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TNO-report

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Deliverable D3.2 - HRS definition and recommendation for improvement

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Table of Contents

1. Introduction and research objective

Hydrogen plays a significant role in the world's energy economy, but this role is almost exclusively as a raw material for the chemical industry; hydrogen is rarely used as a fuel - except in space programs. To become successful as a fuel for use in the utility and transportation sector an infrastructure, with a network of hydrogen refuelling stations (HRS), will need to be developed.
A widespread HRS network will require that layout, installation, approval and operation of HRSs are harmonised. This includes the development of compatible regulations, standards (e.g. minimum safety distances) and dimensions (e.g. the same couplings for dispensing the same type of fuel).

Within the sixth framework programme (priority 6.1.II) the Hy-Approval project was defined, intended to be a 24 month project, aimed at developing a handbook to facilitate the approval of hydrogen refuelling stations for road vehicles.

The handbook shall provide guidelines for facilitating the approval process and allowing (at an early stage) an "Approval in Principle" from relevant authorities and the identification of specific local issues that should be addressed. Consequently the document will be a *best practice* on how to help achieving approval at an early stage. The document will reflect the existing technical and regulatory environment, will be flexible and will allow updates as the market conditions change. These best practices are also derived from existing experience and case studies gained through projects such as Clean Urban Transport for Europe (CUTE), Ecological City Transport System (ECTOS), European Integrated Hydrogen Project (EIHP), Clean Energy Partnership Berlin (CEP), Lombardia and Rhein-Main towards Zero Emission: Development and Demonstration of Infrastructure Systems for Hydrogen as an Alternative Motor Fuel (ZERO REGIO) and Safety of Hydrogen as an Energy Carrier (HySafe) as well as other consortium partner initiatives.

The project contains a number of work packages. The objective of work package 3 (WP3) is to identify the requirements of the authorities with respect to the *safety assessment* for the approval of an HRS in 5 EU member states and the USA. The 5 EU member states are: France, Germany, Italy, Spain and the Netherlands.

On the basis of the information gained (Deliverable 3.1) a harmonised approval process will be proposed. This report contains the results of the activities in which the requirements were identified for the safety assessment for the approval of an HRS in the 6 countries mentioned above. Also, conclusions and recommendations with respect to the requirements are given (Deliverable 3.2). Results will be presented to stakeholders for comments and recommendations, after which a final version of this harmonised approval process will be included in the handbook (results in Deliverable 3.3).

2. Applied method

As outlined in the description of work for WP3 identification of the safety requirements for approval of an HRS was done through interviews. For each country these interviews were carried out by local partners in WP3.
The following activities were performed:

1) Identify stakeholders to be interviewed
2) Prepare an interview protocol
3) Perform interviews
4) Report findings
5) Prepare draft for harmonised safety assessment.

In the following chapters these issues will be discussed.

3. Identification of stakeholders

It was agreed between the participants of WP3 that representatives of the following categories of stakeholders would be the most suitable for the interviews:

- *The owner of the HRS* who will generally be the applicant for the permit(s).
- *The authority or authorities issuing the permit(s).* Depending on the political organisation of the various countries the authority could be an autonomous region, a local regulator, or even an accredited supervisory board. Often separate permits are required for building and operation of an HRS.
- *Advisors to the* authorities issuing the permit(s). The authority may seek specialised advice for the issues to be considered like environmental impact, public health and safety and workers health and safety. The following was suggested:
  - *Fire brigade.* In most countries the fire brigade gives (compulsory) advice on permits on (preventive and mitigating) safety measures and on contingency planning.
  - *Labour inspectorate and /or other inspectors.*
- *The (governmental and/or advisory) bodies responsible for creation and / or implementation of guidelines and legislation* as applied by the authorities issuing the permit(s).
- *Members of the public working and/or living in the vicinity of the (future) HRS*

Each of the 6 partners performing the interviews was asked to identify representatives of each of these categories to be interviewed. In those EU countries where HRSs had been established in the framework of the CUTE (Clean Urban Transport for Europe) project (Germany, Spain, The Netherlands) the authorities involved in the approval process, were approached. In Italy and the USA authorities involved in the approval process of HRSs, built outside the CUTE context, were approached. As no HRS exist in France it was decided to approach the authorities involved in the regulations on dangerous substances (like SEVESO II) as a starting point.
In Table 3-1 an overview of the organisations interviewed is given.

Table 3-1 Overview of parties interviewed in various countries

Country	Approval role	Name of organisation interviewed
Germany	Issuer of permit	Behörde für Soziales, Familie, Gesundheit und Verbraucherschutz - Hamburg
	Advisor to issuer	Gewerbeaufsichtsamt bei der Reg. v. Oberbayern - München
	Inspection authority	Regierungspräsidium Darmstadt, Abt. Arbeitsschutz. Frankfurt.
France	Advisor to issuer	Firebrigade Fontaines, Isère
		Ministère de l'Intérieur, Direction de la Défense et de la Sécurité Civile DDSC - Risk and Crisis Management – in charge of technical and chemical hazards.
	Responsible for legislation	Ministère de L'écologie et du développement Durable - coordination of inspection services (DRIRE).
	Issuer of permit	Prefect of the "département" : not interviewed
	Inspection authority	DRIRE (Rhône Alpes region)
	none	Coordination of Hydrogen project founding in Direction Générale des Entreprises.
Italy	Issuer of permit	Sportello unico per le imprese del comune di Mantova (Single Counter for Business Activities of Mantova City Council)

	Advisor to issuer	Azienda Sanitaria Locale (ASL) della Provincia di Mantova, Servizio Prevenzione Sicurezza Ambienti di Lavoro (Local Health Service of the Province of Mantova, Service for Prevention and Safety in the Working Environment)
	Advisor to SIUC for building permit and operating licence, issuer of Fire Prevention Certificate	Comando Provinciale Vigili del Fuoco (Provincial Fire Brigades Headquarters)
	Hierarchically superior to Provincial Fire Brigade Headquarters	Ispettorato Regionale dei Vigili del Fuoco della Lombardia (Lombardy Region's Fire Brigades Headquarters)
	Advisor to issurer	Agenzia Regionale Protezione Ambiente (ARPA), Dipartimento di Mantova, Unità Operativa: Territorio e Attività Integrate (Lombardy's Regional Environmental Protection Agency, Department of Mantova, Operative Unit: Territory and Integrated Activities)
	Inspection authority	ISPESL (technical-scientific body in the National Health Service)
Netherlands	owner	GVB – Municipal Transportation Company Amsterdam
	Issuer of permit	Amsterdam City council
	Advisor to issuer	Environmental & Building Department (DMB-Amsterdam)
		Fire brigade Amsterdam
	Responsible for legislation	VROM inspectorate (Ministry of Housing, Spatial Planning and the Environment)
	None	NIFV Netherlands Institute Physical Safety Nibra Arnhem (Task a.o: Training institute for fire brigade)
Spain (MADRID)	Owner	Empresa Municipal de Transporte (EMT) - Madrid
	Issuer of permit	Comunidad de Madrid. Dpt. De Industria. Madrid
Spain (BARCELONA)	Customer	TMB (Transportes Metropolitanos de Barcelona)
	Issuer of permit	Generalitat de Cataluña. Dpt. De Trabajo e Industria. Secretaría de Industria. Barcelona
USA	Advisor to issuer District of Columbia	DC Office of the Fire Marshal
		DC Department of Health: Environmental Division
		DC Department of Consumer and Regulatory Affairs
	Advisor to issuer State of Michigan	Michigan Department of Environmental Quality/Waste and Hazardous Materials Division/StorageTank Unit
	Advisor to issuer State of California	Office of the State Fire Marshall
	Issuer of permit State of New York	New York State Dept. Division of Code Enforcement and Administration
	Issuer of permit State of Nevada	Local government of Las Vegas
	Advisor to issuer State of Florida	Department of Environmental Protection, Tallahassee, Florida
		Division of State Fire Marshal Tallahassee
	Issuer of permit State of North Carolina	Office of the State Fire Marshall in the Authority Having Jurisdiction (AHJ)
China	Issuer of fire protection permission	Beijing Fire Brigade Bureau

No 'members of the public' were interviewed.

