HYDROGEN GENERATION ON ORKNEY: INTEGRATING ESTABLISHED RISK MANAGEMENT BEST PRACTICE TO EMERGING CLEAN ENERGY SECTOR

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ABSTRACT

The European Marine Energy Centre's (EMEC) ITEG project (Integrating Tidal Energy into the European Grid), funded by Interreg NWE, combines a tidal energy and hydrogen production solution to address grid constraints on the island of Eday in Orkney. The project will install a 0.5MW electrolyser at EMEC's existing hydrogen production plant. EMEC and Risktec collaboratively applied best practice risk assessment and management techniques to assess and manage hydrogen safety. Hazard identification (HAZID) workshops were conducted collaboratively with design engineers, through which a comprehensive hazard register was developed. Risktec applied bowtie analysis to each major accident hazard identified from the hazard register, via virtual workshop with design engineers. The bowties promoted a structured review of each hazard's threat and consequence, identifying and reviewing the controls in place against good practice standards. The process revealed some recommendations for further improvement and risk reduction, exemplifying a systematic management of risks associated with hydrogen hazards to as low as reasonably practicable (ALARP). Hardware based barriers preventing or mitigating loss of control of these hazards were logged as safety critical elements (SCE), and procedural barriers as safety critical activities (SCA). To ensure that all SCEs and SCAs identified through the risk assessment process are managed throughout the facility's operational lifetime, a safety management system is created, giving assurance of overall safety management system continued effectiveness. The process enables the demonstration that design risks are managed to ALARP during design and throughout operational lifetime. More importantly enabling ITEG to progress to construction and operation in 2021.

1.0 INTRODUCTION

1.1 ITEG project

ITEG will develop and validate an integrated tidal energy and hydrogen production solution for clean energy generation to be demonstrated in Orkney. Funded by Interreg North-West Europe, the €11m project addresses energy related carbon emissions in North-West Europe and will tackle grid export limitations faced in remote communities.

The integrated solution combines three low-carbon technologies. These include Scottish tidal developer, Orbital Marine Power, and their next generation 2 MW floating tidal energy converter the Orbital O2, a custom built 500kW Elogen electrolyser, and an onshore Energy Management System (EMS) which will be deployed at EMEC's hydrogen production site on the Orkney island of Eday.

The EMS will support the production of hydrogen by routing any excess energy generated by the Orbital O2 turbine on EMEC's Fall of Warness tidal test site to be used to power the Elogen electrolyser.

1.1.2 ITEG project objectives

The ITEG project objectives are detailed below:

- Develop and validate an integrated tidal energy and hydrogen production solution for clean energy generation in remote areas

- Open new market opportunities for the ocean energy sector through hydrogen production and energy storage
- Optimise the EMS and fast-track a clean energy generation, management and storage solution towards commercialisation
- Build a roadmap to support the replication of the integrated solution in other remote, grid restricted areas

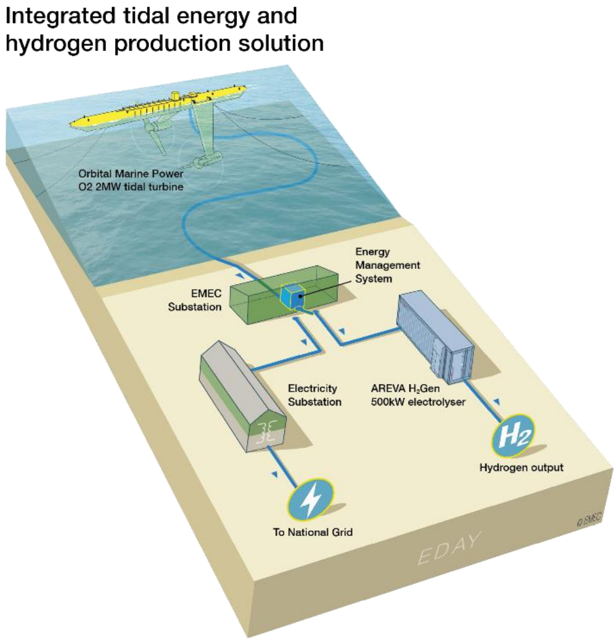

Figure 1. ITEG graphic showing the three technologies (courtesy of ITEG)

1.1.3 Project status

ITEG is currently in a period of increased activity occurring on site in preparation for the deployment of the technologies. Tidal developer Orbital Marine Power have completed the build of the O2 tidal turbine and have successfully towed the device from Dundee to Orkney and installed the device on to EMEC's Fall of Warness tidal test site.

