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NON TECHNICAL SUMMARY

This application is for an environmental permit for a hydrogen generation system (HGS) (application ref EPR/NP3606MX/A001). The HGS is located at the existing Saint-Gobain Glass production facility at Weeland Rd, Goole, DN14 0FD within the current hydrogen storage area. The site will be operated by HyGear.

The current hydrogen back up storage and mixing skid will be removed after the HyGear plant is commissioned. The new plant will remove the need for two hydrogen storage trailers to be located on site at all times and on average avoid five road tanker deliveries to site per week reducing national and local HGV traffic movements as well as avoiding associated road CO_2 emissions.

Currently there is 560 kg of hydrogen on site in the back-up system and storage trailers. When the HGS is in operation this will increase to 800 kg of storage. Should the HGS shut down and not recover in 36 hours a trailer with 700 kg will be delivered by HyGear as a back-up.

The nature of the HGS has a low potential to impact on the environment. However, as the facility is associated with an existing Part A2 facility which does not meet low impact criteria a bespoke environmental permit is required. Hydrogen will be produced using a steam reforming process with natural gas as the feedstock gas.

The HGS will consist be three HyGEN50 units. Each unit will be capable of producing hydrogen at a pressure of 7 bar(g) and an output of 42 Nm^3/h under optimal circumstances. The total production capacity of the plant is 126 Nm^3/h.

The emissions to air associated with the three HyGEN50 units have been assessed using the Environment Agency's H1 screening tool which concluded that the emissions have an insignificant risk to the environment.

The site will benefit from an Environmental Management System which details the equipment maintenance, accident prevention, complaints procedures, staff competency and training requirements.

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1 INTRODUCTION

1.1.1 This document and its support appendices form an application for an environmental permit for a Hydrogen Generation System (HGS), at Saint-Gobain Glass United Kingdom Ltd's (referred to herein as Saint-Gobain) glass production facility at Weeland Rd, Goole, DN14 0FD.

1.1.2 The nature of the HGS has a low potential to impact on the environment. However, as the facility is associated with an existing Part A2 facility which does not meet low impact criteria a bespoke environmental permit is required.

1.2 Background

1.2.1 In 2021 Saint-Gobain replaced an old furnace with a more energy efficient one and upgraded the glass manufacturing equipment. Saint-Gobain expects to operate the upgraded facility continuously for next 20 years and requires security of interruption free utilities supply.

1.2.2 Saint-Gobain engaged with HyGear to secure continuity of supply of hydrogen that is used as a critical gas in float glass making, where it is mixed with nitrogen and delivered to float bath to maintain a non-oxidising atmosphere above the tin and glass, which is essential for the manufacturing of quality glass. Without this critical gas the process has to be shut down (restart of operations takes two days) affecting supply of glass to the market.

1.2.3 Saint-Gobain has experienced delivery issues with current supplier of hydrogen during the current contract which expires at the end of March 2022. The HyGear plant will provide continuity of production. HyGear's HGS is being relocated to Eggborough from another glass plant in Europe (which has now been decommissioned) and will be installed in a fenced area of the glass works and under the sole responsibility of HyGear to operate and maintain. The plant will provide stable onsite hydrogen generation, reducing potential impacts on the glass making operations as a result of interruptions in hydrogen supply from the external supplier and negating road transport of gas.

1.2.4 The current hydrogen back up storage and mixing skid will be removed after HyGear plant is commissioned. The new plant will remove the need for two hydrogen storage trailers to be located on site at all times and on average five road tanker deliveries to site per week reducing national and local HGV traffic movements as well as associated road CO_2 emissions.

1.2.5 Currently there is 560 kg of hydrogen stored on site in the back-up system and trailers. When the HGS is in operation this will increase to 800 kg of storage. Should the HGS shut down and not recover in 36 hours a trailer with 700 kg will be delivered by HyGear as a back-up.

1.3 Site Location

1.3.1 The site is located within the existing Saint-Gobain glass production facility, located to the east of Eggborough, Yorkshire. The proposed development site on which the HGS be constructed is currently used as the external hydrogen storage area. The national grid reference is SE 57013 23816.

1.3.2 A site location plan showing the proposed permit boundary is provided as Figure 1. The permitted area of the site, is approximately 0.15 ha.