4. Interview Protocol

In order to identify the requirements of the authorities regarding the safety assessment of the approval of HRS, an interview protocol was prepared by TNO. After agreement between all WP3 participants the protocol was used during the interviews in the 5 EU countries and the USA.

The following topics were covered in the interviews:

A. the responsibility and liability of the stakeholder involved in the approval process
B. the required information by the authorities
C. the external and occupational safety policy concerning hydrogen
D. the assessment criteria for the technical systems of the HRS (Technical standards)
E. availability of methodologies and guidelines for the assessment of external (off-site) effects, damage and risks
F. External safety (off-site safety) and land use planning
G. Inspection
H. Emergency planning
I. Dissemination of the Hy-Approval handbook
J. Remarks / other issues / gaps

In those cases where a particular HRS was discussed technical information on this station was obtained. Depending on the interviewed party, certain topics gained more attention than others.

The interview protocol is shown in Annex I.

5. The interviews

The interviews took place by visits, by phone or via correspondence. They were done in the period May –November 2006.

Summarised results of all interviews, as prepared by the local participants of WP3 are shown in Annex II. Below a compilation of the interviews is given and important points are highlighted.

5.1 Responsibility and liability of the stakeholder involved in the approval process

Parties interviewed are listed in chapter 3. The following was emphasised by all parties:

Coordination

The coordination between the stakeholders involved is an important issue, whereby it should be clear which authority has the coordination role. It is advisable that the parties involved seek after agreement on discrepancies in an early stage.

Community relations

To facilitate community acceptance of the HRS it is advisable to determine the requirements for community relations efforts. Neglect of the community concerns and issues may delay the implementation of the project afterwards.

5.2 Required information

5.2.1 Laws/regulations applied

The information that is required for the approval of the building and operation of an HRS will depend on the laws and regulations applicable. As HRSs are a relatively new type of infrastructure there is not yet a complete view of the risks involved. Neither no dedicated regulations nor guidelines exist. Hence other sources of information are used.

In some countries the national implementation of the SEVESO-II guideline is the leading document. As quantities of hydrogen currently stored, or planned to be stored, at an HRS (max. 3.5 tons) are well below the lower limit specified in the SEVESO guidelines (5 tons) these guidelines are, strictly speaking, not applicable. They were mainly used as an information source for methods, techniques and criteria that could be useful for the safety assessment of an HRS. Once the safety risks associated with an HRS are understood, a more general approach (as for e.g. LPG stations in the Netherlands) may be adopted. Of course the Hy-Approval handbook aims to be an aid in this process.

Table 5-1 shows the regulation and guidelines used for the approval of an HRS according to the interviewed parties in the various countries.

Table 5-1 Guidelines and regulations applied for approval of HRSs in various countries

Country	Laws/regulations applied regarding HRS
France	- Loi n°76-663 du 19 juillet 1976 relative aux Ins tallations Classées pour la Protection de l'Environnement / French regulation for hazardous industrial activities - Décret n°77- 1133 du 21 septembre 1977 pris pour l'application de la loi n°76-663 du 19 juillet 1976 relat ive aux Ins-

	tallations Classées pour la Protection de l'Environnement / Application decree for above regulation. - Arrêté ministériel du 10 mai 2000 modifié par l'arrêté du 29 septembre 2005 (Loi Bachelot - Arrêté du 29 septembre 2005 relatif à l'évaluation et à la prise en compte de la probabilité d'occurrence, de la cinétique, de l'intensité des effets et de la gravité des conséquences des accidents potentiels dans les études de dangers des installations classées soumises à autorisation) - Loi du 30 juillet 2003 relative à la prévention des risques technologiques et naturels et à la réparation des dommages - Circulaire du 29 septembre 2005 relative à l'appréciation de la démarche de maîtrise des risques. The above regulation sets two authorisation regimes depending on the hazardous potential of the industrial site: - declaration regime (lowest hazard) - authorisation regime (highest hazard) <u>Under declaration regime:</u> ▪ Arrêté type – rubrique n° 1416 de ICPE[1] Stockage ou emploi de l'hydrogène (hydrogen storage environnemental expectations for stored quantity above 1000 kg). ▪ Arrêté type – rubrique n° 1415 de ICPE[2] fabrication industrielle d'hydrogène (hydrogen production environnemental expectations for on site hydrogen production whatever the quantity) <u>Under authorisation regime:</u> - Circulaire du 24 mai 1976 relative aux dépôts d'hydrogène liquide / Technical note for liquid hydrogen storage Approval from local authority required on the basis of a specific safety and environmental study (Etude de danger et Etude d'impact).
Germany	Betr.S.V
Italy	DM 31 August 2006 Fire Prevention Technical Rule for HRS (SEVESO-II is optional)
Spain	In Barcelona, I.I.A.A. (national implementation for SEVESO-II), in Madrid, Reglamento de aparatos a presión
Netherlands	BRZO (implementation of SEVESO-II)
USA	International Fire Code, NFPA 52, NFPA 55, and NFPA 70.
China	Design Code for hydrogen station (GB50177-2005)

5.2.2 Permits required

Annex II shows, under the heading 'Permits required', that the approval process of an HRS may consist of obtaining a number of permits:

- a building permit,
- an environmental permit and
- an operating permit.

Not all permits are required in each country and the order in which permits have to be obtained differs as well.

This report is focussed on the requirements of the authorities regarding the *safety assessment* of the approval (being the objective of WP3).

Three target groups can be distinguished for a safety assessment:

[1] ICPE: Installation classée pour la protection de l'Environnement

[2] ICPE: Installation classée pour la protection de l'Environnement

- The general public, outside the HRS. This is the target group for *external* safety. The basic principle of external safety is to guarantee the general public a specific level of protection against threats posed by dangerous substances in their immediate environment. The table in Annex II shows that external safety is not always (Germany) or not anymore (Italy) identified as a separate topic. The authority that pursues the policy in this respect may be a health authority (Germany) or/and an environmental authority (The Netherlands, France, Spain).
- Employees of the service station – This is workers safety. This is often the concern of the Labour inspectorate. This aspect was not specifically addressed during the approval process, except in Germany. However, the HRS operating permit itself often contains regulations concerning the skills of attendants and the procedures to be followed by them (e.g. in case of an emergency). Also it is implicitly assumed that compliance with technical standards will largely take care of workers safety. This applies for the Netherlands, Spain and Italy. In France, safety of workers concerns is handled by Labour inspectorate. However, topic such as ATEX zoning (EC/99/92 CE) is dealt by both labour inspectorate and environmental authority when hazardous industrial activities are concerned.
- Safety of customers at the filling station. For professionals, like the bus drivers of hydrogen fuelled busses, the HRS operating permit may require that persons that execute the refuelling operation should be well instructed. For private customers safety should be more or less guaranteed by proper technical standards or similar rules as for professional drivers may apply.