For the development of the EMEC's Hydrogen Production Plant, an Engineering Procurement & Construction (EPC) contract was awarded to local contractor Bryan J Rendall and work is underway, preparing the layout of the site including civil works, detailed Hydrogen integration to the existing Hydrogen system by Logan Energy and design validation of the EMS which will be installed to manage the system requirements in the Summer of 2021.

The delivery of the electrolyser to site has been delayed due to COVID-19 but it is expected that the system will be deployed in the summer months of 2022. The ITEG electrolyser will join an existing ITM electrolyser on site, the interfaces with which were considered in this work.

1.1.4 Challenges including COVID-19

COVID-19 has presented supply chain challenges for some project partners which has resulted in the delayed delivery of some of the elements of the project. Given the impacts of COVID-19, the project has been granted an extension until December 2022 to allow more operational time of the ITEG solution.

Like most projects, business and organisations, the ITEG consortium have had to work remotely utilising software to be able to continue to make progress in the project and keep transparent communications with each partner's progress.

Our industry partners have had the most challenges with supply chains, furloughed staff and making the manufacturing environment COVID safe for the workforce return to enable work to progress, albeit behind the original timelines.

As a result of COVID-19 restrictions, workshops carried out in support of the risk management process described in this paper were carried out remotely by means of virtual meetings. This process has been an adaptation from standard practices and has been largely received as an adequate means of undertaking this kind of work with some parties expressing a preference for this remote approach.

1.1.5 Island energy system replication as a model for similar islands economies

The integrated ITEG tidal to hydrogen production aims to demonstrate a solution for grid export limitations faced in remote communities which can be replicated. Islands are innovation laboratories which are resilient by nature but also peripheral communities which are at grave risk of climate change effects across the world. Coastal and island communities living at the end of supply chains have a new economic and security opportunity through green hydrogen, energy system decarbonisation and system integration. Orkney is a living example of this, and by demonstrating localised solutions, we are also testing solutions that can be replicated across islands globally. Projects including ITEG, Surf 'n' Turf, BigHIT have established an exemplar hydrogen territory on Orkney through the demonstration of hydrogen generation, storage and distribution. Key learnings gained are being shared in other recently launched replication projects including HEAVENN, Islander and Green Hysland, which will see hydrogen territories established across the Netherlands, and islands in Germany and Spain.

To analyse the Orkney energy system, the ESC's EnergyPath Networks^{TM} (EPN) modelling framework has been used. EPN is a whole system optimisation analysis framework that aims to find cost effective future pathways for local energy systems to reach a carbon target whilst meeting other local constraints.

EPN is spatially detailed, covers the whole energy system and all energy vectors, and projects change over periods of time. This analysis is conducted firstly for the specific Orkney energy system. Then, later in the project, further analysis using complementary tools and methodologies assesses the potential wider roll-out in suitable locations across North West Europe, and the associated conditions required for suitable commercial roll out and deployment in different systems.

1.2 Background to EMEC

Established in 2003, EMEC is the world's leading facility for testing wave and tidal energy converters in real sea conditions. The centre offers independent, accredited grid-connected test berths for full-scale prototypes, as well as test sites in less challenging conditions for use by smaller scale technologies, supply chain companies, and equipment manufacturers. To date, more marine energy converters have been deployed in Orkney, Scotland, than at any other single site in the world with 20 wave and tidal energy clients spanning 11 countries having tested 32 marine energy devices. The organisation is committed to supporting the transition to net zero and has expanded activities into new sectors including green hydrogen, energy systems and floating wind.

EMEC originally expanded into the area of green hydrogen to address local gird constraints through a flagship project called Surf 'n' Turf which saw the installation of a rapid response electrolyser at EMEC's site on the island of Eday. The electrolyser enabled green hydrogen production from excess wind and tidal energy which could then be stored and used at a later date when required. EMEC achieved a world first in 2017, generating hydrogen using tidal power for the first time. Using Orkney's renewable energy to produce green hydrogen, EMEC is a partner in a growing number of innovative energy systems and hydrogen demonstration projects, driving the development of the local hydrogen economy working alongside stakeholders to decarbonise power, heat and transport across land (distilleries, airport), sea (ferries) and air (planes).

1.3 Background to Risktec

Risktec Solutions Limited (Risktec) is an established, independent and specialist risk management consulting and training provider, part of the TÜV Rheinland Group. The company supports clients, from SMEs to multinationals, in major hazard industries including oil, gas & chemical, nuclear, transport and clean energy, in both regulated and unregulated environments, as well as commercial and public sectors to manage health, safety, security, environmental (HSSE), asset and business risk.

2.0 OVERVIEW OF THE BOWTIE TECHNIQUE

2.1 Background to bowtie

The bowtie is a graphical risk analysis technique, allowing for a structured investigation on the threats and consequences of a chosen scenario. The bowtie method is a qualitative method, intended to provide a contextualized narrative to support barrier analysis.