1.3.3 The surrounding land is occupied by industrial land use and the closest residential properties are located approximately 250 m to the west of the site, in the village of Eggborough.

1.3.4 There are no sensitive ecological receptors within 1 km of the site.

1.3.5 The Site Condition Report is presented in Appendix B.

1.4 Operator Details

1.4.1 The operator is HyGear , they are register in the Netherlands.

1.4.2 The company director is:

- Dr. Ellart De Wit

1.5 Structure of the Permit Application

1.5.1 This section provides an overview of the proposals. This is supplemented by further details in Sections 2 – 5 as follows:

- Section 2 addresses the operational measures which will be in place to prevent and/or control any potential environmental effects of the proposal.
- Section 3 summarises the management systems in place
- Section 4 addresses the environmental risk and effects

1.5.2 Supporting documents, assessments and application forms are provided within the appendices list as set out in the contents page.

2 OPERATIONS

2.1 Overview

2.1.1 The proposed HGS will consist of three HyGEN50 units. They will be capable of producing hydrogen at a pressure of 7 bar(g) and an output of 42 Nm^3/h each under optimal circumstances. The total production capacity of the plant is 126 Nm^3/h.

2.1.2 Hydrogen will be produced using a steam reforming process with natural gas as the feedstock gas.

2.1.3 Each HyGen50 unit includes a natural gas de-sulphuring system and as such can be connected directly to the natural gas line. Other connections required are feed water, electricity (for controls and auxiliaries) and compressed air (for valves). There will also be a nitrogen feed to the plant, which will be mixed with the generated hydrogen and subsequently transferred directly to the Saint-Gobain facility.

2.2 Activities

2.2.1 Each HyGEN50 unit is a standalone operating system that consists of six modules:

- Fuel Preparation Module (FPM)
- Hydrogen Generation Module (HGM)
- Reformate Cooling Module (RCM)
- Hydrogen Clean-up Module (HCM)
- Hydrogen Buffer Module (HBM)
- System Control Module (SCM)

Fuel Preparation Module

Natural Gas

2.2.2 The Fuel Preparation Module (FPM) prepares natural gas at the right pressure and cleans the natural gas feed to remove odorants. Removing these odorants (de-sulphurisation) avoids problems in the reforming process related to contamination in the natural gas feed stream.

2.2.3 The odorants in the natural gas are absorbed by two types of pellets, one of which is crystalline based and the other is copper based.

Feed Water

2.2.4 The water purification system prepares the water for the correct purity and removes disinfectants from the feed water stream, such as chlorine. The water purification system has four sequential stages starting with a sediment filter, followed by a carbon block filter, a Reverse Osmosis (RO) unit and an Electro De-Ionisation (EDI) module.

2.2.5 In the EDI module the water is passed between an anode and a cathode. The ion-selective membrane allows the positive ions to separate from the water toward the negative electrode and the negative ions toward the positive electrode. This results in high purity deionized water.

Hydrogen Generation Module (HGM)

2.2.6 Steam is generated with an integrated steam generator and preheated by an internal recuperative heat exchanger. Steam is added directly to the natural gas and this mix goes into the steam

reformer The steam/natural gas is passed through the reformer tubes filled with a nickel-based catalyst at high temperature This process converts the natural gas and steam mixture into a hydrogen rich stream.

2.2.7 The necessary heat is brought into the system using an integrated burner that combusts the off-gas coming from the VPSA through the off-gas section (as detailed in Hydrogen Cleaning Module Section below).

Reformate Cooling Module

2.2.8 For correct functioning of the VPSA, the hydrogen rich stream from the HGM must first be cooled. This is cooled within the reformate cooler when the ambient temperature is in the range of -20 to 10 °C. The process waste heat is used to keep the system's cabinet temperature above zero in case of ambient frost conditions.

2.2.9 An external dry cooler is also installed next to the HyGEN50 unit, when ambient temperatures exceed 10°C the reformate gas will be mainly cooled by this external cooler.

Hydrogen Cleaning Module

Vacuum Pressure Swing Adsorber

2.2.10 The VPSA operates at the exit pressure of the reformer cooling module. In a continuous cycle, the hydrogen rich stream coming out of the reformer section is fed into one of two vessels, whilst the other one is cleaned and pressurised. Contaminants (water and carbon dioxide) are adsorbed via activated carbon pellets. When the vessel adsorption material is saturated with contaminants, the system switches to the other VSPA vessel which has been cleaned and pre-pressurized.