5.2.3 The required information by the authorities

The owner of the HRS has to apply for the permits.
In most countries the following documents have to be submitted to the authorities:
- Location of the HRS and its surroundings (drawing and lay-out)
- List of plant components e.g. piping, fittings, vessels, materials, heat exchangers etc. and used guidelines/regulations.
- A short description of the process and Process Flow Diagrams (PFD’s)
- Impact study on environmental impact in day to day use (gaseous and liquid emissions, noise emissions, waste water, soil contamination)
- Mitigating and preventive safety measures including explosion and fire detection
- Intervention measures in the event of abnormalities

In addition some countries/states require:
- Hazard identification study, special attention for brittleness (For information on brittleness see EIGA Doc 15 05)
- Qualitative or quantitative Risk assessment studies (QRA)
- Declaration of installation of pressurised equipment
- Electrical design as well as grounding system and lighting protection system
- Listing of measuring and control systems
- Listing of applicable Codes & Standards
- Installation plan and utilities
- Operating instructions

5.3 External and occupational safety policy concerning hydrogen

5.3.1 Safety Policy

Conceptually three stages can be distinguished in a safety policy:

1. Prevention of accidents by application of state of the art technology and following technical standards
2. Creation of a safety zone or safety distance.
3. Optimal preparation of emergency services (contingency planning).

In all countries interviewed these three elements were identified.
The prime assurance for the prevention of accidents (and thus taking care of external, worker's and customer's safety) is reached by applying state-of-the-art technology through standards and guidelines. These guidelines are mostly based on experience with compressed natural gas (CNG) but may also be formulated in general terms (like the BetriebsSicherheitsVerordnung Betr.SV – Germany) (see also paragraph 5.4). A review of best practises on actual experiences with HRS is also presented in WP4 (Deliverable 4.1).

In addition to the prescriptive safety policy, risks may further be reduced by spatial zoning, i.e. the application of safety distances.
France and the Netherlands use a Quantitative Risk Assessment (QRA) to determine the safety distance.
In Italy specific safety distances for HRS included in DM 31/8/2006 are used (based on previous experience with CNG). A QRA, performed on the first HRS in Italy, had shown these to be adequate.
In the US safety distances are determined on the basis of state regulations and applicable codes.
No particular mention of safety distances is made by Spain, although it is mentioned that the normative for CNG is used for the approval of HRSs in Spain. In Spain, both HRS's are inside the bus station perimeters so they do not consider special distance requirements. The HRS's are not considered to be "public" ones.
Germany mentions the use of safety distance, but no method is specified.

In all countries contingency planning is also part of the safety policy. Usually the fire brigade is the leading party in here See also paragraph 5.8.

5.4 Technical standards for the construction of an HRS

In Table 5-2 and Table 5-3 the technical standards for the construction of an HRS used in all European countries are mentioned as well as those used in the USA.

Table 5-2 Technical standards used in all European countries

Pressure Equipment Directive 97/23/EC
Machinery Directive 98/37/EC
Low voltage Directive 2006/95/EC
Electro Magnetic Compatibility Guideline 89/336/EC
ATEX 137 Directive 99/92/EC Guidelines for determination "non-classified", "zone 0", "zone 1", zone2 in IEC 60079-10. Explosion safe equipment according EX-Zone 1 at locations where H2 is

present in apparatus and pipelines

Table 5-3 Technical standards used in the USA

NFPA 52 (Vehicular Fuel Systems Code)
NFPA 55 (Standard for the Storage, Use and Handling of Compressed Gases and Cryogenic Fluids in Portable and Stationary Containers, Cylinders and Tanks)
NFPA 30A (Code for Motor Fuel Dispensing Facilities and Repair Garages)
NFPA 57 (Liquefied Natural Gas Vehicular Fuel Systems Code 1999 Edition) (THIS DOCUMENT HAS BEEN PHASED OUT AND INCORPORATED INTO NFPA 52)
NFPA 70 (National Electric Code)
ASME BPV Code Section VIII, Div.I and Section IX

In Table 5-4 Technical standards taken into consideration for approval of HRS's in various European countries are shown.

Table 5-4 Specification of regulations for approval of HRSs

France	Regulation for NGV stations may be used as a starting point. "Arrêté types 1415 &1416 " mentioned above for hydrogen storage and hydrogen production are also likely to be used.
Germany	Technical regulations in BetrSV (leading document)
Italy	DM 31/8/2006 (leading document) Non binding references: NFPA 50A (now NFPA 55) - EIGA 15/96 ISO 15916[1]
Spain	Regulation of Pressure apparatus Real Decreto 2486/1994 (CNG regulation)
Netherlands	PGS 25 (CNG) NFPA 50 (now NFPA 55) NFPA 57-02 (LNG)
China	In China, BP is the major equipment supplier in Beijing Hydrogen Park. BP applied internationally recognised hydrogen safety codes, principally the NFPA (US National Fire Protection Association codes : NFPA50A, NFPA55, NFPA52)
Various countries	Regulations for the storage of hazardous substances.

[1] ISO/TR 15916:2004 provides guidelines for the use of hydrogen in its gaseous and liquid forms. It identifies the basic safety concerns and risks, and describes the properties of hydrogen that are relevant to safety. Detailed safety requirements associated with specific hydrogen applications are treated in separate International Standards

5.5 Availability of methodologies and guidelines for the assessment of external (off-site) effects, damage and risks.

The methods used to asses external safety, as mentioned in the interviews, are shown in Table 5-5.

Table 5-5 Methodologies and Guidelines for the assessment of external (off-site) effects, damage and risks

France	The evaluation of the risk is the responsibility of the owner and must be done with both quantitative and qualitative methods with a risk based approach but without commonly accepted methods or software. Latest regulation (Arrêté et circulaire du 29 septembre 2005 relative aux critères d'appréciation de la démarche de la maîtrise des risques d'accidents) sets criticality matrix to be used.
Germany	Limited to a hazard evaluation according to BetrSV and Explosion protection
Italy	Because of the small amounts of dangerous substances involved, an external safety study is not legally required for an HRS, as for other low-to-medium risk activities by DL n. 334 of 17/8/1999 that implements EU Directive 96/82/EC. DM 31/8/2006 requires a QRA only for the in-situ hydrogen production section of the HRS. However, being the first public HRS of its kind in Italy, a quantitative risk analysis on the whole HRS as prescribed by the "High Risk Activities" Seveso Directive was also considered in the approval procedure for the Zero Regio's HRS in Mantova.
Spain	No QRA will need to be done for each station. No specific guidelines exist. The existing normative for compressed natural gas is used, taking into account the special characteristics of H2.
Netherlands	In NL a QRA will need to be done for each station. No specific guidelines exist for HRSs and *until specific requirements for H2 are specified (as with LPG) this will be the case*. The Dutch guidelines (as defined for Seveso establishments in CPR-18) will be leading, i.e. scenarios and failure frequencies, will be derived from this to determine safety distances. Relevant distances are also used for land-use planning purposes, e.g. if risk criteria are not met, relocation will be necessary.
USA	In general, states or local governments do not perform quantitative risk assessments nor do they require them of project developers. However, in the United States, it is very common for project developers themselves to perform quantitative and/or qualitative risk assessments and/or FMEAs
China	Because the novelty of HRS in China, assessment is checked by experts in an argumentation meeting. In China, BP is the major equipment supplier in Beijing Hydrogen Park. BP applied quantitative risk-engineering techniques which look at potential incidents and their prevention (frequency/probability reduction) or mitigation (consequence reduction). One such technique is Quantified Risk Assessment (QRA)

