HyNet Hydrogen Production Plant 1 – Technical Note

EPR Response – 17a - Safety Studies

Requirement

17(a) - Safety studies

Provide an outline narrative description of all the safety studied undertaken as part of the design of the installation or planned for the detailed design stage.

Safety Studies Undertaken

A systematic approach to safety studies has been implemented on the project.

Design HSSE Philosophy

The project's safety goal is to minimise the risk to people, environment, and asset throughout the design, by applying in order of precedence the concepts of:

- Inherently safer design;
- Prevention (design to avoid hazards);
- Control (design measures to control hazards);
- Mitigation (design measures to minimise consequences); and
- Emergency Response.

Identification of hazards have been determined using appropriate hazard identification techniques including hazard identification (HAZID), with subsequent consequence analysis being conducted as part of QRA to determine the potential scale and effect of these hazards, in particular possible fire, blast and gas dispersion impacts. Results from these QRA studies were fed back to the engineering disciplines to drive the design activities, including plant layout and separation distances.

The project has adopted the following overarching strategies for the management of flammable and toxic hazards wherever possible:

- Elimination/minimisation;
- Substitution;
- Isolation;
- Control;
- Organisation;
- Protection.

Safety Studies Programme

The project arranged the following safety studies in accordance with process IMS-OG-GL-ENG-PFL-0003. Each review was generally proceeded by a terms of reference to allow the attendees to prepare, followed by the safety study itself. A report of each design was developed.

Table Error! No text of specified style in document..**1 – Summary of Safety Reviews Undertaken**

Study	Approach
Plot Plan Review	Systematic study of the 2D layout of the plant – includes review of safety features of the layout design to protect safety and environment. Relevant sections of Plant Layout Checklist, IMS-OG-GL-ENG.PIP-TMP-0003-01 and Layout Safety review Procedure, IMS-OG-GL-ENG.PRO-PRO-0015
P&ID Review	Systematic study of the process design of the plant – includes review of safety features of the process design to protect safety and environment. IMS-OG-GL-ENG.PRO-FRM-0002 - Checklist - P & I Diagrams
30% Model Review	Systematic study of the 3D design of the plant – includes review of safety features of the layout design to protect safety and environment. Carried out using relevant sections of IMS-OG-GL-ENG-PRO-0011 - 3D Model Review and IMS-OG-GL-ENG-TMP-0049-01 - 3D Model Review-Readiness Assessment Guideline - Stage-1 (30%)
Plant Safety Review (HAZID / ENVID)	Systematic study to identify the safety and environment hazards arising from the project. Carried out in accordance with relevant sections of "Risk Assessment During Engineering", ref IMS-OG-GL-ENG.PRO-PRO-0017 and "PHA (HAZID/ENVID/OHID) Methodology" Document No: IMS-OG-GL-ENG-PRO-TMP-0009-01.
SIMOPS / SAFOP Review	Systematic study of simultaneous operations – risks arising of activities on different sites (e.g. construction of new plant next to an operating plant). Generally following Risk Assessment During Engineering, IMS-OG-GL-ENG.PRO-PRO-0017
HAZOP Review	Systematic study of process design of the plant using the piping and instrument diagrams. Study included an assessment of process safety and environmental hazards and risks arising. Carried out in accordance with relevant sections of "Risk Assessment During Engineering", ref IMS-OG-GL-ENG.PRO-PRO-0017 and IMS-OG-GL-ENG.PRO-PFL-0015 - HAZOP Study Flowchart
Constructability	Study included an assessment of construction safety and environmental hazards and risks arising. Carried out in accordance with relevant sections of "Risk Assessment During Engineering", ref IMS-OG-GL-ENG.PRO-PRO-0017 and relevant sections of our "Constructability Procedure" Document No: IMS-OG-GL-CON-PRO-0009. Construction Design and Maintenance (CDM) risk register, which includes safety and environmental risks, is included in the Health and Safety File for the project.
Quantitative Risk Assessment (QRA)	Calculation of risk was carried out using risk integration models.

The following sections provide more information on the significant safety studies carried out for the plant design.

Hazard Identification

A HAZID and ENVID exercise was undertaken during the FEED stage.