A key advantage of the bowtie method is that the final diagram is a clear graphical representation which is readily understood by the 'non-specialist' and so enables good communication of the risk assessment process to every potential reader. The bowtie requires a collaborative process, allowing each participant to explore the management of risks and potential hazards.

The American Institute of Chemical Engineers (AIChE) established the Centre for Chemical Process Safety (CCPS) in 1985. The CCPS has been at the front of developing, sharing and publishing guidelines on risk assessment methodologies for numerous industries and specific assessments. The CCPS has created more specific guideline books, including more recently the 'Concept Series'. Within this series, the CCPS book "Bow Ties in Risk Management: A Concept Book for Process Safety" can be referred to for further information into the bowtie standards and methodology [2].

2.2 Risk assessment and management systems

Barriers interrupt the progression from threat to top event (preventive barriers) or top event to consequence (mitigation barriers). In this way, bowties are related to the Swiss Cheese Model of Accidents Causation [3] as shown in Figure 2. The holes in the Swiss Cheese represent weaknesses or potential failures of the barriers and these holes can be related to degradation factors in the bowtie model. The size of the holes relate to the significance of the degradation factors and the effectiveness of degradation factor barriers [2].

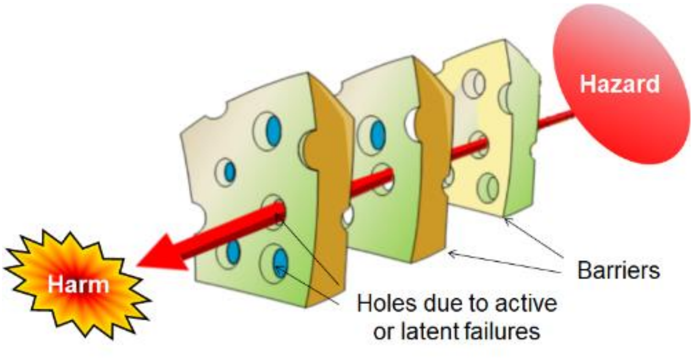

Figure 2. Bowtie Diagram Schematic and Definitions Swiss Cheese Model [3]

Bowties provide a framework for *barrier analysis*. The technique is focussed on the assurance of barriers, i.e. what is required to be done in order to ensure that the barriers are implemented. In effect, each barrier is subjectively risk assessed to ensure that it is effective and that sufficient measures are in place to ensure that it is implemented. This supports both the reduction of risk to acceptable levels, and the demonstration that risk has been reduced to acceptable levels, as well as supporting compliance with regulations and standards.

The ability for the bowtie technique to visualise risk management components provides the additional benefit that it can be used to support compliance with management regulations, such as the Construction (Design and Management) (CDM) regulations 2015 in the UK, particularly where accountability for barriers and responsibility for activities and equipment are assigned. The persons responsible for ensuring that each aspect of design reduces risk to acceptable levels, for example a Principal Designer under the CDM regulations, thereby has an effective means of keeping track over the responsibilities of different parties who may be spread across multiple organisations.

The bowtie is a risk assessment tool, which is part of the wider management system. As well as highlighting effectiveness and accountability, barriers on a bowtie can be expanded to include the following information:

- Safety (or HSEQ) Critical Elements (SCE);
- Safety (or HSEQ) Critical Activities (SCA);
- Documentation.

This is an important part of the assurance and demonstration that risks are not allowed to increase as the lifecycle of a system or facility progresses. Figure 3 provides an illustration of how the bowtie can provide the pivot point between risk assessment of significant (or major) accident hazards and management systems. The following (as shown in Figure 3) are examples of key linking points:

- SCE performance standards, which identify critical assurance tasks (which are also SCA) that must be implemented to ensure that there is no degradation of equipment / hardware required to implement barriers;
- Competence requirements for SCA (and critical assurance tasks), which feed into the competence management system for the system / facility;
- Input into audit plans to ensure that, for example, critical assurance tasks, e.g. preventive maintenance of SCE, are carried out in timely fashion, and that training needs analysis takes into account competence requirements.

SCE performance standards are developed from the bowtie, outlining the performance expectations and the tasks that should be carried out during the operational lifecycle to ensure that these expectations are met.