From the information in Table 5-5 it can be concluded that for Netherlands, Italy, France, where external safety was/is an identified important issue, QRAs, along the lines of the local interpretations of the SEVESO II guidelines, have been or should be performed, resulting in an assessment of off-site effects, damage and risks. In the other countries no specific methods for external safety were mentioned. Nonetheless, for all countries documents are required in which the safety measures are outlined. In Spain, USA (where external safety was also considered important) and also the Netherlands the choice of the most suitable method is left to the expert judgement of operator, constructor and / or owner of the HRS.

5.6 External safety (off-site safety) and land use planning

Although all countries, apart from Spain, mention the use of safety distances it is not always clear how (or if) they are used in relation to land-use planning. Safety distances (damage radius for a given accident probability / external safety) should not be confused with so called "ATEX zoning" that relates to occupational health and to the choice of appropriate equipment to prevent explosive atmosphere ignition. Only for the countries in which these distances are based on methods derived form the SEVESO directive (Italy, Netherlands France) a link seems to be present (see Table 5-6).

In the USA, zoning issues and land use requirements, with respect to the siting of HRSs, come under the cognizance of local governments, rather than the Federal government or requirements in codes and standards.
Of course we are concerned here with safety distances beyond the zoning in the sense of the ATEX guideline, where it concerns avoiding ignition in the event of release of small quantities of hydrogen.

Table 5-6 External safety and land-use planning

France	Safety distances are set for specific installations like storage of large quantities of liquid hydrogen. For other cases, the safety study shall demonstrate that the hydrogen installation is not likely to cause external effects. Minimum safety distance can however be recommended in the handbook as best practices. Safety distances exist nowadays for conventional and NGV refuelling stations (declaration regime).
Germany	Safety distances inside and outside the HRS are applied.
Italy	The location of the HRS must be compliant with the City Council's general plan and zoning ordinance for ordinary refuelling stations and preferably CNG refuelling stations. In case the HRS is located in an area comprising an high-risk activity, local authorities at the higher level than the City Council, i.e., the Province and/or the Region has to compile a risk analysis report of the whole area by putting together the information provided by each single activity in the area. This document must take into consideration also any planned future business or building activity in the area. Anyway, there is no specific provision for HRS.
Spain	Both of the HRS were considered as temporarily ones and operating into already restricted areas (bus stations). Outside safety distances are applied according the City Council's general plan.
Netherlands	A municipality may only designate a piece of land for a high-risk activity in an establishment if the associated risks to the vicinity do not exceed the limit values laid down in the External Safety Establishments Decree. The Decree established environmental quality standards in the form of limit values for location-based risk, e.g. 10^{-6} per annum for vulnerable objects and for sites in the process of remediation.
USA	Safety distance requirements inside HRS are provided in ICC and NFPA codes, if the local governments chose to adopt them. Safety distances outside HRSs are governed by local zoning and siting laws and regulations.
China	Fire separation distance between hydrogen station or hydrogen supply station or hydrogen gas receiver and building or construction shall be no less than that as specified in GB50177-2005.

5.7 The inspection protocol

Only France reported to have an inspection protocol for any installation including HRSs. Nonetheless some kind of inspection protocol exists for The Netherlands, USA, Italy and Germany. As can be seen in Table 5-7 these protocols are usually based on maintenance/inspection demands of the equipment used (as prescribed by the owner and / or manufacturer). The fire brigade can be involved in these inspections. In Spain an inspection protocol, based on the risk, is currently being developed.

Table 5-7 Inspection protocols used in various countries

France	Inspection of ICPE in France is clearly organised and not delegated to private notified bodies (except for pressure vessels). The protocol for inspection is available (in french) at the following address : http://www.drire.gouv.fr/environnement/controle.html It is under the responsibility of the **DRIRE civil servants under the sole authority of the Préfet (local representative of the government).** In France, 850 inspectors (civil servants) are in charge of inspecting 63 200 installations subject to authorisation regime. In case of request from the préfet combined inspections by veterinary (in case of refuelling station in a supermarket when food is sold), DRIRE, and fire brigades can be done.
Germany	According BetrSichV every 5-years by **Competent Safety Organisation**. Tubes every half year by **operators + manufacturers** regulations. Also: 24 months after start-up and every three years.
Italy	No specific protocol exists. General procedure for conventional or, better, CNG refuelling station will apply. Only the first inspection during the plant start-up will be carried out by all inspecting bodies simultaneously. In Italy the responsible authority for workers safety (ASL) is present at the start-up inspection and may carry out further inspections during operation. The **fire brigades** will make an inspection every three year.
Spain	No specific protocol exists. **Fire brigade** applies general checklist. **Owner** does visual checks but without high regularity. **Supplier of equipment** does 6 monthly check or, at least, the time suggested for the devices manufacturer. This, however, is primarily because of the novelty and the experimental character of the Madrid and Barcelona HRS. Technical reliability of the HRS is determined by equipment supplier. Owner is alerted when replacements are due.
Netherlands	No specific protocol exists. **Fire brigade** applies general checklist. **Owner** does regular (once a week or so) visual checks. **Supplier of equipment** does a weekly check. This, however, is primarily because of the novelty and the experimental character of the Amsterdam HRS. Also VROM will apply 'general' inspection techniques. Technical reliability of the HRS is determined by equipment supplier, and monitored by the software. Owner is alerted when replacements are due. There is an increasing tendency in the Netherlands to have private notified bodies perform the obliged controls of the installation. However, such a notified body for HRS's does not exist yet.
USA	The states are not involved in conducting periodic (i.e., annual or unannounced) inspections of hydrogen fueling stations. Uniformly, this is the responsibility of the **local fire marshal and/or fire department.** Local fire protection authorities, in general, have the authority to cite project operators for violations of safety regulations or shut down a facility if they believe that there is an imminent fire safety hazard. In nearly all projects, **the operators and/or vendors** have documented, systematic inspection protocols.

5.8 Contingency planning

Emergency response organisations like the fire brigade, ambulance services and the police should be prepared for accidents that might occur. In most countries the leading party regarding contingency planning is the fire brigade.

Many of the interviewed parties indicated that they would like to see the intervention measures for the various incident scenarios at HRSs explicitly stated in the Hy-approval handbook.

