexes

10.1 Annex I

Detailed Cross-country research framework WP1

MultHyFuel – Task 1.1 Definition of Scope

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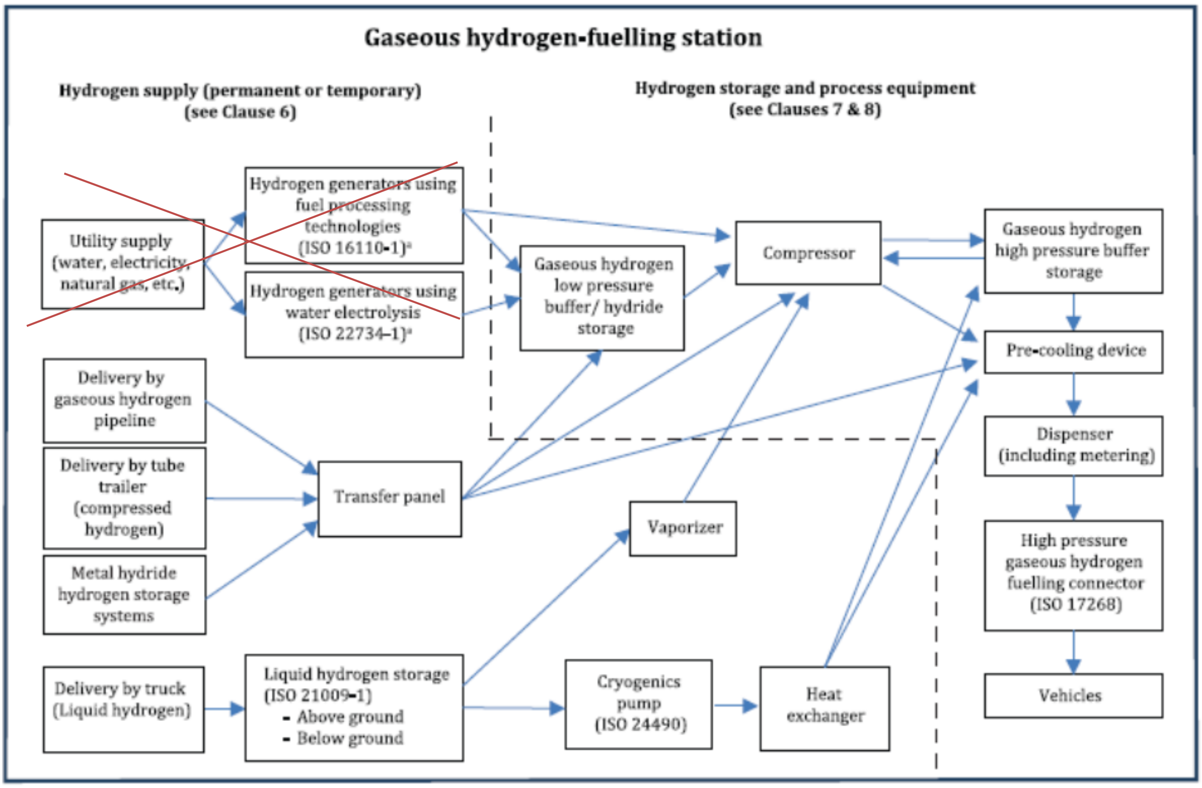
10.1.2 Background and Context

The aim of WP1 within the MultHyFuel Project is to provide a comprehensive cross-country review of existing **permitting requirements and, where applicable, public guidance on risk assessment methodologies (including, for example, hazardous areas and safety distances)** used within the EU for hydrogen **in multi-fuel refuelling stations**.

In Figure 2 the typical elements of a Hydrogen Refuelling Station (HRS), as defined within ISO 19880-1:2020, are shown. The focus of the research will have to take into account the specificities associated with multi-fuel-stations (e.g. where distances between storage and dispensing of different kinds of fuel may have to be considered). Onsite production of Hydrogen will not be addressed (see: Scope, Ch. 0)

Figure 2: Elements of a Hydrogen Refuelling station (crossed elements are out of scope), Source: ISO 19880-1:2020



10.1.3 Scope of Research

The scope of research on regulations, codes and standards for this framework includes **permitting requirements and, where applicable, public guidance on risk assessment methodologies (including, for example, hazardous areas and safety distances) for public outdoor HRS for mobile applications with the focus on road vehicles** (trucks, buses, FCEV). The aggregate state of refuelled hydrogen can be gaseous or liquid, which means that both compressed hydrogen in different pressure levels and LH_2 are included.