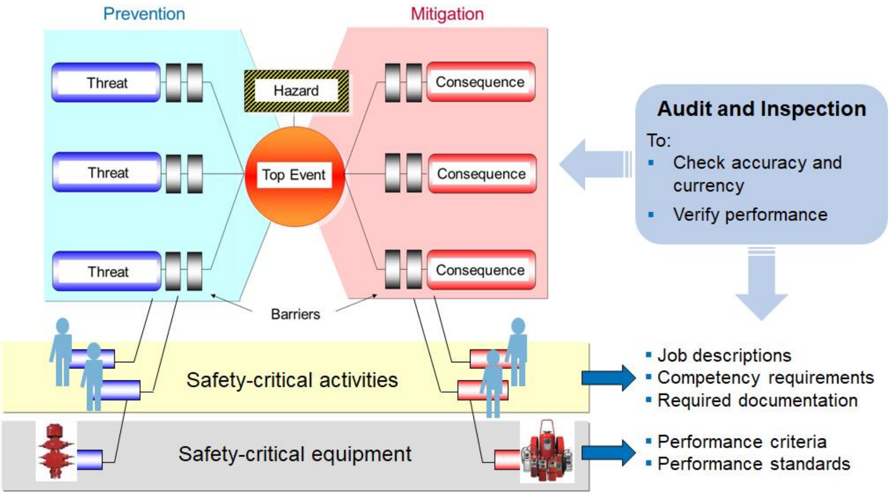

Figure 3. Link between bowties and management systems

3.0 ITEG PROJECT DESCRIPTION

The bowtie method represents a proportionate approach to managing risk of significant accident hazards, ensuring that risk is reduced to acceptable levels and managed to acceptable levels throughout the life of the ITEG facility. The risk management approach followed for ITEG is particularly appropriate for this type of facility, where there are known significant hazards (in this case hydrogen), but the inventory of those hazards is not sufficient to trigger regulation pertinent to major accident hazards such as COMAH in the UK. Good practice and regulation are developing for the burgeoning hydrogen industry, and the approach taken for ITEG is intended to represent a good practice approach for other hydrogen facilities. This section describes the process followed.

3.1 Risk Management Process

The risk management process for the ITEG project included the following activities:

- Hazard Identification (HAZID);
- Bowtie Analysis;
- Development of Performance Standards for Safety Critical Elements (SCE).

HAZID workshops were conducted collaboratively with design engineers, through which a comprehensive hazard register was developed.

The HAZID workshop was pre-COVID and held face to face in Stromness, Orkney in June 2019. The workshop took the form of a structured group discussion of hazards and threats, using a set of guidewords adapted from ISO 17776 [4] and DSEAR Approved Code of Practice (ACOP) [5]. The checklist was developed to include specific elements that were applicable to a hydrogen facility, including additional guidewords for hydrogen and ignition sources. The workshop facilitator led the team through discussion of a full list of hazards, with a focus on areas of the facility that would operate in hydrogen service. These areas were divided into nodes based on factors that included supplier of the equipment and operating pressures. This process enabled detailed consideration of the properties of hydrogen, how they affect realisation of the hydrogen hazard, and the safeguards in place to reduce the associated risk. Each identified hazard was risk ranked.

The HAZID was reviewed online, as a virtual workshop (see Section 1.1.4 for mention of challenges associated with COVID-19) in September 2020 as a precursor to the development of the bowties. This workshop review involved participation from EMEC, Logan Energy, and the electrolyser suppliers Elogen (then ArevaH2Gen) and ITM Power[1].

The HAZID process, supported by risk ranking, enabled the identification of significant hazards that would then be subject to further detailed analysis. The following significant hazards were identified from this process:

- Loss of Containment of Hydrogen from electrolyser trains;
- Loss of Containment of Hydrogen in transport (road / ferry);
- Loss of Containment of Hydrogen from storage.

These were then taken forward for bowtie analysis.

3.2 Electrolyser Bowties

Based upon the documented findings from the HAZID workshop and the hazard register developed from the HAZID, which provided a detailed list of relevant threats and safeguards, Risktec developed a set of

[1] ITM Power are not part of the ITEG project; however, they are they suppliers of an existing 500 kW electrolyser on the Eday site which will be joined by the new Elogen electrolyser in 2022. The ITM electrolyser on Eday predates the ITEG project and has been recently refurbished.

draft bowties for each of the significant hazards identified. These were then reviewed in online, virtual workshops with design engineers.

Bowtie workshops were held in October 2020, focussing on the electrolyser trains. As described in Section 2 of this paper, these aspects are documented below the barrier, by identification of SCEs and SCAs. Such hardware and activities are classed as safety critical by virtue of the fact that they appear on a bowtie for a significant accident hazard.

