Proposed Hydrogen Production and Blending Facility – Derby Street – DA/25/2021

Comments on Proponent's Response to GRC

Reference - Letter to Shaunte Farrington dated 31 January, 2022 DA/25/2021 – Further Advice Response

Summary of this commentary

Independent Engineers (Advisian) have reviewed the proposed plant design, and highlighted on several occasions the hazard of vessel over-pressurisation and ejection of debris over a wide range. AGIG has failed to address this hazard adequately, and appears to be pretending that it doesn't exist.

None of AGIG's responses have adequately addressed the hazard of rupture of pressure equipment due to over-pressurisation. On the information provided to date, the proposed installation carries unacceptably high probabity of failure, and completely unacceptable consequences of rupture. It is unreasonable and reckless to impose this risk (so far unassessed) on the surrounding community.

No assessment has been made of the consequences of pressure vessel rupture, such as projectile size and range.

AGIG have failed to respond to requests for comparisons of stored pressure energy.

AGIG continues to quote irrelevant comparisons in terms of nitrogen gas bottles and chemical energy equivalents, none of which contribute to reasoned assessment of this application.

Documents Included with Referenced Letter

A. Responses to Submissions

Rupture of pressure equipment due to over pressure has not been included. The text seems to down-play this hazard.

"Negligible likelihood of failure" does not preclude the requirement to assess consequences. Likelihood of failure will not be negligible, and will be much higher than due to material failure alone, because of the use of administrative controls to limit pressure to the hydrogen system, creating a parallel, relatively high probability cause of failure.

Comments on ductile failure may be evidence that the proponents don't understand failure modes or fracture mechanics.

There is still no evidence of measures to prevent over pressure rupture.

Measures quoted are all ineffective when relying on administrative controls. Comments on "only 3 MPa" are misinformed, misleading, and show complete lack of understanding of the hazard.

Comments on Risk

There is more unjustified repetition of "negligible risk". There are more comparisons of chemical energy, but no comparison of stored pressure energy, as requested by GRC.

AGIG concluding summary

Their statement is misleading, as the proponent has chosen to ignore critical points in the independent consultant's report.

B. Asset Management Approach …

1.2. AGIG Asset Management Strategy

Asset Description

There is no mention of design criteria – including the expected large number of fatigue cycles, required failure mode (leak before break), non-destructive testing including sizing of defects and their relationship to failure mode (fracture mechanics). These should be sighted, reviewed and approved by a RPEQ.

The proponent must be able to demonstrate the safety of the hydrogen storage vessel and other pressure equipment to the satisfaction of an independent engineer (RPEQ), including the following criteria as a minimum -

(a) The design of the vessel is safe for the maximum allowable operating pressure that can potentially be applied – that is, the pressure of the natural gas supply line. (This is discussed later.)

(b) The vessel's first failure mode is designed to exhibit a limited leak rather than a catastrophic rupture.

(c) Non-destructive testing has been carried out by a N.A.T.A accredited organisation, with sufficient resolution to reveal defects or imperfections large enough to affect the anticipated rupture mode of the vessel shell or other components. These records must be stored permanently and kept available for life assessment purposes.

(d) Fracture mechanics assessments demonstrate that the vessel is safe to operate under the possible extremes of pressure, and the fatigue conditions that will apply.

(e) The vessel has traceable conformity in accordance with Australian Standards to demonstrate that it has been acquired in accordance with its design.

None of the above criteria should be considered onerous, as they should have been part of a well-managed design and acquisition process, and be incorporated into the asset management strategy.

Examination of the Process and Instrumentation Diagrams (P&IDs) shows that in all cases, pressure relief valves are isolated by manual isolation valves making them potentially ineffective. It is also possible to subject the hydrogen generation system to the full pressure of the natural gas supply line. With the current arrangement the plant is not inherently safe, and these hazards can only be controlled by administrative measures.

Formal Safety Assessment

Formal review of the original QRA found that not all hazards had been identified, and listed over-pressure rupture as a potential high risk event.

C. Gladstone Hydrogen Park Quantitative Risk Assessment – Rev 1.

This is basically a re-run of the previous version. It has failed to address the hazards recommended for assessment by the independent engineer.

The text generally dismisses the probability of catastrophic failure of the hydrogen storage vessel as "negligible". The QRA quotes a value of 2 chances per million per year (cpm).

Reference 10 in the QRA reviews numerous studies of failure statistics, and concludes that a reasonable mean probability of catastrophic failure is 6.5 cpm, which is 3.25 times the probability quoted by the proponents. Significant contributors to this value in the source data were over-pressurisation due to operating error.

There is no assessment of consequences for this event, and hence no risk value is derived.

D. Review of QRA Study – Advisian 28 January 2022

Quoting from Advisian's report -

"Whilst there may be other effects from the equipment failure on the site (e.g. projectiles), these are not generally included in the QRAs conducted for land planning purposes. These effects are not expected to impact the calculated risk measures and/or alter the conclusions reached. **Rupture of hydrogen storage vessel is a low probability event but should be considered.**"

Comment - The apparent reliance on control systems and administrative measures to achieve a low probability of rupture results in a system that is not mechanically robust, and likely to have a much higher probability of failure than historical data would indicate.

Quoting from Advisian's report -

"The fatality risk to a typically exposed individual that will be transiting past the site on the way to the school or nearby housing was found to be low (< 10^{-7} annum), comparable to the risk of being struck by lightning."

Comment - Multiplying this by the number of exposed people (say 1000 per day?) results in an aggregate fatality risk of 1 x 10^{-4}, not a negligible number.

Figure 2.2 shows a pressure relief valve downstream of an isolating valve. This is potentially extremely dangerous, as noted earlier.

Table 2.3 shows the probability of ignition of the contents of the hydrogen storage vessel as 2.3 x 10^{-1}. This is for a 100 mm diameter hole, not for a catastrophic release, when the probability of ignition would be expected to be much higher.

Modelling Exclusions

Quoting from Advisian's report -

“With respect to catastrophic failure of the vessel due to over-pressurisation, hazard ranges attributed to projectiles could be significantly larger than thermal effects / overpressures. Other quantitative risk assessment techniques such as LOPA should be used to ensure the likelihood of vessel failure is adequately mitigated given the potential for offsite effects in the event of a catastrophic failure.”

Comment – This is effectively saying “Take whatever measures are required to reduce the probability of failure in this mode, because the consequences are dire.” As discussed previously, with the arrangement of plant made available to date, it is unlikely that the probability of over-pressurisation can be reduced to acceptable levels. The consequences of rupture due to over-pressurisation have not been assessed or reported, but are expected to be extremely dangerous. The most direct method of managing this risk to an acceptable level is to remove the facility from this location.

2.4.3 Projectile Impact from Hydrogen Storage Vessel

The second paragraph starts out discussing projectiles, ignores projectile damage, and concludes with remarks on fires and explosions. It does not contribute to addressing consequences of flying debris. It is worth noting that a person struck by a large fragment of a disintegrated pressure vessel is unlikely to survive.

Comparison of operating pressures with the pressure in a nitrogen storage bottle is gratuitous, and of no value to this assessment. Nitrogen bottles are designed to a known high standard to withstand their controlled fill pressure and expected rough handling, and are regularly inspected and maintained under rigorous regulations. It is unlikely that this has been done for the hydrogen storage vessel.