Hydrogen Refuelling Stations
Safety, Regulations, Codes and Standards.
Lessons Learned: Interim Report 1
H2ME2 Deliverable 5.19

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Abbreviations
AHJ Authority having jurisdiction
ATEX Explosive atmosphere
CE Conformité Européene
DEMA Danish Emergency Management Agency
DGPR Direction Générale de la Prévention des Risques
DREAL Direction Régionale de l'Environnement, de l'Aménagement et du Logement
EFTA European Free Trade Area
FCEV Fuel cell electric vehicle
FCH JU Fuel Cells and Hydrogen Joint Undertaking
FC REEV Fuel cell range-extended electric vehicle
H2ME Hydrogen Mobility Europe
HRS Hydrogen refuelling station
ICPE Installations Classées pour la Protection de l'Environnement
MTES Ministère de la Transition Écologique et Solidaire
PED Pressure Equipment Directive
RCS Regulations, codes and standards

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Executive summary

Hydrogen Mobility Europe (H2ME, 2015-2022) is the largest passenger vehicle and hydrogen refuelling station demonstration initiative co-funded by the Fuel Cells and Hydrogen Joint Initiative (FCH JU). This report provides four country case studies – Denmark, France, Iceland and the UK – of hydrogen refuelling station (HRS) installations supported by H2ME from 2016-2018 to understand how regulations, codes and standards (RCS) are applied in each country to the station permitting and planning process, and to document the lessons learned from each country.

In the case of Nel Hydrogen Fueling in Denmark, H2ME HRS installations build on its existing relatively large HRS installed base. In Denmark, HRS building and permitting are controlled by centralised regulation, but are implemented by municipalities. Nel has been able to use the established precedents of its past stations as examples to the municipalities to try to encourage them to adopt standard, tested solutions to any concerns that they have about HRS installations. Consequently, station permitting times have fallen from around six months in 2012 to four days in 2016.

The French hydrogen refuelling network is just beginning. Permitting for stations involving on-site generation using electrolysis, such as the H2ME Sarreguemines station installed by McPhy, has proven a complex process, with responsibility for authorisation split between a national body (DGPR) which sets the regulations, and the implementation of regulations by regional bodies (the DREAL). This has meant that each station permitting application has been time-consuming as, effectively, each time it has had to start afresh. AFHYPAC, the French Hydrogen and Fuel Cell Association of which McPhy is a member, is leading a process to streamline HRS permitting. It is hoped that this will be in place by July 2018.

Nel Hydrogen Fueling was also responsible for the building of the HRSs opened in June 2018 in Reykjavik and Keflavik Iceland as part of its Icelandic Hydrogen joint venture with fuel retailing company Skeljungur. In terms of HRS installation, Iceland follows a similar path to Denmark, with building and permitting controlled by centralised regulation, but implemented by municipalities. While these H2ME stations are the first in the its planned HRS network, Iceland’s experience with HRS installation (having deployed the world’s first commercial HRS in 2003), plus Nel’s policy of engaging in advance with relevant stakeholders to address concerns and potential issues, meant that permitting times for the stations were approximately one month.

The UK hydrogen refuelling network is also at the beginning of its development. In the UK, there is centralised legislation to follow and local planning approval is required, as such the UK is somewhere between the Danish and French models. ITM Power has expended considerable efforts to establish best practice for forecourt-integrated HRS, working with stakeholders to help author guidance which will mean that the H2ME Beaconsfield HRS is the UK’s first forecourt-integrated HRS.

In terms of lessons learned: comparing the country case studies shows that, while there is commonality in terms of the overall EU directives that are followed in each country, there are differences in the processes and involved in HRS permitting and installation, despite the continued evolution of hydrogen refuelling RCS such as SAE J2601 and ISO/TS 19880. The optimal situation for
speed through the HRS permitting and planning process in a given country appears to be a relatively centralised decision-making system which allows established precedent and experience gained through HRS installation to be applied to each future proposed installation (i.e., the situation which exists in Denmark). Future editions of this report will provide updates and case studies to assess whether process of permitting and installation begins to harmonise across European countries as additional stations are installed during the H2ME project, and RCS are developed further, and whether this will in turn reduce HRS planning and installation times across Europe.