The national rules may reflect certain EU-directives (e.g. EIA - Environmental Impact Assessment, SEA - Strategic Environmental Assessment, IED - Industrial Emissions Directive and SEVESO – Major Accident Hazards). These Directives create various obligations, in accordance with the amount of hydrogen stored on site. For keeping the scope within an efficient frame, the focus of this framework is limited to <5000kg H_2-storage on site. Topics like land use planning[4] shall not be treated. On-site production of hydrogen fuel is also not included. **The full scope of existing permitting requirements and, where applicable, public guidance on risk assessment methodologies should be covered. This includes definition of hazardous areas, risk assessment with accidental scenarios and leak sizes, and the relevant parts of permitting.**

10.1.4 National Experts Framework

In the cross-country review, 14 countries are within the scope of this framework[5]. For each country, national experts will be responsible for carrying out the research and answer the questions proposed in this framework. This document provides the specifications for national experts but allows some degree of flexibility in the format for providing answers

The national experts shall describe the permitting requirements for their country in general, however, where regional, local rules differ considerably from rules applicable at national level, experts may use a single region as case study, while explaining what aspects may differ in other regions.

The research work is structured around 4 main chapters:

(i) Existing permitting requirements (focusing mostly on process and on the legal/administrative sources for those requirements
(ii) Risk assessment regulations/methodologies
(iii) Safety distances
(iv) Maintenance provisions

[4] While public planning and zoning (e.g. the ability to build and operate HRS in residential / commercial and/or industrial areas) is not covered, relevant internal zoning considerations (e.g. ATEX zones, etc.) remain within scope.
[5] Austria, Belgium, Bulgaria, Finland, France, Germany, Hungary, Italy, Netherlands, Poland, Spain, Sweden, United Kingdom, Norway.

10.1.4.1 Existing permitting requirements for HRS

Requirement 1:

Please answer the following questions with the existing permitting requirements for HRS in your country. For clarity and comprehensiveness, **please provide a comprehensive response to EACH question.**[6] The responses should be clear, comprehensive and self-standing, providing a sufficient level of understanding of the situation without the need of added context and background or further research or consultation of sources.

1) **Which national authorities are involved in the permitting process and what is their role? Please describe their level in governmental structure.**

2) **Are there maximum limits for the duration of the permitting process? If yes, please describe.**

3) **Are there different levels (national/regional/local) within the permitting process? If yes, do they lead to regional or local differences in the process? Please describe.**

4) **Are local authorities familiar with the permitting procedures? Are they well experienced in the process?**

5) **Are rules open to interpretation and, if yes, by which of the responsible people in the permitting authorities?**

6) **Do the requirements depend on specific criteria, such as HRS size (quantity of hydrogen stored/other criteria), public/non-public access, size/type of vehicle being refuelled?**

7) **Do the requirements depend on the type of integration into Multi-fuel-environment?**
   i) Do the rules allow you to place the H_2-dispenser on the same 'island' as other fuels?
   ii) Is it allowed to use the same dispenser for several fuels, including hydrogen?
   iii) Please describe requirements compared to the (today) most common scenario, the separate integration of H_2-dispenser within the area of multi-fuel stations.

8) **Is there any applicable current public guidance for the permission process? If yes, please describe the main points. Please provide guidance documents as annex.**

9) **Which kind of documents are to be worked out and transferred to the authority?** (e.g. permitting proposal, soil expertise, site plans and construction plans, Risk Assessment, safety and

[6] Please note that some of the questions below may have been answered by the HyLaw evaluation in 2018, https://www.hylaw.eu/database. You may consult this database as a source, however, please correct and/or complement the information as necessary

health protection plan, hazardous area documentation, conformity declarations (ATEX, electrical safety, PED, ...), delivery and filling instructions as well as public refuelling instructions, declarations of involved Notified Body or equivalent (if applicable at several stages of the process), fire protection plan)

10) Are there regulations or model documents, which are fixing content and format of the technical documentation of an HRS? If yes, please describe their content and specifications and provide references and links.

Regulatory technical requirements

11) Are there any mitigation measures regulated against fire and domino effects/protection of neighbourhood or third parties?

12) Are there any technical barriers on the process flow to limit the accidental scenarios (flow limitations, PRD, burst disk, break away, electrostatic protection…)

13) Are there any required barriers against physical contact?

14) Are there any obligations in terms of:

i) Emergency shutdown
ii) Detection and ventilation
iii) Type of fire extinguisher

10.1.4.2 Risk Assessment regulations /methodologies

The term 'risk assessment' can be understood in different ways. The understanding the authors want to establish within the MultHyFuel project is based on the simple formula:

Risk Assessment = Risk Identification + Risk Analysis + Risk Evaluation

Risk Assessment could be performed Qualitatively (i.e. Hazid), Quantitatively (i.e. QRA), or a hybrid of both, semi-quantitatively (i.e. sQRA). For QRA, calculation toolkits like HyRAM or SAFETI-NL are typically used. To explain a common understanding for risk assessment methodology, excerpts from the **international definitions out of ISO 19880-1:2020**, to be found within the Annex **Error! Reference source not found.**, may provide more details and clarity.