Table 1. SCE/SCA categorisation

SCE
Hazard containment (HC)
Equipment Protection (EP)
Facility (FS)
Control Systems (CS)
Monitoring (MN)
Detection (DS)
Emergency Systems (ES)
Protection Systems (PS)
Personnel Safety (IP)

SCA
Procurement Activities
Construction and Commissioning Activities
Inspection and Maintenance Activities
Operational Management Activities
Operational Engineering Activities
Emergency Response Activities
Personnel Training and Competence and Permit to Work

Safety Critical Elements were identified for the bowties. A total of thirty-seven Safety Critical Elements groups were grouped into nine categories, listed in Table 1 and presented in Figure 6. Each of the SCE and SCA groups are included in the bowtie barriers, providing a link between the risk assessment and the management systems.

A simplified example of the bowties developed for the ITEG electrolysers is presented in Figure 5, below. This diagram also includes flags to indicate where and how specific hydrogen properties were considered. Readers should note that this is not an excerpt from the actual bowties produced; it is a simplification focussing on some of the key aspects that are hydrogen specific and specific to electrolyser technologies. For illustration, the actual bowties contain approximately twenty threats and five consequences each.

Safety critical elements and safety critical activities are shown in Figure 5 underpinning the barriers. These include such aspects as Pressure vessels / tanks and associated material selection (HC-01), water purification systems (CS-03), and Hazardous Area Classification (FS-03).

Many of the barriers developed during the bowtie analysis are similar (at least superficially) to barriers that would be typical to oil and gas, and other process systems. The detailed consideration of the properties and hazard of hydrogen is often borne out in the barrier text, and ultimately in the performance standards. Table *2*, below provides an example of some further barriers and considerations brought out by the bowtie analysis.

Table 2. Example design considerations regarding Hydrogen and Electrolysers for the bowtie analysis

Example Hydrogen design considerations
Material selection suitable for Hydrogen service for all piping and joints. This is to reduce hydrogen embrittlement, internal and external corrosion.
Pipework connections designed to be suitable for Hydrogen. Hydrogen has a high leak frequency and all the connections need to compensate for this.
Dew point monitoring – Hydrogen not to be exported from electrolyser unless below the set dew point.
Ventilation to ensure any concentration of released Hydrogen is minimised.
Gas detection system to identify any Hydrogen, as well as heat and smoke detection.
Pressure testing / monitoring to identify any Hydrogen leaks.

Example Hydrogen design considerations
Separation distance between components based on conservative flame length assumptions
Certification of all electrical equipment with appropriate classification to account for reactivity of hydrogen.

Effectiveness of barriers was considered during the bowtie analysis (as marked by the + and ~ symbols below the barrier text in Figure 5). As described, this is a subjective assessment that considers aspects such as the potential for the barrier to fail and the extent to which it prevents a threat or mitigates a consequence. There is an intrinsic relationship between the effectiveness rating that can be applied to a barrier and the uncertainty inherent in the subjective assessment. This is illustrated by Figure 4 , below.