In terms of safety, all HRS covered in this report (and all stations so far installed by the H2ME project) are operating safely. As of November 2018, H2ME project refuelling stations have dispensed almost 22 000 kg of hydrogen with no safety incidents. If any safety incidents occur at H2ME stations in the future, they will be addressed in subsequent editions of this report.
1 Introduction to H2ME

Hydrogen Mobility Europe (H2ME, 2015-2022) is the largest passenger vehicle and hydrogen refuelling station demonstration initiative co-funded by the Fuel Cells and Hydrogen Joint Initiative (FCH JU). H2ME is formed of the two separate FCH JU-co-sponsored projects:

- H2ME-1 (2015-2020), which aims to deploy 300 fuel cell electric vehicles (FCEVs) and fuel cell range-extended electric vehicles (FC REEVs) and 29 hydrogen refuelling stations (HRS).
- H2ME-2 (2016-2022), which aims to deploy 1 100 FCEVs and FC REEVs and 20 HRS.

The aims and scope of H2ME are summarised below in Figure 1:

![H2ME initiative (2015 – 2022) Project overview](image)

Figure 1. H2ME vehicle and HRS deployment summary (H2ME, 2018)

2 Purpose of this document

The document is not intended to provide a comprehensive listing of regulations, codes and standards that are applicable to the installation of HRS in Europe as that has been addressed elsewhere by projects such as HyFIVE (HyFIVE, 2017) and H2Moves Scandinavia (SP, 2010). The aim of this report is to provide an overview of the safety and regulations, codes and standards (RCS) lessons learned during the installation of 49 HRS in eight countries during the H2ME project. The document will be updated as HRS are added to the project in new countries to form a living resource which will be of value to all stakeholders involved in HRS permitting and installation.
3 Document scope
This second version of the RCS lessons learned report covers station installations by the H2ME project until mid-2018. It addresses the installation of the H2ME HRS summarised below in Table 1:

Table 1. H2ME HRS covered in this report

<table>
<thead>
<tr>
<th>Country</th>
<th>Location</th>
<th>Station description</th>
<th>Opened</th>
<th>Installer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>Kolding</td>
<td>700 bar HRS integrated into conventional refuelling station supplied by centralised electrolyser.</td>
<td>March 2016</td>
<td>Nel Hydrogen Fueling</td>
</tr>
<tr>
<td>France</td>
<td>Sarreguemines</td>
<td>350 bar stand-alone station supplied by on-site electrolyser.</td>
<td>April 2017</td>
<td>McPhy</td>
</tr>
<tr>
<td>Iceland</td>
<td>Reykjavík and Keflavík</td>
<td>700 bar HRS integrated into conventional refuelling station supplied by centralised electrolyser.</td>
<td>June 2018</td>
<td>Icelandic Hydrogen (Nel Hydrogen Fueling and Skeljungur)</td>
</tr>
<tr>
<td>UK</td>
<td>Beaconsfield</td>
<td>Dual 350/700 bar HRS integrated with conventional refuelling station. Supplied by on-site electrolyser.</td>
<td>March 2018</td>
<td>ITM Power</td>
</tr>
</tbody>
</table>

Future versions of this document will add lessons learned from the installation of H2ME stations in Germany, Holland, Norway and Sweden, plus further experience gained from additional installations in Denmark, France and the UK.

3.1 Safety
All stations covered in this report (and all stations so far installed by the H2ME project) are operating safely. As of November 2018, H2ME project stations have dispensed almost 22 000 kg of hydrogen with no safety incidents. If any safety incidents occur at H2ME stations in the future, they will be addressed in subsequent editions of this report.