Table 5-8 Contingency planning

France	Dedicated plans to be made. - "Plan d'operation interne" under the responsability of the owner (when installation under authorisation regime) - "Plan particulier d'intervention" under the responsability of the prefet (when installation under authorisation regime)
Germany	Action plan of the fire brigade and safety response plan
Italy	Similar to ordinary and CNG refuelling stations
Spain	Similar to ordinary refuelling stations
Netherlands	The environmental permit states that the establishment should have an emergency plan and a plan of attack for the fire brigade based on the possible scenarios. The environmental permit states the contents of the plan of attack as well. The fire brigade identified the possible scenarios and their response. A contingency plan should not be mono disciplinary (only assistance by the fire brigade) but also refer to the role of the GHOR (Health Assistance in the event of Accidents and Disasters) and the Police
USA	Required, regardless of the governmental/ approval agency
China	Fire brigade, ambulance services and police are all involved in contingency plan

5.9 Dissemination of the handbook

Table 5-9 presents the response of the interviewees on the subject dissemination of the handbook.

Table 5-9 Dissemination of the handbook

France	Organisations would use the handbook if it would contain relevant information to particular problems. However, the handbook has no legal status. It can therefore only be referred to as best practice information. Dissemination through DDSC[1] (Department at governmental level in charge of fire services)
Germany	Some interviewees answered that the handbook will not be used because it has no legal status
Italy	Organisations would use the handbook if it would contain information related to their field of responsibility. Formal recognition of the handbook by Italian authorities would greatly help its dissemination and acceptance.
Spain	Organisations would use the handbook if it would contain relevant information to problems such as: 1. What functions and buildings are allowed near HRS's? 2. Technical Standards 3. Intervention measures
Netherlands	Organisations would use the handbook if it would contain relevant information to problems such as: 1. What functions and buildings are allowed near HRS's? 2. Technical Standards 3. Intervention measures
USA	Based on a survey of states that are actively involved in pursuing hydrogen technology and implementing HRS projects, they are not familiar with the handbook
China	Organisation would use the handbook If it would contain relevant information with respect to their particular problems (such as safety).

[1] DDSC: Direction de la Defense et de la Securité Civile..

As can be expected from the response the use of the handbook will depend on the relevance of the information in the book to the problems that the various stakeholders are confronted with. Of course this will become much clearer after the first draft of the handbook has been presented to them.

A point to be noted is that the (legal) status of the handbook will also affect its use.

6. Remarks / other issues / gaps

The importance to involve the local community at an early stage in the approval process is mentioned by various countries.

Some of the interviewees felt the fact that the labour inspectorate had not been involved in the approval proces in their country (except Germany) as an omission.
In Italy the labour inspectorate was not involved in the HRS approval process so far. The main responsibility for workers safety lies within ASL – the local health service.

In the USA, both permitting officials and HRS project developers emphasize the importance of community involvement in implementing projects – the earlier that involvement, the better.

France reported that the classification of the risks is based on the quantity of hydrogen stored on site, regardless of the pressure, type of tanks and location of the tanks. Quantity of hydrogen stored mainly affect the administrative status of the refuelling station (declaration or authorisation regime) and therefore the amount of documents to prepare for authorities. Authorisation regime always apply when hydrogen is produced on-site.

The risks associated with “non classical” technical solutions (buried storages for instance) would also be interesting to develop.

7. Conclusions and Recommendations

In all interviewed countries either explicitly or implicitly three stages of safety assurance could be distinguished in the approval process of an HRS:

1. prevention of accidents by application of state of the art technology and following technical standards
2. creation of a safety zone or safety distance.
3. optimal preparation of emergency services (contingency planning).

Ad 1.
Conclusion:
There was good agreement on the first of these stages between all 5 EU countries They all used the same technical standards (EU regulations) sometimes augmented with local regulations. Also some American standards (most notably NFPA-standards) are used sometimes.
The USA have their own technical standards, although many are similar to EU regulations.
China has no existing regulations specially for HRS, but there is relating code GB50177-2005.

Recommendation:
The handbook should contain a detailed technical description of the HRS, thereby making sure it is in good agreement with all regulations applicable.

Ad. 2
Conclusions:
Although all countries do mention the use of safety zones it is not always clear how they are derived and which criteria acceptability levels are used.
Very clear are the Dutch standards for external safety, which are also used for land-use planning. Calculated are Location Based risk (PR) and Societal Risk (GR). Acceptance levels are PR < 10^{-6}/yr and GR < $10^{-3}/N^2$, in which N represents the cumulative number of fatalities.
Also in France risk based criteria for external Safety came into force recently. In addition to fatalities (as in the Netherlands) injuries to persons are used as a criterion. Acceptability levels are not clearly defined, but agreed during discussions between stakeholders
Italy assessed the consequences according to damage limits provided for in DM 9/5/2001. No acceptance levels are stated by laws. Acceptance levels have to be negotiated and agreed upon by interested parties and authorities having jurisdiction. Based on pilot studies on a few early HRSs and the long experience with CNG, it has already been decided that safety distance as provided by DM 31 August 2006 can be used. If the HRS complies with DM 31 August 2006 then a QRA is required only for the in-situ hydrogen production section of the HRS. If the safety distances of the HRS do not comply with DM 31 August 2006 then a QRA is required on the whole HRS to convince the authorities that the safety characteristics of the non-compliant HRS are equivalent to those of a compliant HRS.

In the USA safety distances are set on a state by state basis, using their adopted codes and standards or regulations. No generally applied method or criteria exist. Choice of suitable methods is often left to the builder / contractor / owner of the HRS.

Spain has not adopted specific safety distances that are related to the possible risks of the HRS. Due to the situation of the HRS (inside bus station perimeter, not open to the public) the safety distances are the same as used for the bus station itself (City Council's general plan).
Germany report the use of safety distances. It is however unclear how they are derived, which criteria are used and what the acceptability levels are.

Recommendations:
All safety studies reported should be detailed enough so individual countries can extract the information that is useful for their particular safety approach or policy. This means effect / safety distances should be Reported as a minimum (deterministic approach). Probability of corresponding scenario could also be proposed.

Ad.3
Conclusions:
In all countries contingency planning was reported to be a factor to consider. Most countries reported a leading role for the fire brigade in this area.
In the Netherlands their advise is binding.
In France they prepare a dedicated plan (Plan d'Organisation Interne – POI) for installations under the authorisation regime if the prefet (local goverrment representative) ask for it. A POI defines contingency procedures and related emergency ressources in order to protect employees, neighbours and the environment in case of an accident. This plan is written by the owner of the installation under his/her responsibility. Fire services should be consulted. It is not likely that a POI will be requested for hydrogen refuelling stations.
In Germany they prepare an action plan and safety response plan.
In Italy, emergency planning is coordinated by local authorities, either township, province or region, depending on the extension of the interested area. The region is responsible for the implementation of the Seveso Directive in the case of high-risk plants. The Fire Brigades are always a key actor. No specific emergency plan for HRS was mentioned during the interviews.
In Spain Fire brigades visit the HRS, are informed about risks and safety devices and propose safety response recommendations.
For the USA, there are no Federal regulations regarding contingency planning. Contingency planning requirements (where they exist) are established at the state and/or local government level.
In China**,** the fire brigade plays the leading role.