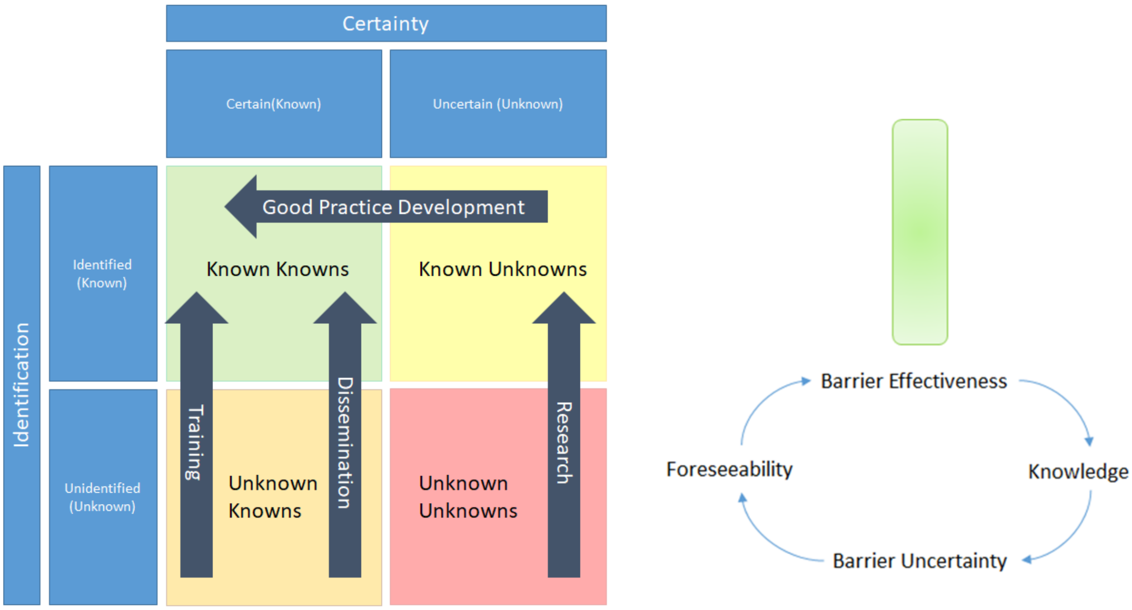

Figure 4. Management of Uncertainty

As well as the relationship between barrier effectiveness and uncertainty, Figure 4 shows a taxonomical system for appraising the extent of knowledge for hydrogen and other developing technologies. Risk assessment is about gathering knowledge that can be used and synthesized to form the basis for an informed decision. Notwithstanding, some risks are inherently unknowable, some risks are currently unknown and can be better understood either locally or globally, and some risks are well understood, addressable by the adoption of good practice measures. Aleatory risk is dealt with through effective barriers, whereas epistemic risk must be mitigated through learning and industry participation. Figure 4 shows the importance of the ongoing research into hydrogen, the development of good practice standards and the wider dissemination of existing research.

The risk assessment process sought to mitigate this epistemic risk by bringing together different parties with different expertise together in multi-disciplinary workshops for the HAZID and bowtie analysis, synthesizing their varied experience and knowledge. The performance standards then build on this basis, incorporating existing good practice and developing it further using the output of the bowtie analysis.

3.4 Performance Standards

Bowtie analysis is a detailed but qualitative approach, which is focused on the assurance of integrity of barriers, rather than the quantification of the likelihood of failure. Performance standards built from the bowtie analysis are a key method for supporting this assurance.