4 Topics covered in the document
To ensure that answers could be compared across countries and regions, installers of HRS were asked to respond to a standard set of topics as presented below:

- A high-level overview of the process of station permitting and installation.
- The key RCS for installing stations in each country.
- How the process for installing stations in each country has evolved from the installation of early, pre-H2ME, HRS to the latest stations in H2ME (if applicable).
- Whether the presence of onsite hydrogen generation using electrolysers influences the applicable RCS, and therefore the planning and installation process (if applicable).
- Whether the RCS and planning processes for station installations differ between countries.
- How installers have worked to establish a pool of contractors for stations.
- How station installers have worked with operators of conventional refuelling stations to ensure that HRS that are integrated with conventional refuelling stations are safe and customer-friendly (if applicable).
5 Country experience of HRS installation and RCS

5.1 Denmark – Nel Hydrogen Fueling

Nel Hydrogen Fueling has extensive experience of installing hydrogen refuelling stations – with or without integrated electrolysers. The company has installed 22 modern, state-of-art 700 bar HRS in Europe since 2011, plus dual pressure 350/700 bar stations in Norway and Latvia and a 350-bar bus refuelling station in Antwerp.

The author would like to thank Ulrik Torp Svenson of Nel Hydrogen Fueling for providing much of the content in this section.

5.1.1 Key RCS for station installation in Denmark

- The key documents/procedures are:
  - ISO/TS20100:2008. This has now been superseded by ISO19880:2016, but at the time of Nel’s first 700 bar installations in 2011 this was the key standard to work to.
  - The National Technical Guideline for Gases (DEMA, 2010).
  - Stations involving onsite generation and/or significant amounts of onsite storage need a permit from the Defence Ministry which has national responsibility for risks and operations that involve gas storage.
  - The Danish Building Code.
- Nel’s track record of station installations is also crucial, as discussed further below.

5.1.2 The process for installing a HRS in Denmark

- Two processes are involved – building permitting and operation permitting.
- HRS building and permitting are controlled by centralised regulation, but are implemented by municipalities, as illustrated below:

![Figure 2. HRS permitting process in Denmark (DEMA, 2012)](image)

- Building permitting:
  - Nel has used its extensive experience in HRS installation to become skilled in preparing and submitting applications.
Early in the project Nel meet with all relevant municipality stakeholders (e.g., fire marshals, planning officers) to ensure that any concerns that they may have (e.g., interpretation of safety distances) are addressed.

- Any concerns that stakeholders have (such as safety distances) can be mitigated in different ways – e.g., firewalls. The key point is that Nel tries to operate in a standard fashion in each installation which establishes precedent that can be followed and passed on to each municipality.

**Operational permitting:**
- The key sign-off point is the local fire marshal.
- As part of an effort to facilitate the process of operational permitting, Nel was instrumental in getting the fire marshals together at a national level to share best practice and knowledge of H₂. In addition, it helped author national regulations which were not well developed when we began installing stations (DEMA, 2012).
- As part of the process of obtaining buy-in and establishing a relationship with fire marshals, Nel offers ongoing training and support once the stations are operational.

### 5.1.3 How the process for installing HRS in Denmark is evolving

- The permitting process for the Copenhagen South station (opened in 2013 with FCH JU support during the HyTEC project) took around six months. The latest (Esbjerg) took four days: the application was send in May 27th, 2016 and the permit was granted on May 31st 2016. The HRS in Korsør under HyFive only took 48 hours from submission of the application and appendixes to the granting of the permit.
- According to Nel, the reduction in permitting time is due to factors such as:
  - The process of consultation with each municipality that Nel has established for each install ensures that all relevant stakeholders are consulted before and we have addressed their concerns before we submit the planning documentation
  - Nel being directive in terms of using the established precedents of past stations as examples to the municipality and to try to encourage them to adopt standard, tested solutions to any concerns that they have.