Requirement 2:

The national experts shall **describe the national regulated methodology for risk assessment of HRS in general terms. The legal, normative, etc. sources shall be given as a reference. Please fill-in Table 11 regarding the risk assessment regulation in your country. As there may be different methodologies prescribed for different elements of a HRS, please fill-in each row stating/describing if there is specific regulation concerning that specific HRS element. Feel free to add rows to the table if necessary to best describe the risk assessment requirements in your country.**

For quantitative risk assessment, please provide the risk matrix and scale for severity and likelihood evaluation, or value used for risk acceptance criteria.

Table 11: Risk assessment methodologies

Specifications	Methodology	Links
H_2 Delivery/Supply		
H_2 Storage		
Dispenser		
Electrical Components		
Electrical Safety Components		
Mechanical Safety Components		
Piping		
Selection of harm criteria to a specified level of harm		
"Tolerability of risk" criteria (e.g. individual risk per annum) of people exposed to the hazards, etc.		
OTHER SPECIFICATIONS		

Requirement 3:

In case the risk assessment methodologies prescribed in your country cannot be adequately, or comprehensively described using the table above, **please provide the general description of the requirements for risk assessment in your country:**

Table 2 General description of requirements for risk assessment

Text:	
Links	

10.1.4.3 Safety or separation distances

Requirement 4:

Please describe the content and specifications of national regulations, codes and standards that contain **safety or separation distances regarding construction and operation of HRS**. Please mention if the regulations depend on the HRS size (e.g. fuel storage size) or on other criteria (e.g. the dispenser pressure, i.e. H35 or H70, the flow rate, i.e. <60 g/s , >60 g/s, etc). In your general description, please explain if „*negligeable extent*“ criteria are used and if yes, what are they and how are they defined. Please also do the same for „*minimum harm criteria*“, (do they exist, how are they defined and how are they applied, etc.?). You may use the table below to provide your answer.

Table 3: Safety or separation distances regarding construction and operation of HRS

Text:	
Links	

Requirement 5:

If possible, **please fill in Table 12 below**. If some of the distance classes/types are not defined, **please add additional rows and describe alternative national criteria to ensure safety**. Please refer to the basic regulation and, if there are definitions out of other applications than HRS (e.g. CNG refueling), mention them as well.

For the definition of safety distances, please refer to the first Column of the table below, based in international defined safety distances worked out by ISO TC 197[7], and refer to Figure 3 within the Annex for further orientation.

[7] **A.2.2 Example safety distances from each country / region**
ISO maintenance portal URN (https://standards.iso.org/iso/19880/-1/ed-1/en) includes a table of examples of safety distances collected by ISO/TC 197, through country representative members during the preparation of ISO/TS 19880-1, which conveys a status of country specific safety distances at that the time of publication of the ISO/TS 19880-1 (2016). It demonstrates the wide range of results that can be found for similar equipment in similar environments around the world. This table was not an inclusive list of values internationally and is not meant to be a recommendation for these applications.

Table 12: Safety distance definition

Class of safety distance	Type of safety distance	Value in m <u>or</u> description of definition criteria	Comments / Links / References/ regulations / Codes /Standards (if necessary)
RESTRICTION DISTANCES *Distance from, or area around, hydrogen equipment where certain activities are restricted or subject to special precautions.* **Clarification: Activities and constructions around regarded as the hazard, hydrogen equipment as the target*	Potential area of flammable / explosive atmosphere around compression unit		
	Potential area of flammable / explosive atmosphere around storage unit		
	Potential area of flammable / explosive atmosphere around dispenser		
	Sparking equipment, open flames, welding		
	Outdoor discharge for relief valves or vents		
	OTHER NATIONAL DEFINITIONS		

Class of safety distance	Type of safety distance	Value in m or description of definition criteria	Comments / Links / References/ regulations / Codes /Standards (if necessary)
INSTALLATION LAYOUT DISTANCES *Minimum distance between the various sub-systems of of the hydrogen installation required to prevent units causing damage to one another in case of incidents.*	Between Sub-System/ Equipment of any kind		
	Between H2 Storage and other Sub-System / Equipment		
	Between Compressor and other Sub-System / Equipment		
	Between Equipment and barriers around the plant (access and circulation)		
	Between hydrogen dispenser and other non-hydrogen equipment except vehicle		
	OTHER NATIONAL DEFINITIONS		

Class of safety distance	Type of safety distance	Value in m <u>or</u> description of definition criteria	Comments / Links / References/ regulations / Codes /Standards (if necessary)
PROTECTION DISTANCES *Minimum distance required between the installation/ equipment to be protected of the possible source of an external hazard (e.g. a fire) to prevent damage.* **Clarification: People and constructions are regarded as the hazard, hydrogen equipment as the target.*	Presence of (liquid) combustibles above ground (like gasoline storage or a tank truck)		
	Private or public road (Collision by a vehicle, either present at the fuelling station or passing by on a nearby road)		
	Presence of (gas) combustibles above ground (like CNG storage or a tank truck)		
	Fire Loads		
	OTHER SPECIFICATIONS		