2.2.11 The saturated VPSA vessel is cleaned with water and the contaminants are released from the adsorption material, therefore this adsorption material does not need to be replenished after use. The waste water from the cleaning is discharged into the foul sewer.

2.2.12 The vacuum pump creates a pressure below atmosphere, which improves the cleaning capacity. The off-gas (a mixture of H_2, CH_4, CO, CO_2 and some other fractions) all goes to the off-gas vessel.

Off-Gas Vessel

2.2.13 The off-gas vessel section contains a 900 litre stainless steel storage vessel where the off-gas is collected. This vessel is used to equalize the pulsating off-gas stream from the VPSA into a continuous stream, which is fed back into the burner of the HGM There it is utilised to generate heat in the integrated burner.

Hydrogen Buffer Module

2.2.14 The hydrogen stream coming out of the VPSA is an intermittent flow due to the process operating condition of the VPSA. In order to provide a steady flow of hydrogen, the pure hydrogen stream is fed into a 900 litre stainless steel buffer. The hydrogen is buffered at a maximum pressure of 7.0 bar(g) inside the system.

2.2.15 There will be 800 kg of hydrogen stored on site in the buffer .

System Control Module

2.2.16 The entire HyGEN50 system is automatically controlled and under normal operation there is no input from HyGear or Saint-Gobain required to operate the plant. There is a control panel

interface on site which has a sign start and stop signal. All essential process and sub-process parameter are monitored and where required controlled remotely by HyGear. In case of an error, HyGear and Saint-Gobain will be notified automatically. Trained Saint-Gobain staff will be available to take any required onsite action and if required, they can call HyGear to solve the error. Further detail on accident prevention and management is provided in Section 3.3 of this document.

3 MANAGEMENT

3.1 Management Systems

3.1.1 A site-specific Environmental Management System (EMS) will be produced and put in place prior to commissioning of the site.

3.1.2 The EMS will detail the procedures for environmental management on site to minimise the environmental risk from the activities covered by the permit, albeit the environmental risk of this facility is considered low.

3.1.3 All staff and external contractors shall be given information on the requirements of the EMS as part of the induction training and a copy will be made available on site.

3.1.4 A copy of the EMS shall be kept at the site for use by staff when required.

3.2 Site and Equipment Maintenance

3.2.1 Management systems will be put in place to ensure that the facility is operated as designed. These systems will not only cover normal running but will also address abnormal operation and start-up and shutdown of the facility.

3.2.2 Planned maintenance routines will be established to ensure all key plant components which have the potential to affect the environmental performance of the facility remain in good working order.

3.2.3 Maintenance routines will draw on manufacturer's recommendations, modified as appropriate by operational experience during the lifetime of the facility. The operator will undertake long term maintenance and ensure that all plant and equipment is maintained to the manufacturer's or supplier's recommendations. Routine maintenance will be undertaken by HyGear engineers.

3.3 Accident Prevention and Management Plan

3.3.1 The EMS will contain environmental incident and emergency response procedures. This will include an emergency response plan and risk assessment.

3.3.2 The plan will identify potential incidents that could have an environmental impact, the cause and consequences; measures taken to avoid the accident happening and actions to minimise the impact on the environment from the accident. It shall include details of how accidents shall be reported, investigated and what the response shall be.

3.3.3 Emergency response facilities shall be made available on site to deal with any such incidents should they occur.

3.3.4 In the event of an accident on site, HyGear will liaise with Saint-Gobain staff in order to resolve the issue and/or report the accident to emergency services and the Environment Agency, as required.

3.3.5 After the immediate actions have been undertaken to resolve the accidence a non-conformance report shall be completed along with a health, safety and environment report. This shall be reviewed by HyGear's health safety and environment committee and safety measured will be implemented.

3.4 Complaints Procedure

3.4.1 A contact number for complaints is included in the site identification board at the entrance to the site.

3.4.2 A complaint report will be completed by HyGear for any complaint received at the site. This will be reviewed to decide if any corrective action is required.