### 5.1.4 How HRS RCS and planning processes differ between Denmark and other countries

- **Denmark:** regulations are established nationally and implemented locally. Therefore, once precedent is established, the process runs smoothly.
- **Germany:** it’s clear that the process in Germany currently takes much longer than Denmark. Nel’s primary observation is that each station is almost viewed as the first, there seems to be little-no learning allowed at the local level from station installs in other regions, and so all processes (permitting, third party approval, etc.) take a correspondingly long time. Nel recognises that H2Mobility Deutschland is trying to change this, but it looks like it’s going to take a long time.

### 5.1.5 Practical measures that Nel has adopted with contractors to speed HRS installation

- Nel always issues a tender for civil works for each new HRS.
- Contractors that have experience of working on previous HRS can give better, firm quotes.

### 5.1.6 Measures taken to work with operators of conventional fuelling stations to ensure that forecourt-integrated HRS are safe and customer-friendly

- Nel has worked closely with Shell throughout the process of installation.
- Shell was initially concerned with the amount and type of equipment that the HRS would keep on site.
Installation of first HyTEC station at Copenhagen South involved a workshop with Shell.
Subsequent stations used this example as a precedent and Shell are now happy with the process so it runs smoothly.
Nel has developed its own health, safety, security and environment (HSSE) system which is closely aligned with Shell and the permit to work (PTW) system.

5.2  France – McPhy

In France, McPhy in the past built relatively small-scale, cost-effective 350 bar HRS for captive fleets with a very simple, relatively low-cost specification based on the strategy of Mobilité Hydrogène France (AFHYPAC, 2014). The H2ME station in Sarreguemines that was opened in April 2017 built on this experience.

The author would like to thank Romain Guichon and Florian Peter of McPhy for providing much of the content in this section.

5.2.1  Key RCS for station installation in France

- At the time of writing (February 2018) there are no regulations covering stations with less than 100kg onsite hydrogen storage.
- McPhy’s key responsibility therefore has been to ensure that all station components are CE (Conformité Européene) marked.
- Recognising that the market will evolve, McPhy has continued to monitor global standards activities, such as ISO19880 and SAE.
- The H2ME Sarreguemines station is therefore compliant with SAE2601 (2014) and incorporates precooling which makes it possible to fuel any vehicle requiring the SAEJ2601 protocol.

5.2.2  The effect of incorporating on-site electrolysis into an HRS

- In France, the incorporation of onsite electrolysis makes a significant difference to station RCS requirements.
- Having an electrolyser on-site means that the HRS becomes one of the Installations Classées pour la Protection de l’Environnement (ICPE), which are facilities that are considered to have the potential to endanger public safety, public health and/or the environment.
- Monitoring each ICPE facility is the responsibility of the French Environmental Inspection Agency DREAL (Direction Régionale de l’Environnement, de l’Aménagement et du Logement), which is composed of environmental engineers and officials implementing the environmental policy of the state that are responsible to the regional préfet.
- In cases of non-compliance of an operator with environmental requirements, the préfet can impose administrative sanctions.
- The DREAL, which are responsible for more than 500,000 ICPE across France, are devolved regional bodies of the Ministère de la Transition Écologique et Solidaire (MTES, https://www.ecologique-solidaire.gouv.fr/services-deconcentres-du-ministere), controlled by the regional préfet.
- Another, centralised, body of the MTES, the Direction Générale de la Prévention des Risques (DGPR) has responsibility for ensuring the safety of facilities (https://www.ecologique-solidaire.gouv.fr/direction-generale-prevention-des-risques-dgpr).
5.2.3 **How the process for installing HRS in France is evolving**

