Hydrogen safety

HyClyde AUCHENTOSHAN

About hydrogen

Hydrogen is the simplest and most abundant element in the universe, and although we are currently seeing a rapid growth within this industry, the use of hydrogen is not new. The UK is a leader in the hydrogen market and has been producing and distributing hydrogen for over a century.

Green hydrogen is produced by splitting water into hydrogen and oxygen using renewable energy. The use of renewable energy ensures the production process has a very low carbon footprint. Hydrogen is colourless, odourless and non-toxic. When the hydrogen is used, it turns back to liquid water or water vapour. This means that it does not have many of the safety and environmental concerns of petrol, diesel or conventional natural gas.

Green hydrogen projects are now a feature of many cities and the UK government intends for 10 gigawatts (GW) of low carbon hydrogen power to be in production by 2030.

Safety requirements

Hydrogen, similar to hydrocarbons such as petrol and natural gas, is covered by international codes, regulations and standards to ensure its safe production, storage, transportation and use. It has been used within the UK for a range of industrial purposes for decades, and the UK has a strong track record in the safe distribution and storage of combustion gases.

Hydrogen is captured under the definition of "gas" in the Gas Act 1986 and is regulated as part of the gas network. All the components and processes used in creating and operating the production and tube trailer loading will comply with the required British Safety Standards.

Hydrogen, like other gases is heavily regulated from a health and safety perspective.

The Health and Safety Executive (HSE) requires compliance with the following regulations:

- Storage of Hydrogen is regulated by The Planning (Hazardous Substances) Regulations 2015 and/or the Control of Major Accident Hazards Regulations 2015 (COMAH), depending on the quantities involved. COMAH sets a high bar of requiring operators to take all measures necessary to prevent a major accident and limit consequences for human health and the environment. The operator must have in place various strategies, including safety plans, emergency plans and a Major Accident Prevention Policy.

  COMAH applies to facilities that store hazardous substances above specified thresholds. Two tiers of facility are identified, Lower and Upper Tier, with

Hydrogen safety

HyClyde AUCHENTOSHAN

Upper Tier sites being considered higher risk and are subject to a higher degree of regulation. For hydrogen the thresholds for COMAH are:
• Lower Tier – 5 tonnes
• Upper Tier – 50 tonnes

The facility will be designed to provide approximately one day of storage to allow for intermittency of renewable power and variations in hydrogen demand. The total quantity of hydrogen stored and present within the process will be less than 5 tonnes and therefore it is expected that the facility will fall below the Lower Tier requirements.

- Under the Hazardous Substances Regulations, consent is required to store 2 or more tonnes of hydrogen, and a further consent is required where 5 or more tonnes of hydrogen will be stored.

- The Dangerous Substances and Explosive Atmosphere Regulations 2002 sets out requirements for the use of equipment and protective systems in potentially hazardous environments, including those where hydrogen is produced or stored.

Safety in design

The facility at Auchentoshan is a small-scale hydrogen production site, similar to other hydrogen production facilities operating in urban environments in the UK and Europe (including HyBont in Bridgend, Wales) with no reported safety incidents.

A range of measures have been incorporated into the safety-led design.

Facility design:

Safety is of paramount importance and will be built into the design of the HyClyde green hydrogen project. To ensure the safety of the design, industry recognised safety reviews will be carried out throughout the facility design and construction including, as a minimum:

- **Hazard Identification Review (HAZID):** conducted early in the project and throughout design, construction and operation, HAZIDs identify any potential hazards (including consequence assessment) and appropriate mitigation measures. The first HAZID was completed in December 2023 and the second was completed in April 2024 to ensure the highest levels of safety for the project.

- **Hazard & Operability Review (HAZOP):** this is a structured and systematic examination of the entire facility and its operation to identify and evaluate potential safety risks and identify required safeguards. The HAZOP will be completed by the FEED Contractor while the detailed design is carried out and a further review will be conducted when the Engineering, Procurement and Construction (EPC) Contractor has been appointed.

Hydrogen safety

HyClyde AUCHENTOSHAN

- **Quantitative Risk Assessment (QRA):** similar to the HAZOP Review, the QRA provides numerical (quantitative) estimates to understand risk exposure to people (operatives and public) and the environment. It will be completed by the FEED Contractor A further review will be conducted once the EPC contractor has been appointed.

- **Layer of Protection (LoPA) Review:** this review will consider all safeguards identified during the HAZOP Review to ensure their effectiveness. The LoPA Review will evaluate plant hazards in order to reduce the frequency and/or consequence severity of hazardous events and will be completed when the EPC Contractor has been appointed.

- **Safety Integrity Level (SIL):** a formal method of assessing the probability that a functional safety system will not fail when it is needed. This has been considered by the FEED contractors and will be completed fully when the EPC Contractor has been appointed.