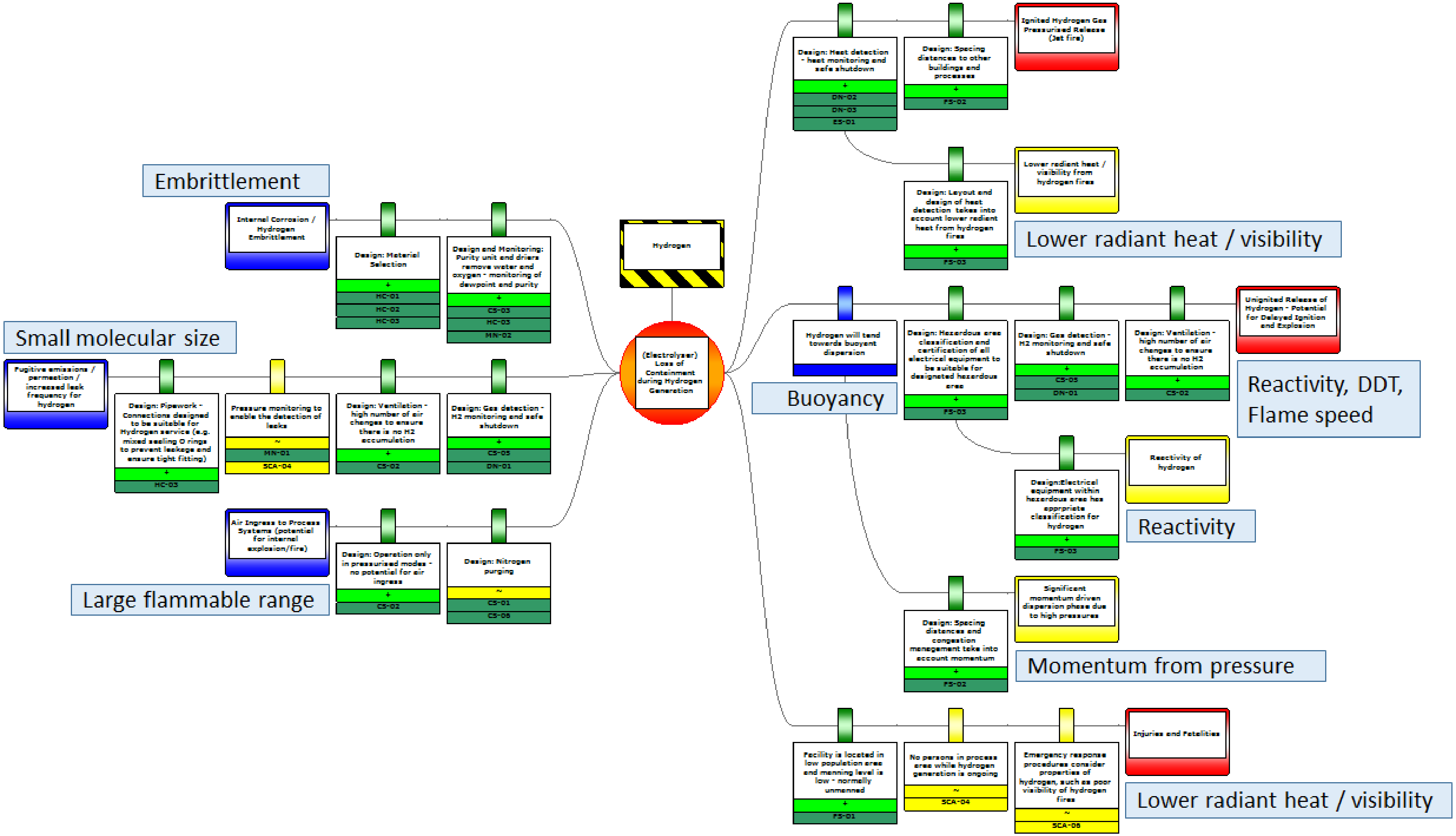

Figure 5. Simplified Bowtie Illustrating Consideration of Hydrogen Properties

Performance standards are in development to ensure that the integrity of the identified SCE are maintained throughout the operational lifecycle of the ITEG project. These performance standards identify the following, as applicable to each of the SCE groups listed shown in Figure 6:

- Functional requirements (F);
- Availability / Reliability / Maintainability requirements (ARM);
- Survivability requirements (S).

Against each of the above FARMS requirements, performance criteria are identified, linking to good practice and standards, where necessary and possible (such as the DSEAR ACOP [5]), as well as the identification critical assurance tasks to ensure that the required performance criteria are achieved over the lifecycle.

Performance standards, developed in this way, help to ensure that the requirements identified from the risk assessment for management of risk are actually implemented, and also to demonstrate that they are and will continue to be. They describe the assurance intent in detail, and provide a basis against which the maintenance management system can be audited to demonstrate technical safety integrity for the ITEG facility.

Development of performance standards also has wider implication for future projects. Bowtie analysis in combination with performance standards provide a template against which future projects can be assessed. The process of incorporation of existing good practice (known knowns - Figure 4) provides a detailed platform for future projects adopting similar to avoid technology to avoid 'reinventing the wheel'. A library of performance standards can be developed and built upon as knowledge and understanding increases.

3.5 Demonstration of risks reduced As Low As Reasonably Practicable

The principle of *reasonable practicability* originates in UK common law. The most prominent judgement that is generally regarded as establishing the principle is the Edwards v National Coal Board case in 1949. The judgement essentially determined that where an assessment, made in advance of an accident occurring, demonstrates that the cost of further risk reduction is grossly disproportionate to that risk, there was no obligation on duty holders to implement further measures to reduce the risk further. The definition of ALARP has been developed through case law, statute and guidance since this judgement. It is included in legislation in the UK, most notably the Health and Safety at Work etc Act 1974, which requires that duty holders reduce risk to their employees or others who may be affected by their *undertaking* so far as reasonably practicable. It is also included in company standards around the world. The HSE show that adoption of authoritative good practice is essential for demonstration that risks are reduced ALARP, where such good practice is available. Whether or not the concept of ALARP is adopted in a particular application, it offers a pathway to risk acceptability, while taking account of the economic necessity of the relevant undertaking.

The bowtie method is suited to supporting the demonstration that risks have been reduced ALARP. It allows an assessment of the barriers for each threat and consequence branch, in terms of effectiveness, gaps against good practice, and the opportunity for further risk reduction. A staple of the bowtie workshop method is asking the question 'what more can we do to reduce the risk?'. A potential failing of risk assessment processes is the lack of identification of a comprehensive set of risk reduction options (regardless of whether they are implemented) [7]. The bowtie supports the demonstration of ALARP by enabling this process of systematic identification of further risk reduction options, as well as providing a powerful visual tool for presentation of the risk management narrative.