- For the ICPE regulation, there are different rubrics with different thresholds (declaration and authorisation, with different administrative procedures): 3420 for electrolysers is a long administrative procedure involving different regional and central actors:
  - For a station incorporating an electrolyser, such as the H2ME HRS at Sarreguemines, the operator sends an application file to the prefecture with different studies (safety and environmental ones and others), and the préfet will send this studies to the DREAL which is the regional technical body to treat these demands.
  - The DGPR defines the global reference point for all these steps.
- In practical terms, this meant that achieving authorisation for the Sarreguemines HRS which incorporates an electrolyser was a long process.
- AFHYPAC, the French Hydrogen Association, is coordinating efforts to provide a centralised approach to hydrogen station regulation in France (AFHYPAC, 2016).
- Through these efforts, it is hoped to get a new ICPE HRS rubric under French legal law which will provide a single point of reference for all the regional DREAL in July 2018.
- Once this is established, it is hoped that a simple checklist can be agreed whereby each station can be ICPE declared, which will provide a single, streamlined process.

5.3 **Iceland – Icelandic Hydrogen (Nel Hydrogen Fueling and Skeljungur)**

As discussed in Section 5.1, Nel Hydrogen Fueling has extensive experience of installing hydrogen refuelling stations – with or without integrated electrolysers. Nel Hydrogen Fueling is installing three H2ME-supported integrated HRS in Iceland – at Reykjavik, Keflavik and a planned station at Selfoss – as part of its Icelandic Energy joint venture with Skeljungur, which operates 65 fuel outlets across Iceland.

The author would like to thank Ulrik Torp Svenson of Nel Hydrogen Fueling for providing much of the content in this section.

5.3.1 **Key RCS for station installation in Iceland**

- As a member of the European Free Trade Area (EFTA), national regulations in Iceland (like Norway) regarding HRS are generally in alignment with EU directives.
- The key regulations in Iceland are therefore essentially the same as those in Denmark; see Section 5.1.1.
- In reviewing Icelandic regulations prior to the installation of the Reykjavik and Keflavik HRS, the only difference that was apparent is that Iceland has not yet implemented the most recent (2014/34/EU) version of the ATEX (Equipment for Potentially Explosive Atmospheres) directive.

5.3.2 **The process for installing a HRS in Iceland**

- This is essentially the same as Denmark (see Section 5.1.2) in that two processes are involved – building permitting and operation permitting – which are governed by centralised regulation but implemented by municipalities.
- Building permitting:
  - The two H2ME HRS are the first in the country’s planned HRS network, but Iceland already has experience in HRS installation and operation, having deployed the world’s first commercial HRS in 2003 on the same site as that of the H2ME in Reykjavik station. Nel believes this experience was important because key stakeholders were already aware that hydrogen stations can be operated safely.
Based on its extensive record of HRS installation, in mid 2017 Nel began a process of engagement with all relevant local and national authorities having jurisdiction (AHJ) (e.g., fire marshals, planning officers) to ensure that any concerns that they may have were addressed.

In addressing concerns, Nel was able to point to tried and tested solutions which conform to established RCS which have been implemented in many other countries. As part of this process, extensive risk assessments that had been conducted on each HRS module was explained to the national AHJs to get alignment on the site layouts, and further risk assessments were conducted at each HRS site in accordance with ISO 19880:2016.

Skeljungur had overall responsibility for submitting the planning application. This included translating documentation into Icelandic as appropriate as well as responsibility for architectural and technical drawings.

- **Operational permitting and installation:**
  - All modules are manufactured in Denmark as finished and Pressure Equipment Directive (PED) approved with full CE marking.
  - As a result of the preparations, Nel Hydrogen Fueling managed the installation, commissioning, PED Module G and Site Acceptance Test (SAT) approval of the two stations in less than two weeks.
  - Once, completed, Nel used the same notified body as it uses in Denmark to sign off the conformity of the stations.

5.3.3 **Hydrogen supply to the HRS**

- When the Icelandic H2ME stations were initially proposed, the Reykjavík station was planned to incorporate on-site electrolysis.
- Due to economies of scale, particularly the costs of upgrading the power supply, and to allow for the possibility of future expansion, the electrolyser was instead located at a geothermal plant operated by Orka Náttúrunar (ON Power) at Hellsheiði.
- Hydrogen is trucked to the Reykjavík and Keflavík stations by road at 200bar.
- Nel and Skeljungur were responsible for securing the building permit for the electrolyser at the geothermal plant.