3.4.3 If required the operator will send a service technician to site to resolve the issue.

3.5 Staff Competence and Training

3.5.1 Staff remotely operating the plant or providing onsite maintenance will be sufficiently trained to ensure that they are technically competent undertake their role. The Saint-Gobain staff required to interact with the HGS, specifically in an emergency situation, will also be sufficiently trained to ensure they are technically competent. HyGear technical specialists will be available at all times to advise as required.

3.5.2 All staff, contractors and relevant Saint-Gobain staff will receive training on the EMS requirements as part of their induction, this will include environmental awareness including awareness of the environmental permit.

3.5.3 Copies of relevant plans, procedures and the environmental permit shall be kept at the site for reference.

3.5.4 Job specifications are defined within the EMS and include details on relevant qualifications and training (including where relevant, on the job training) required for that role. As a minimum records will include details relating to the date, type of training and training provider. Records shall be available for inspection as required.

3.5.5 Procedures will also be in place to ensure that contractors undertaking work on the Hydrogen Production Plant are qualified for the task they are undertaking and that they are made aware of relevant requirements of the EMS and environmental permit requirements relevant to their work. This will include all maintenance staff carrying out routine maintenance of the site in the event that any third party maintenance is required.

3.6 Records

3.6.1 The operator shall maintain records of any incident, accident, emergency or non-compliances shall be kept. All monitoring (where required by the permit) including samples and analysis results shall be recorded.

3.6.2 A copy of all documents will be held in HyGear's office and made available upon request. All records shall be kept for at least six years.

3.7 Site Security

3.7.1 The site is surrounded by a 2.4 m high fence, the site gate is always locked. There will be no direct public access to the site.

3.7.2 The hydrogen production plant controls are in a locked room and monitored remotely.

4 ENVIRONMENTAL RISK AND EFFECTS

4.1 Energy Efficiency

4.1.1 There will be minimal energy consumption at the site, the main energy use is heat (steam generated from burning off-gas and for the control panels. Other power consumption at the site will be limited to a small amount of electricity (159.15 kW) and for the control panels and energy usage from natural gas (1.25 MW).

4.1.2 The HGS will be subject to routine maintenance in accordance with manufacturers recommendations to ensure systems remain in good working order.

4.1.3 Overall, energy consumption from the site is therefore not expected to be significant. Every four years the activities at the HGS will be reviewed to identify whether there are opportunities to improve energy efficiency.

4.2 Raw Materials, Water and Waste

4.2.1 The main materials used within the plant will include natural gas, water and hydrogen. Details of the raw materials and their usage is detailed in Table 4-1 below.

Table 4-1: Raw Materials

Raw material	Use of Raw Material	Programme for replacement
Natural Gas	Hydrogen Production process	N/A
Water	Steam for hydrogen production process	N/A
Hydrogen	Buffer for hydrogen production	N/A
Particle Filter	Water purification	6 monthly
Carbon block filter	Water purification	6 monthly
Reverse Osmosis membrane	Water purification	Yearly
Absorbent Pellets (crystalline based)	Desulphurisation of natural gas	6 monthly
Absorbent Pellets (copper based)	Desulphurisation of natural gas	6 monthly
Adsorbant Pellets (activated carbon)	PSA	N/A

4.2.2 Waste generation from the plant is anticipated to be low and will result primarily from maintenance activities.

4.2.3 The site will produce limited volumes of hazardous waste which will comprise the following:

- Natural gas compressor oil needs to be refreshed annually. The annual volume would be 15 litres in total; 5 litres per compressor.
- Hydrogen compressor oil needs to be refreshed twice a year. The annual volume would be 15 litres.

4.2.4 In addition to the waste compressor oil, the systems also include desulphurisation pellets which require replacing twice a year. This produces 175 kg of waste pellets per unit, twice per year so for all three units this totals 1050 kg per year. The total average hazardous waste produced (oil and desulphurisation pellets combined) is ~2.9 kg per day.

4.2.5 The total volume of hazardous waste produced annually will be ~ 213 kg.

4.2.6 There will not be more than 20 tonnes of other waste produced in any one day.

4.3 Emissions to Air

4.3.1 Emissions to air from the HGS will result from exhaust gases generated from the burning of off-gases within the integrated burner of the HGM.

4.3.2 There is an exhaust stack located on each of the three HyGEN50 units. The locations of these emission points are shown in Appendix A. The primary air pollutants of concern with the potential to impact on human health from the exhausts pipes are NOx and CO.