Recommendation:
The role of the fire services should be outlined and an emergency response plan should be in the Hy-approval handbook. In this plan the intervention measures for the various incident scenarios at HRSs should be explicitly stated in the handbook. Most of the interviewed parties indicated that they would like to see this. At least emergency measures should be outlined.

General recommendations:

Communication between stakeholders
Good coordination between the stakeholders in the approval process involved was seen as an important issue by the interviewees. This should also be emphasised in the handbook, whereby it must be clear which authority has the coordination role. It is advisable that the parties involved seek agreement on potential discrepancies in an early stage.

This includes Community relations**.** To facilitate community acceptance community concerns should be addressed as otherwise the implementation of the project could be seriously delayed, particularly because of the novelty of HRs, with (certainly to the general public) unknown risks.

Inspection regime
An inspection regime would have to be set in accordance with the risk imposed by the HRS. A number of countries reported that no specific inspection protocol exists. An (example of an) inspection protocol should be given in the handbook.

Dissemination
The use of the handbook in the approval process of a HRS is not guaranteed as long as its status is not recognised. A statement from the competent authorities concerning the conditions under which they will endorse the use of the handbook would be welcome.

I. Annex I - Interview Protocol

Below the interview protocol is shown, as used in all 6 countries is shown:

Questions to authorities involved in the approval procedure of hydrogen refuelling stations (HRS).

1. Introduction / General questions regarding existing HRS's.
The technology at the hydrogen station has to be specified because there are different approaches to the safety measures according to whether hydrogen is produced from natural gas or through electrolysis.
(note: some questions under 1. 1 until 1. 8 exclude each other)

1.	**Some characteristics of the HRS**	
1. 1	Is the H2 trucked-in CGH2 or LH2?	□ CGH2 □ LH2 □ not applicable
1. 2	Is it on-site reforming?	□ yes □ no if yes specify: □ natural gas □ methanol water solution □ kerosene □ coke oven gas (COG) □ naphta □ LPG □ □ desulphurised ed gasoline □ other ……..(specify)
1. 3	If applicable: is the feedstock supplied by pipeline as per existing u/g lines?	□ pipeline above ground pipeline underground □ not applicable
1. 4	Is it on-site electrolysis?	□ yes □ no
1. 5	Is it a stand-alone site or combined with an existing refuelling station?	□ stand-alone □ combined
1. 6	a. Is LH2 dispensed? b. Specific measures for LH2?	□ yes □ no if yes specify:
1. 7	At what pressure is the H2 dispensed: at 350 or 700 bar or a combination of all?	□ 350 bar □ 700 bar □ other ……..(specify)
1. 8	Specific rules or limits to how high the pressure can be in hydrogen tanks?	□ yes □ no if yes specify:
	Please enter other specifications ……..	

The questionnaire below is partly based upon questionnaires in the framework of other studies.[1] These questions have to be answered by the competent authorities in France, Italy, Spain, Germany, USA and the Netherlands.

[1] Shape Risk and
Company notes: opportunities for learning and co-operation in external safety policy by Environmental resources management under the authority of the Ministry for Housing, Spatial Planning and Environment.

The role of the competent authorities varies and the elements under A until J may be identified. *It depends of the responsibility of the respondent which questions can be answered by the interviewee.*

J. the responsibility and liability of all stakeholders involved in the approval process
K. the required information by the authorities
L. the external and occupational safety policy concerning hydrogen
M. the assessment criteria for the technical systems of the HRS (to be provided by the HyApproval handbook)
N. availability of methodologies and guidelines for the assessment of external (off-site) effects, damage and risks
O. the issue external safety (off-site safety) and land use planning
P. the inspection protocol
Q. the emergency planning
R. dissemination of the hyapproval handbook
J. gaps

A.	**Responsibility and liability of the stakeholders**	
A. 1	Stakeholders □ competent authority □ owner □ inspection authority □ fire brigade □ notified bodies for approval of equipment and assemblies of equipment. □ other, ……	Name: Visiting address: Post address: Contact person:
A. 2	a. Role of interviewee in the approval process in terms of responsibility and liability	Specify……
	b. Main stages in the approval process - sequence of the approval steps	Specify……
A. 3	Do the stakeholders communicate • to coordinate the requirements, • to determine the location of the HRS, • to discuss the milestones in the process • with notified bodies involved in approval of equipment and assemblies of equipment • with similar/other authorities to ask for assistance?	 □ yes □ no □ yes □ no □ yes □ no □ yes □ no □ yes □ no
B.	**Required information by the authorities**	
B. 4	What information is required by the authorities in order to start the approval procedure?	□ description of the HRS and its operation, □ components, pipelines, Process Flow Diagrams, □ HRS lay-out □ location and its surroundings □ hazard identification studies □ risk assessment studies □ mitigating safety measures including explosion and fire protection □ shut-off procedures

		□ other, ……
C.	**External and occupational safety policy**	
C. 5	a. Are external and occupational safety issues concerning hydrogen refuelling stations (HRS) implemented in legislation?	□ yes □ no if no, go to C. 6 if yes, specify directive numbers
	b. has the authority any experience with hydrogen production/storage/transport etc.?	□ yes □ no if yes, specify
C. 6	If no specific legislation is available, please describe how external and occupational safety are considered in practice (are comparable processes for other compressed gaseous fuels like e.g. CNG in place and applied analogously to hydrogen?).	
C. 7	Is external safety linked to environmental/exploitation permit application procedures?	□ yes □ no if yes, specify
C. 8	Will the approval approach be: • Based on rules which mean that the licence to operate is given if the installation fullfills the requirements of those rules? • Risk based: for every new HRS installation, the whole approval process has to be followed and a QRA has to be performed? • Based on a deterministic approach (e.g. worst case, worst credible case scenarios)?	□ yes □ no □ yes □ no □ yes □ no
C. 9	Experience in the approval process: Were there any items/aspects either of technical or administrative nature that were particular/ exceptional/new in the approval process?	□ yes of technical nature, specify □ yes of administrative/ managerial nature, specify □ no
C.10	Will new legislation in the field of external safety be implemented in the near future and will it affect HRS's?	□ yes □ no if yes, specify
C.11	a. Was occupational safety considered during the approval process? b. Was the labour inspectorate involved? c. Were there any conflicts of interest between environmental and occupational issues?	□ yes □ no □ yes □ no □ yes □ no if yes, specify

D.	**Regulations and technical standards available**	
	The handbook will present the best practices for hydrogen refuelling stations as well as the regulations, codes and standards (RCS) affecting design, installation, operation and maintenance of a hydrogen refuelling station. Consequently the handbook will try to provide the answer to the following questions for future HRS's.	
D.12	Which mandatory regulations and technical standards defines the acceptability of existing (and planned) HRS installations?	□ apparatus according Pressure Equipment Directive Guideline 97/23/EC □ Machinery Guideline 89/392/EC □ Low voltage Guideline 93/68/EC □ Electro Magnetic Compatibility Guideline 89/336/EC □ Explosion safe e quipment according EX-Zone 1 at locations where H2 is present in apparatus en pipelines □ Best Available Technology (BAT) □ □ □
D.13	What kind of techniques/methods have been/are used to determine if technical systems meet the requirements?	
D.14	How do you determine if the measures taken are adequate?	
E	**Methodologies and Guidelines for the Assessment of External Effects, Damage and Risks**	
E.15	Does the approval process require the execution of a risk analysis in all circumstances?	□ yes, in all circumstances □ no, only if the production capacity exceeds ……. kg/h □ no, only ……. (specify)
E.16	Give an indication of the characteristics of the risk assessment • Qualitative versus quantitative analysis;	□ qualitative □ quantitative
	• Use of specific methodologies/software models/etc.;	□ SAFETI □ RISKCURVES □ SAVE-II □ ……
	• Are the models suited for calculations with Hydrogen?	□ yes □ no □ overestimation because …….. □ other ……..