5.3.4 **How HRS RCS and planning processes differ between Iceland and other countries**

- **Iceland:** as highlighted previously, regulations are established nationally and implemented locally. Therefore, now the precedence has been established, the process is expected to run smoothly and relatively quickly.
- **Germany:** Based on Nel’s experience, the key difference between Germany and countries such as Iceland is the degree of regional autonomy involved. In Germany, each time an HRS is planned in a different region (Land), particularly those with limited or no experience of HRS installation, it is effectively like restarting the HRS permitting in a different country with little or no account taken of experience by Nel or other parties in Germany or Denmark. This means that the process of engagement with AHJs effectively starts afresh with each installation, which inevitably slows the process.
- As an example of this difference in approach, in Germany each Land employs its own notified body to sign off a HRS in addition to Nel’s own notified body.
5.3.5 Measures taken to work with operators of conventional fuelling stations to ensure that forecourt-integrated HRS are safe and customer-friendly.

- As described above, Nel has worked closely with Skeljungur throughout the process of installation.
- Similar to its procedures in Denmark (see Section 5.1.6) this has included extensive training for the local operators.

5.4 UK – ITM Power

At the time of writing (February 2018) ITM Power operates four hydrogen refuelling stations in the UK which incorporate on-site electrolysis. The company is in the process of opening a further five stations in the next two years supported by H2ME at Beaconsfield, Birmingham, Gatwick, London and Swindon.

The author would like to thank Jenny Hewitt and Nick Hart of ITM Power for providing much of the content in this section.

5.4.1 Key RCS for HRS installation in the UK

- At the time of writing (February 2018) RCS in the UK are evolving.
- Recent efforts have focused on the transposition of the EU’s Alternative Fuels Infrastructure into UK law as the Alternative Fuels Infrastructure Regulations 2017 (Gov.uk, 2017).
- For hydrogen refuelling points, only a reference to ISO 17268 has been included (connectors for motor vehicles for the refuelling of gaseous hydrogen must comply with the ISO 17268(c) gaseous hydrogen motor vehicle refuelling connection devices standard), along with other more general requirements (references to ISO/TS 20100 and ISO 14687-2, which are referenced in the AFID, are omitted).
- For details of general legislation that could be applicable to hydrogen refuelling stations in addition to regulations that implement relevant European Directives see Month 44: RCS status: Final Report (HyFIVE, 2017).

5.4.2 How HRS RCS and planning processes differ between the UK and other countries

- In the UK there is centralised legislation to follow and local planning approval is required; as such the UK is somewhere in between the Danish and French model.
- The differences between local planning offices in the UK seem to be due to resourcing of planning departments rather than differing approaches to HRS.
- In the UK, the current practice (with the intention of being consistent with other pressurized flammable gas installation hazardous area classification activities) is to assume a leak rate resulting from a combination of the high internal pressure of the system and an assumed pinhole leak, consistent with the ATEX harmonised standard IEC 60079-10-1. However, this appears to be a practice not followed in some other countries around Europe. The uncertainty in the suggested leak rates and resulting EX-zones obtained using this method may not lend itself to application to these high-pressure systems, as both fittings and piping is designed differently from typical lower pressure flammable gas applications, and most often are significantly smaller in size. This is an area that would benefit from further detailed investigation in the future.
- The requirements may differ slightly in different countries within the UK but there typically are not significant differences in approaches in different areas of each country as far as we are aware. The same European Directives are applied across all of Europe, however there do not tend to be prescriptive requirements in the UK for the most part as seen for example, in
France – the prescriptive legislation for hydrogen refuelling stations is currently being developed. It is worth noting that the interpretation of some European Legislation differs significantly between countries in Europe, for instance the Industrial Emissions Directive.