There are a wide range of safety measures incorporated into the design of the different components of the facility. This includes:

- Production and storage areas being only accessible to trained staff, as well as systematic maintenance checks following approved methods. This is key to eliminating potential ignition sources, such as flames or sparks.

- The plant control system will be designed to ensure abnormal conditions and malfunctions are detected and appropriate automatic controls will safely shut down the plant, if needed to prevent an accident. For example, early warning systems and alarms as well as the use of fire and gas leak detection systems, safety relief valves, isolation valves and hydrogen and oxygen vents to dispel gas safely.

- Safe construction practices to avoid potential risks. For example, to reduce the risk of small hydrogen leaks, the number of mechanical joints on hydrogen pipework will be minimised and any joints that are required will be fully welded where possible – this lowers leak risk compared to mechanical connections e.g. bolted joints. Where welded connections are used, welding will take place in a controlled factory environment or on site by qualified welders in accordance with the applicable design code.

- Regular, proactive, rigorous and systematic maintenance checks (such as equipment calibrations and material quality) will ensure equipment and piping are reliable at all times and can perform safely.

- In the unlikely case of a major hydrogen leak, a range of safety measures will be included, such as escape routes, safety equipment, fire and gas detection systems (suitable for hydrogen) and firefighting systems.

Hydrogen safety

HyClyde AUCHENTOSHAN

In the event of a leak, hydrogen's physical properties, such as it diffusing rapidly and having high buoyancy (ability to travel vertically to the sky), can become a significant safety asset when used in the correct process design. In the event of a fire or explosion the above properties, in addition to hydrogen's low ability to transfer heat, reduce the risks of creating secondary fires.

Hydrogen has low ignition energy compared to natural gas, which means that even small sparks are capable of igniting hydrogen/air mixtures. This is an important characteristic and will be properly considered in the design and operating procedures for equipment inside the production area. For example, all equipment will be adequately earthed to avoid the build-up of static electricity and operators will be equipped with low static PPE.

Hydrogen is nontoxic, non-poisonous and is not listed as a carcinogen. Hydrogen is not perceived to be more dangerous than any of the gases we currently use widely in our day-to-day life.

As hydrogen is the lightest element on earth, in the unlikely event of a leak it would travel upwards and disperse rather than moving across the ground like heavier gases. For this reason, there will not be a building or roof over the storage or production areas. Therefore, in the unlikely event of a leakage, gas will escape upwards into the atmosphere and dissipate.

Site layout:

- The hydrogen production equipment is located in an area that is not accessible to the public.
- The hydrogen storage tanks will be located a safe distance from the high voltage electrical substation.
- Please see the Location and Layout Fact Sheet for more information.

Overhead cables:

Marubeni will ensure an adequate distance from the overhead cable when developing and constructing the site. The EPC Contractor will employ experienced workers to navigate around it safely.

Fire walls:

The hydrogen production equipment will be surrounded by fire walls so, in the unlikely event of a fire, the fire will be contained and will not spread. The fire walls will act as a physical barrier to protect the hydrogen storage and production areas from external hazards.

Qualified/experienced staff:

To help ensure the highest quality design and build, Marubeni has selected a qualified Front-End Engineering Design (FEED) contractor, who will also serve as the Principal Contractor. The FEED contractor will have the correct skills,

Hydrogen safety

HyClyde AUCHENTOSHAN

knowledge and experience to develop an optimised and safe site, which will subsequently be handed over to the Engineering, Procurement, and Construction (EPC) contractor.

Marubeni will engage with the supply chain to identify and select an experienced Engineering Procurement and Construction (EPC) Contractor with a proven track record of developing hydrogen plants of similar scale. The contractually binding design specifications only allow for proven technology and equipment with an extensive record of safe operation to be installed at the site.

All staff working onsite will be fully trained by the original equipment manufacturer (OEM) and EPC contractor to safely operate and perform maintenance activities on the specific equipment installed onsite, in line with regulations and safe practice methods. Operators will be specially trained to handle hydrogen during day-to-day operations and also during an emergency response such as a leak. They will also have the opportunity to attend a university course to further their knowledge.

External audits

The UK has a rigorous safety record with the storage and distribution of gases and flammable materials particularly at a commercial/industrial level.
As part of the Pre-Application Consultation and Planning Application process, South Wales Fire and Rescue and the Health and Safety Executive are being consulted.
Prior to the facility becoming operational, independent safety reviews will be completed as required for regulatory bodies and insurers.
The operator of the facility will implement procedures and processes to ensure the ongoing safe operation of the facility.
To ensure that these procedures are adhered to, the operator will carry out audits. In addition to this, the Health and Safety Executive, the national regulator for workplace health and safety, will carry out inspections to ensure that standards are adhered to.