	• Consequence (deterministic approach) based? Risk based? • Guidelines for scenario selection, assessment of damage/ probabilities of scenario occurrence/risks (individual risk contours, societal risks, …)	□ consequence based □ risk based □ CPR-18 Guideline □ worst case, worst credible case (specify) □ …… (specify) □ …… (specify)
	• Taking into account existing/planned mitigating measures;	□ yes □ no
	• Taking into account the implementation of management systems on safety and/or environment (e.g. OHSAS18000, ISO14001, etc…);	□ yes □ no
E.17	a. Are safety distances applied, either within the establishment (for instance hazardous area classification) or outside the establishment (for instance risk contours) applied, or both? b. Is the ALARP[1] principle applicable?	□ inside yes □ inside no □ outside yes □ outside no □ yes □ no
F.	**External safety and land-use planning**	
F.18	a. Is external safety linked to land-use planning? b. Is it applicable to HRS?	□ yes □ no □ yes □ no
F.19	Is there a policy to avoid the establishment of HRS's and similar activities in populated areas?	□ yes □ no please provide examples.
G.	**Enforcement auditing or inspection**	
G.20	Which documents should be available at the establishment, in the operation phase?	□ licence to operate from the competent authorities □ documents for pressure equipment according PED Directive 97/23/EC □ ATEX-documents Directive 94/9/EC □ Machinery directive 98/37/EC □ documents according any other EC directive: please specify □ hazard assessment studies □ electrical switch plans □ Interlock system □ alarming and emergency plan □ other …… □ □
G.21	Description of (expected) inspection protocol	□ inspection of documentation on completeness and accuracy,

[1] ALARP: As Low as Reasonably Practicable.

		□ correctness of the installation and assembly (for instance leakage inspection), □ inspection set-up according to regulations, □ inspection of electric facilities/provisions, □ inspection of explosion protection measures □ ……. □ …… □ …….
G.22	Is it advisable to combine inspections regarding the enforcement of regulations by the various inspection bodies? For instance combined inspection by the labour inspection and environmental inspection?	□ yes □ no
G.23	a. How frequent would a hydrogen station have accomplish an inspection and which criteria should be applied after first permit period? b.Are there criteria set by inspectors that they would demand as evidence for continuous safe operation?	Every ... month / year □ yes □ no if yes, specify
H.	**Emergency planning**	
H.24	Are emergency situations incorporated in land-use planning?	□ availability of evacuation infrastructure □ accessibility for fire brigades □ …….. □ no
H.25	Referring to possible accident scenario's what kind of preparations should be taken by the various stakeholders and the emergency response organisations in particular? (e.g. ambulance, fire fighting organisation, police, municipality)	
I.	**Dissemination of the handbook**	
I.26	Would you use the Hyapproval handbook for future approval procedures of HRS's?	□ yes □ no
I.27	What would in your country be the way to disseminate the handbook under the organisations/bodies most concerned in the hydrogen approval process?	
J.	**Gaps**	
J.28	Are there any gaps/subjects missing in this table that are important in the approval process?	□ yes □ no if yes, specify

II. Annex II Approval requirements in five EU countries and the USA

+ = required
- = not required

Approval requirements for HRS	Netherlands	France	Italy	Germany	Spain	USA
Laws/regulations taken into consideration for the construction of the hydrogen production unit, storage facility and refuelling station	SEVESO II PGS25 (CNG guideline) US NFPA 50A US NFPA 57-02 EIGA 15/96, ISO 15916	(SEVESO II) - Loi Bachelot - Circulaire du 24 mai 1976 relative aux dépôts d'hydrogène liquide ; - Arrêté type – rubrique n° 1416 de ICPE[1] Stockage ou emploi de l'hydrogène ++++++	DM 31/8/2006 SEVESO II Italian Decree on transport and storage of CNG Non binding references: US NFPA 50A EIGA 15/96, ISO 15916	- BetrSichV - Technical Guideline Pressurized Gasses (TRG) for liquefied gasses and natural gas. -Occupational Protection Law (ArbSchG) Manufacturer's own safety concepts	- Real Decreto 2486/1994 [2] - ITC MIE-APQ-5 [3] - ISO 15916: 2004[4]	NFPA 52 NFPA 55 NFPA 30A NFPA 70 NFPA 57 ASME BPV Code Section VIII, DIV. I and Section IX State Regulations
Safety Policy:	1. prevention of accidents by applying state-of-the-art technology through standards and guidelines 2. prevention of risks by spatial zoning through the establishment of statutory risk standards that are based on the concepts of location-based risk (PR) and societal risk (GR)	Probability of occurrence v.s. consequences v.s kinetics v.s. gravity. Related to the quantity of hydrogen on site regardless pressure.	Prescriptive based on CNG	Prescriptive according BetrSV	Prescriptive using Spanish compressed natural gas regulations including pressure reservoirs code.	Prescriptive using adopted national codes and standards (sometime adopted and based on experience with CNG)
Best Available Techniques	Required in handbook	Required in handbook		According Guideline Pressurized Gasses	According (inter)national codes and	According to national codes and standards

[1] ICPE: Installation classée pour la protection de l'Environnement
[2] Compressed natural gas regulations in Spain
[3] Almacenamineto y utilización de botellas y botellones de gases comprimidos, licuados y disueltos a presión.
[4] Consideraciones básicas para la seguridad de los sistemas de hidrógeno.