5.4.3 How ITM worked with UK agencies to achieve forecourt integration of its HRS

- The document used for the permitting of petrol stations in the UK is published by the Energy Institute, and called Guidance for Design, Construction, Modification, Maintenance and Decommissioning of Filling Stations” – this is known as the Blue Book”. This is considered to be best practice, and to enable petrol station designers and operators to meet the requirements of The Petroleum (Consolidation) Regulations 2014”. (The Blue Book replaced the previous HSE document HS(G)41 on Petrol filling stations: Construction and operation in 1999).
- Before the start of the HyFIVE project, in the absence of appropriate documents being developed within ISO TC 197 at the time (the development of ISO 20100 had stalled), ITM worked with others in the British Compressed Gases Association (BCGA) to develop CP41: The design, construction, maintenance and operation of filling stations dispensing gaseous fuels (BCGA, 2016). This was initially published in 2014.
- At a similar time, the Association for Petroleum and Explosives Administration (APEA) and London Fire Brigade (LFB) had an approach from Air Products to install a station at a Sainsbury’s petrol station in Hendon, London as part of the LHNE project. The LFB provided feedback on the BCGA CP41 that they were unhappy with the approach of gas companies installing hydrogen refuelling equipment on petrol forecourts until there was national guidance on hydrogen alongside petrol. (This led to Air Products being unable to install their station at Hendon on the same site as the Sainsbury’s petrol station – as a result, the hydrogen dispenser had been located sufficiently far away from the petrol dispensing and filling activities to be considered delinearised by the HSE, and therefore not to need approval from the petroleum officer.)
- Following this, at the Health and Safety Executive’s (HSE) request, the BCGA engaged with the Energy Institute and the APEA to develop an addendum to the Blue Book to allow integration of hydrogen refuelling onto a UK petrol station. The resulting Blue Book addendum was published in spring 2017, titled Guidance on hydrogen delivery systems for refuelling of motor vehicles, co-located with petrol fuelling stations (EI, 2017).
- During the development of the Blue Book hydrogen addendum, as part of the HyFivE project, a station was installed at Shell Cobham. Due to the location of the dispenser just off the forecourt, this was not regarded as needing approval from the Petroleum Officer for the petrol dispensing activities on the station, although the station approval from LFB benefitted from the process of familiarisation of the LFB and APEA with hydrogen refuelling stations through the process of preparing the Blue Book hydrogen addendum.
- The H2ME station at Beaconsfield is the first hydrogen station in the UK to require approval from the Petroleum Officer as part of the petrol station licence, and to put the Blue Book addendum into practice.
- The Blue Book is a UK specific requirement, based on the experience gathered from petrol stations by the UK Health and Safety regulators, and industry, over the course of the past three to four decades. Wherever feasible (there are some long standing practices which are slightly different to conventional industrial practices) requirements for hydrogen in the Blue Book addendum are aligned with those in BCGA CP41. BCGA CP41 references the published ISO TS 20100, as this was the most significant hydrogen refuelling station technical document available at the time. Once ISO 19980-1 has been revised by ISO TC 197, CP41 will be revised.

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to align it with the ISO standard, thereby minimising differences between the CP41, the Blue Book hydrogen addendum and ISO 19880-1.

5.4.4 Practical measures that ITM has adopted with contractors to speed HRS installation

- The process for appointing contractors is as follows:
  - ITM prepare site layout drawings and agree these with any equipment suppliers as applicable and landlords.
  - Once planning is approved architects are appointed to prepare civil tender drawings.
  - Tender drawings are issued to a minimum of three contractors (for Shell sites these are Shell approved contractors).
  - ITM review the tender responses based on best value for money.

5.4.5 Measures taken to work with operators of conventional fuelling stations to ensure that forecourt-integrated HRS are safe and customer-friendly.