The following is a listing of some of the main major accident hazards identified:

- Release of process gas (natural gas, syngas, ROG or hydrogen) with:
  - Immediate ignition resulting in a jet fire or fireball.
  - Delayed ignition resulting in a flash fire or vapour cloud explosion.
- Uncontrolled release of carbon dioxide gas, with potential for asphyxiation of personnel;
- CO2 toxicity has also been considered;
- Uncontrolled release of carbon monoxide and hydrogen sulphide toxic vapours;
- Release of oxygen vapours (from pipework or liquid oxygen tank) resulting in enriched oxygen atmosphere with resulting harm to personnel through promotion of ignition.

It is noted that the hazards associated with oxygen are new to the Stanlow Refinery.

The potential environmental hazards associated with routine operations and incidents.

- The highest severity hazard identified was the potential for damage to widespread habitat due to combustion products from a major on-site fire (e.g., heavy metals, smoke, particulates).
- It was also noted that there is the potential for contribution to global warming due to release of hydrocarbon, carbon dioxide or hydrogen gas to atmosphere (noting that hydrogen is an indirect greenhouse gas).

Hazard and Operation (HAZOP) Study

A project HAZOP study was undertaken during the FEED stage, covering the following systems:

- System 200 (Part 1) – Air and gas, comprising natural gas system, hydrogen, export and distribution header, CO2 metering and export, instrument air and nitrogen;
- System 200 (Part 2) – Carbon Capture Unit;
- System 300 – Utilities and offsites, comprising cooling medium system, river water supply, filtered water supply, demineralised water supply and closed drains system;
- System 400 – Flare system;
- System 700 – Refinery Off Gas (ROG).

Additionally the LCH plant has been HAZOP'ed independently by Johnson Matthey and detailed interface studies will be undertaken at later stages of the project.

Quantitative Risk Assessment

A QRA have been carried out on the HyNet Low Carbon Hydrogen Plant and associated facilities. This included assessment of both individual risk and societal risk for onsite and offsite populations, with a resultant Frequency Number (FN) curve produced.

The calculation of risk was carried out using risk integration models and involved a number of discrete steps defined as follows:

- Hazard identification and scenario selection;
- Assessment of consequences;
- Assessment of containment failure frequency;
- Assessment of ignition probability and fire frequency;
- Risk integration with the following metrics determined in order to quantify the risk:
  - Location Specific Individual Risk (LSIR);
  - Potential Loss of Life (PLL); and,
  - FN Curves.
- Comparison of the societal risks with the Health and Safety Executive's (HSE) risk criteria.

Action Tracking

Action tracking ensures that actions arising from the safety studies are addressed in the design and build of the project. Actions have either been addressed at the current stage of the project, or have been communicated to future phases of the project.

All actions generated in safety and design studies were entered into the project's Safety, Health, and Environment Action Management System (SHEAMS) register and tracked to completion (refer to SHEAMS close-out report 5194812-000-40RA-4-0001).

Process actions were reviewed in relation for their potential impact on the overall design to the project. These actions were addressed as a high priority where this was deemed to have a significant impact.

Kent actions were responded to by discipline engineers and approved by the discipline lead. These were then reviewed by the Technical Safety Lead and if found acceptable a final approval was obtained from the Project Engineering Manager. Where the actions were responded to by another consortia member Kent's Engineering Manager only noted the response.

The following provides a summary of the actions from the FEED phase of the project:

Total closed in FEED	364
Total deferred to future phase	147

Actions have been deferred to future phases either because the action needs to be undertaken in the future phase of the project (e.g. during construction) or the data is not available at this time (e.g. data will be developed by an equipment manufacturer after a purchase order has been placed).

Future Phases

The systematic process of safety reviews will continue into the detailed design and build phase of the project. Per the scope of works for the execution phase of the project (document reference 5194812-000-30AN-4-0001) the following safety studies will be undertaken:

- Update of safety and environmental engineering philosophy and plan
- Fire and explosion risk analysis
- Final QRA
- Human factors review
- Escape, Evacuation, and Rescue analysis
- Final HAZOP and SIL study and report
- Layer of Protection Analysis (LOPA)
- Maintenance of the SHEAMS system to ensure all actions are tracked to close out; and any residual hazards notified to the owner and operator of the plant
- Interface studies and reviews
- SIMOPs
- ALARP demonstration