Approval requirements for HRS	Netherlands	France	Italy	Germany	Spain	USA
				(TRG 406)	standard. Required in handbook	
Statutory Risk standards	Applied: for Local Risk 10^{-6}/jr.	Hazard/objects/ vulnerabiliy reference map (Aléa) according Plan de Prévention des Risques Technologiques. No clear acceptance criteria. The prefet gives final authorization		External Safety not always considered because approval according BetrSV However competent authority on external safety involved.	External safety is part of the environmental permit	External safety is an important issue that is addressed by individual states and local jurisdictions using the national codes and standards. No acceptance criteria
Contingency Planning	Required	Dedicated plan can be made: Plan Particulier d'Intervention	Similar to ordinary and CNG refuelling stations	Action plan of the fire brigade and safety response plan	Similar to ordinary refuelling stations	Required, regardless of the governmental/ approval agency
Occupational safety	Not considered by authorities	Not considered		Considered	Not considered	Not considered
Spatial zoning (planning)	Applied, based on limit value for location-based risk	Safety distances inside and outside the HRS are applied according IPCE[1] law when more than 50 tons H_2 See comments in main text	Applied, ordinance for preferably CNG refuelling stations	Safety distances inside and outside the HRS are applied. Based upon …	Only safety distances outside the HRS are applied (the same for refuelling station)	Planning is done at the state or local government agency having jurisdiction
Permits required	1.Environm. 2. Building 3. Operating	Operating first and then construction	1.Building 2. Operating	Parallel Building and Operating permit	1.Environmental 2. Building (may be simultaneous)	Permitting is done at the state or local government level and in general, the following can be required: o Environmental (or air quality) o Building o Operating

[1] ICPE: Installation Classée pour la Protection de l'Environnement

Approval requirements for HRS	Netherlands	France	Italy	Germany	Spain	USA
Authorities involved	1. City Council 2.Environm. body 3.Fire Brigade 4. VROM Inspectorate	CODERST[1] 1. The local DRIRE under the supervision of the préfet of department. 2. Fire brigade	1. City Council 2.Environm. body 3. Local Health Service 4. Scientific Body Nat..Health Service 5.Fire Brigade	Different institutions per autonomous state. 1. Accredited supervisory board: Gewerbeaufsichts-amt responsible for administration, permission and prohibition 2.Authority for the protection of health of inhabitants and safety of workers:	1. Land owner 2. City Council 3. Industry Department of the Generalitat 4. Fire Brigade (optional)	1. Either state government, collaboratively involving state and local government or entirely local government. 2. Fire Marshall (either state or local) 3. Department of Environmental Quality (state level) 4. State Division of Code Enforcement 5. Air Resources Board (In California, state law, CARB is involved in the HRS process)
Coordination between all parties involved	+ , responsibility of competent authority	Formal commission of authorities involved (CODERST)	+, responsibility of city council	+ , agreement on discrepancies before starting the permitting procedure.	Responsibility of City Council	+ 1. establishment of government agencies to be involved (In most communities, there is coordination between the building code official and the fire marshal) 2. Determine requirements for community relations efforts.

[1] CODERST: Commission Départementale d'évaluation des Risques Sanitaires et Technologiques.

Approval requirements for HRS	Netherlands	France	Italy	Germany	Spain	USA
Required documents by authorities						
Drawing and lay-outs of buildings and surroundings	+	+	+	+ what is meant by certified?	+	+
(Reference Standards for and) List of plant components e.g. piping, fittings, vessels, materials, heat exchangers and machines		+	API standard 618 for reciprocating compressors	+	+	+
Declaration of installation of pressurized equipment		+			+	
Description of process + PFD's	+	+	+	+	+	+ technical review
Electrical design as well as grounding system lighting protection system			+ to be approved by Environmental Body		+	+ not in all states (typically, in accordance with NFPA 70)
impact study on environment in day to day use (gaseous and liquid emissions noise emissions, waste water, Soil contamination)	+	+	+ to be approved by Environmental Body		+	+ not in all states

Approval requirements for HRS	Netherlands	France	Italy	Germany	Spain	USA
Hazard identification study, (special attention for brittleness)	+	+ HAZOP: if storage capacity > 5 tons		Not always required	Not required	Hazardous materials issues (addressed as part of environmental assessments)
Quantitative Risk Assessment/ external safety study	+	+ safety report if storage capacity > 1 ton or in case of production of hydrogen	_	Not always required.	_	Not required by authorities, however done by project developers on their own initiative
Listing of applicable Codes& Standards documents						+(on basis of codes, standards or regulations adopted by the AHJ)
ALARP principle applicable		+				
Operating instructions				+ [1]		+(on basis of codes, standards or regulations adopted by the AHJ)+ not in all states
Listing of measuring and control systems	+			+		+(on basis of codes, standards or regulations adopted by the AHJ)
Installation plan and utilities				+		+(on basis of codes, standards or regulations adopted by the AHJ)
Preventing and Mitigating safety meas-	+	+	+ fire prevention certificate	+ explosion and fire protection document	Required in handbook	++(on basis of codes, standards or regula-

[1] only after the successful proof of a safe operability the permission for operation of the HRS is given

Approval requirements for HRS	Netherlands	France	Italy	Germany	Spain	USA
ures e.g. Accessibilility for emergency services Design of fire protection system Specification of water resources Safety precautions with LH_2 deliveries						tions adopted by the AHJ)
Intervention measures in the event of abnormalities (shutt-off procedures)	+	+		+ (locking plan)	Required in handbook	+(on basis of codes, standards or regulations adopted by the AHJ)+ not in all states
Checklist of required documents			+			
General guidelines used	Pressure equipment Directive 97/23/EC, Machine guideline 89/392/EC, Low voltage guideline 93/68/EC, EM compatibility guideline 89/336/EC, ATEX	Pressure equipment Directive 97/23/EC, Machine guideline 89/392/EC, Low voltage guideline 93/68/EC, EM compatibility guideline 89/336/EC, BAT[1]	Pressure equipment Directive 97/23/EC, Machine guideline 89/392/EC, Low voltage guideline 93/68/EC, EM compatibility guideline 89/336/EC, ATEX	Pressure equipment Directive 97/23/EC, Machine guideline 89/392/EC, Low voltage guideline 93/68/EC, EM compatibility guideline 89/336/EC, ATEX	Pressure equipment Directive 97/23/EC, Machine guideline 89/392/EC, Low voltage guideline 93/68/EC, EM compatibility guideline 89/336/EC, ATEX, BAT	+(on basis of codes, standards or regulations adopted by the AHJ)
Description and operating instructions of the natural gas refuelling station				+ (used)		
Inspection	No specific protocol, general in-	Clearly organised under the	No specific protocol.	According BetrSichV	No specific protocol ,	Whether or not to

[1] BAT : Best Available Technology

Approval requirements for HRS	Netherlands	France	Italy	Germany	Spain	USA
	spection techniques will apply	responsibility of the DRIRE. No specific frequency.	General procedure for CNG refuelling station will apply	every 5-years by Competent Safety Organisation, Tubes every half year by operators + manufacturers regulations. Also: 24 months after start-up and every three years.	inspection regime to be set in accordance with the risk imposed	conduct inspections and inspection protocol used are determined by the local AHJ
Dissimination	Organisations would use the handbook if it would contain relevant information to problems such as: 1. What functions and buildings are allowed near HRS's? 2. Technical Standards 3. Intervention measures	Organisations would use the handbook if it would contain relevant information to particular problems. Dissemination through DDSC[1]	Organisations would use the handbook if it would contain information related to their field of responsibility. Formal recognition of the handbook by Italian authorities would greatly help its dissemination and acceptance.	Some interviewees answered that the use of the handbook will depend on it's legal status.	Organisations would use the handbook if it would contain relevant information to problems such as: 1. What functions and buildings are allowed near HRS's? 2. Technical Standards 3. Intervention measures	
GAPS	Be aware of importance of the local community and involve them in the permitting process.	Which accident scenario's are taken into account. Classification of risk based of the quantity of hydrogen stored on site, regardless pressure, type and location of tanks			Be aware of importance of the local community and involve them in the permitting process..	Be aware of importance of the local community and involve them in the permitting process.

[1] DDSC: Direction de la Defense et de la Securité Civile.