4.3.3 An H1 screening assessment has been carried out and can be found in Appendix C. This has concluded that the emissions to air from the process screen out as insignificant.

4.3.4 There are further vents from the process which are not in use under normal operation. Emissions from these vents would be both infrequent and in short duration. During start up and shutdown, steam and reformate can be vented through the process vent. The steam vent is only steam and the reformate is mainly N_2 and H_2 with 2.5-3.5% CO. The only planned shutdowns are for maintenance twice a year. Venting from the reformate and steam vents during start-up and shutdown occurs for an hour each during which venting would be intermittent.

4.3.5 The off-gas vent is mainly CO_2, H_2 and CH_4 plus ~ 0.3% CO.. Off-gas venting only occurs towards the end of the catalyst life and again would be intermittent. The catalyst life is circa 3 years and therefore venting from this point would only happen, if at all towards the end of each 3-year cycle. Hydrogen venting may also occur in the case of a sudden shutdown or sudden reduction in downstream user demand. This release would be 100% hydrogen. It is concluded that the impacts from any of these vents would be insignificant.

4.4 Emissions to Water and Sewers

4.4.1 Emissions to sewer will result from the wastewater from the reverse osmosis unit which is part of the water purification process within the HyGEN50 units and reformer wastewater. Each HyGen50 produces 65 litres per hour of aqueous waste. In total this gives a combined release of 4.7 m^3/day from all 3 units. This is discharged into the Saint-Gobain drainage system and will subsequently enter into the foul sewer. Saint-Gobain hold a Yorkshire Water discharge consent to discharge to the foul sewer, registration number Y/717/99C, at the time of this application an updated discharge consent is being finalised by Yorkshire Water.

4.4.2 No abatement equipment is required to manage emissions to the environment. The location of the drainage is shown in Appendix A.

4.5 Emissions to Land

4.5.1 There will be no emissions to land associated with the operation of the HGS.

4.6 Noise

4.6.1 An environmental noise survey was undertaken from 1st to 4th November 2021 to establish typical external ambient and background noise levels at the nearest noise sensitive receptors. The noise survey showed that the noise environment at both measurement locations is characterised as being dominated by noise from the nearby A19 with some distant industrial noise.

4.6.2 The nearest NSR (Noise Sensitive Receptor) locations are:

- ‘NSR1’ – Residential Dwellings to the northwest of the site just off the A19, approximately 550m from the proposed hydrogen plant;
- ‘NSR2’ – Residential Dwellings to the Southwest of the site on Tranmore Lane, approximately 300m from the proposed hydrogen plant.

4.6.3 The key sources of noise from the proposed installation are:

- Outlet Damper (3no.);
- Water Chiller;
- Hydrogen Compressor;
- HyGen Units (3no.);
- Natural Gas Compressors (3no.); and
- Instrument Air Compressor.

4.6.4 All other elements of the development do not produce noise levels high enough to cause a material impact.

4.6.5 An assessment of noise from the new hydrogen plant has been completed and demonstrates that, during the daytime period, the rating levels at each NSR are a minimum of 19dB below the background noise level for the site. The assessment also demonstrates that the rating levels at each NSR during the night-time period will be a minimum of 2dB below the background noise level for the site.

4.6.6 The noise impact is concluded to be below the levels at which adverse effects are likely to occur. It is therefore concluded that there is only a low potential for noise impacts at offsite NSRs.

4.6.7 Full details of the noise assessment are provided in Appendix D.

4.7 Odour

4.7.1 Under normal operation the risk of an odour is very low. For safety reasons, natural gas is handled within a fully contained system up to the point of use. Should leaks occur, for safety reasons, the system would be isolated, and repairs made.

4.7.2 The closest off-site receptor is 300 m from the HGS, the potential for odour impacts at this off-site receptor is low.

4.8 Monitoring

4.8.1 The emissions to air from the process screen out as insignificant using the H1 screening assessment and the emissions to sewer will be minimal. Routine monitoring of emissions is not proposed.

Appendix A
Drawings

Appendix B
Site Condition Report

Appendix C
Air Quality Assessment

Appendix D
Noise Assessment

Appendix E
Environmental Risk Assessment