- **Safety:** to ensure the HRS installed at Shell sites are safe ITM and Shell have performed the following activities:
  - Design Safety Review of equipment – technical review of the design of hydrogen equipment to be installed on site.
  - Management of Change procedure
  - Pre-startup Safety Review – this is a Shell document that is completed prior to start-up of new plant. It involves a site visit to ensure that the required safety systems have been installed and tested and that required documentation is in place prior to generation, storage and dispensing of hydrogen. The primary aim of the PSSR is to verify that the safety elements that have been identified in the Desktop Safety Review have been installed in the field and tested.
  - ITM provide training to Shell forecourt staff. This training covers basic information on the station and what to do in an emergency. A laminate training pack is kept on site in the Shell store for training of new staff.
  - ITM provide credit card sized safety cards to Shell forecourt staff as shown below:

- **Customer usability:** to improve customer usability of the HRS ITM has:
  - Developed guidance posters for the dispensers to provide a step by step refuelling guide
  - Appointed a Fuel Sales Manager to provide assistance and training to station users. The Fuel Sales Manager also contacts station users when the stations are down for maintenance.
6 Summary and conclusions

Four country/installer HRS case studies are presented in this report. Brief summaries of each are presented below:

- In the case of Nel Hydrogen Fueling in Denmark, H2ME HRS installations build on its existing relatively large HRS installed base. In Denmark, HRS building and permitting are controlled by centralised regulation, but are implemented by municipalities. Nel has been able to use the established precedents of its past stations as examples to municipalities to try to encourage them to adopt standard, tested solutions to any concerns that they have about HRS installations. Consequently, station permitting times have fallen from around six months in 2012 to four days in 2016.

- The French hydrogen refuelling network is just beginning. Permitting for stations involving on-site generation using electrolysis, such as the H2ME Sarreguemines station installed by McPhy, has proven a complex process, with responsibility for authorisation split between a national body (DGPR) which sets the regulations, and the implementation of regulations by regional bodies (the DREAL). This has meant that each station permitting application has been time-consuming as, effectively, each time it has had to start afresh. AFHYPAC, the French Hydrogen and Fuel Cell Association of which McPhy is a member, is leading a process to streamline HRS permitting. It is hoped that this will be in place by July 2018.

- Nel Hydrogen Fueling was also responsible for the building of the HRSs opened in June 2018 in Reykjavík and Keflavík Iceland as part of its Icelandic Hydrogen joint venture with fuel retailing company Skeljungur. In terms of HRS installation, Iceland follows a similar path to Denmark, with building and permitting controlled by centralised regulation, but implemented by municipalities. While these H2ME stations are the first in the country’s planned HRS network, Iceland’s experience with HRS installation (having deployed the world’s first commercial HRS in 2003), plus Nel’s policy of engaging in advance with relevant stakeholders to address concerns and potential issues, meant that permitting times for the stations were around one month.

- The UK hydrogen refuelling network is also at the beginning of its development. In the UK, there is centralised legislation to follow and local planning approval is required, as such the UK is somewhere between the Danish and French models. ITM Power has expended considerable efforts to establish best practice for forecourt-integrated HRS, working with stakeholders to help author guidance which will mean that the H2ME Beaconsfield HRS is the UK’s first forecourt-integrated HRS.

Comparing the country case studies shows that, while there is commonality in terms of the overall EU directives that are followed in each country, there are differences in the processes and involved in HRS permitting and installation, despite the continued evolution of hydrogen refuelling RCS such as SAE J2601 and ISO/TS 19880. The optimal situation for speed through the HRS permitting and planning process appears to be a relatively centralised decision-making system which allows established precedent and experience gained through HRS installation to be applied to each future proposed installation (i.e., that of Denmark). This country typology is illustrated below in Figure 3:
Future editions of this report will provide updates and case studies to assess whether the process of permitting and installation begins to harmonise across European countries as additional stations are installed during the H2ME project, and RCS are developed further, and whether this will in turn reduce HRS planning and installation times across Europe.
7 References


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