Class of safety distance	Type of safety distance	Value in m <u>or</u> description of definition criteria	Comments / Links / References/ regulations / Codes /Standards (if necessary)
CLEARANCE DISTANCES *Minimum distance between the various units of the multi-fuel station required to prevent units causing damage to one another in case of incidents.*	Personnel of the HRS (1st party)		
	Users of the HRS (clients, 2nd party)		
	Public (3rd party)		

	Other fuelling facilities within the fuelling station, like delivery facilities.		
	Gasoline storage		
	LPG storage		
	CNG hazardous elements		
	Bulk liquid oxygen storage		
	Between H2 dispensing and others fuels (LPG, CNG, gasoline)		
	Buildings inside the plant		
	Building of combustible material		
	Building openings / windows / access doors		
	Air intakes / ventilation		
	Domino sites eg SEVESO/COMAH installations including upper/lower tier major hazard installations		

	OTHER NATIONAL DEFINITIONS		

Class of safety distance	Type of safety distance	Value in m <u>or</u> description of definition criteria	Comments / Links / References/ regulations / Codes /Standards (if necessary)
EXTERNAL RISK ZONE *Distance (or area) outside the fuelling station which has to be protected against hazards caused by the hydrogen installation.* **Clarification: Hydrogen installation regarded as the hazard, people and constructions as the target.*	Public road		
	Lot line		
	Residential buildings		
	Specific public buildings (e.g. offices) Houses		
	Parking		
	School / Hospital / Place of public assembly (e.g. parks, shopping centres, service station on motorways / Other		
	High voltage line		
	OTHER NATIONAL DEFINITIONS		

Requirement 6:

If there are other issues in national definition of safety distances, which are not captured by the structure above, please describe and refer to the regulation document. You may use the table below, determine your own structured table or provide free text, as you deem necessary to explain the issues.

Table 13: Other issues in national definitions of safety distances not captured above.

Type of safety distance	Value in m or description of definition criteria	Comments / Links / References/ regulations / Codes /Standards (if necessary)

10.1.4.4 Intervals and Content of Maintenance

Requirement 7:

Most maintenance intervals of a HRS are defined in detail by the technology providers, due to the specific technical solutions they provided. Nevertheless, especially for safety of relevant components within the HRS, some maximum intervals are defined in national regulations. If there are national or regional maximum maintenance intervals given in your country, please list them below and refer to the relevant documents. **Please fill-in the table below with allowed maintenance intervals for the different equipment and feel free to add other relevant elements.**

Table 14: Maintenance intervals for different HRS elements.

HRS Element	Maintenance interval
H_2 Dispensers	
H_2 Storage	
H_2 Compressor	
Piping and distribution lines	
Safety valves	
H_2 hose	
H_2 Pre-cooling equipment	
H_2 Pre-Cooling	
H_2 Vaporizer	
OTHER ELEMENTS	

Addendum to the detailed cross-country research framework WP1 MultHyFuel

This documents represents an Addendum to the previously written research framework and adds a set of questions that will help better shape the research conducted by the National Experts concerning regulatory technical requirements, promote a more comprehensive overview of the regulatory framework for HRS implementation. The following questions are to be added to the scope of the research under **4.1 Existing permitting requirements** (**Requirement 1**):

Regulatory technical requirements

15) Are there any mitigation measures regulated against fire and domino effects/protection of neighbourhood or third parties?

16) Are there any technical barriers on the process flow to limit the accidental scenarios (flow limitations, PRD, burst disk, break away, electrostatic protection…)

17) Are there any required barriers against physical contact?

18) Are there any obligations in terms of:

iv) Emergency shutdown
v) Detection and ventilation
vi) Type of fire extinguisher

What is MultHyFuel?

The goal of MultHyFuel is to contribute to the effective deployment of hydrogen as an alternative fuel by developing a common strategy for implementing Hydrogen Refueling Stations (HRS) in multifuel contexts, contributing to the harmonization of existing laws and standards based on practical, theoretical and experimental data as well as on the active and continuous engagement of key stakeholders.

MultHyFuel is a project funded by the Fuel Cells and Hydrogen 2 Joint Undertaking (FCH 2 JU).

Further information can be found under https://www.multhyfuel.eu.

For feedback on the MultHyFuel project or the published deliverables, please contact info@multhyfuel.eu.

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BESPOKE RESEARCH AND CONSULTANCY FROM HSE

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INERIS maîtriser le risque pour un développement durable

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