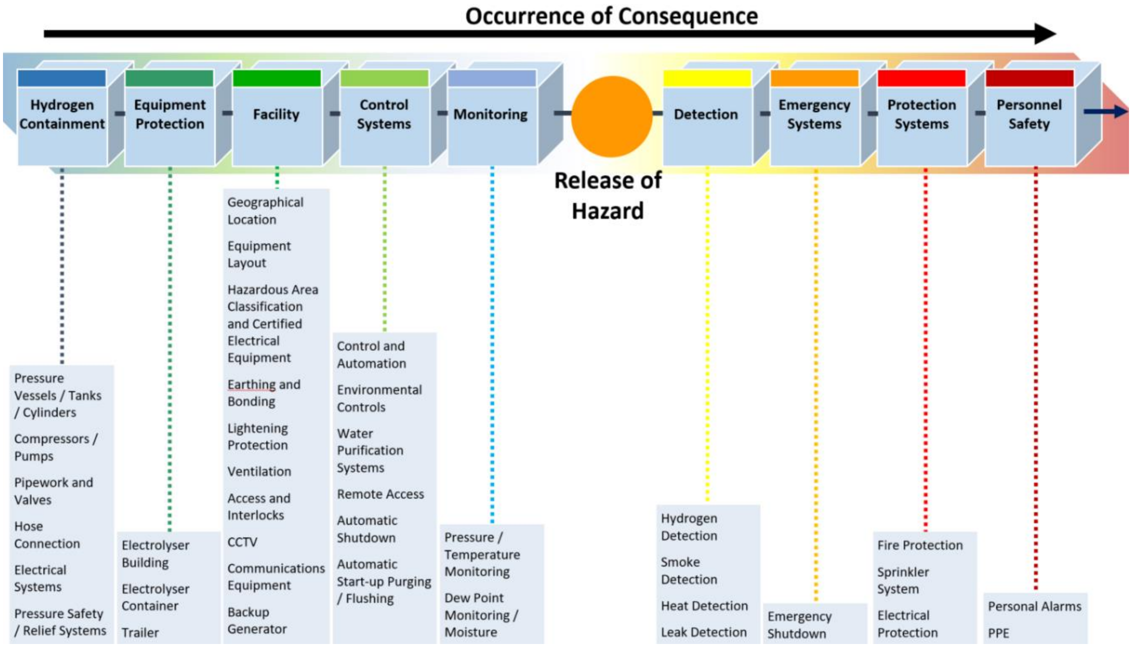

Figure 6. SCE Structure ITEG Bowties

The ITEG risk management process identified recommendations for further improvement and risk reduction, exemplifying a systematic management of risks associated with hydrogen hazards ALARP. To ensure that all SCEs and SCAs identified through the risk assessment process are managed throughout the facility's operational lifetime, performance standards are developed which input to the safety management system, providing assurance of overall safety management system continued effectiveness. The process enables the demonstration that risk associated with significant hazards is managed ALARP during design and throughout operational lifetime, helping to enable ITEG to progress to construction and operation in 2021.

4.0 DISCUSSION

Proportionality in risk management is always an important concept. For Hydrogen, particularly *green* hydrogen, i.e. hydrogen generated through electrolysis powered by renewable energy, proportionality is essential. As described in Section 3, the ALARP principle embodies proportionality, ensuring that the economic necessity of risk taking is protected, while biasing safety through the concept of gross disproportion – cost of further risk reduction must be grossly disproportionate in order to discharge the responsibility to reduce risk. The economic necessity of supporting renewable, green, clean energy technology has never been more evident. Green hydrogen, produced from surplus renewable energy sources will be an essential part of ensuring that the global community meets carbon emission targets, and the pace of deployment needs to accelerate if the targets are to be reached [8].

Notwithstanding this economic necessity, hydrogen is hazardous. Risk management is essential in order to ensure safety and protect the reputation of the industry. Significant safety events may have a negative effect that could set the industry back and prevent it from realising its potential to support the global climate effort. The UK Health and Safety Executive (HSE) at the hydrogen safety conference [9], held in March 2021, voiced support for the principle of *safety as enabler*; safety and risk management become the tool by which the integrity of the industry is preserved and climate targets supported. This paper has described a risk management process that is proportionate, detailed and focused on the hydrogen hazards, while not being overly onerous for a small facility with limited hydrogen inventory. As inventory increases, so must the complexity of the risk assessment, particularly where there are neighbors and sensitive receptors that could be affected by release of the hazards. This process provides a scalable model for other facilities, both technically and from a risk management perspective, particularly those operating in similar island economies.

As described in Section 3, good practice for hydrogen system safe design and risk management is still developing. Adoption of authoritative good practice is essential for reduction of risk ALARP [7, 10] and otherwise to acceptable levels. It is more difficult, however, to adopt good practice where good practice is not available or not necessarily applicable. In such cases, risk assessment processes such as that described in this paper becomes even more important, supporting the development of a first-principles risk assessment narrative, helping to reduce risk and demonstrate adequate risk reduction. This paper is intended to contribute to the development of good practice for hydrogen through demonstration of the applicability and proportionality of techniques that originate in the oil and gas industry.

5.0 CONCLUSIONS

ITEG will develop and validate an integrated tidal energy and hydrogen production solution for clean energy generation to be demonstrated in Orkney. The integrated solution combines three low-carbon technologies. These include tidal energy, a hydrogen electrolyser, and an onshore EMS, which will be deployed at EMEC's hydrogen production site on the Orkney island of Eday.

Risktec, EMEC and the ITEG partners have implemented a proportionate risk management process intended to ensure that risks are reduced to acceptable levels and demonstrate that risks have been reduced, while ensuring that the process is not unduly onerous and time consuming.

In formalising their approach to technical safety and learning from other industries such as oil and gas, EMEC is helping to ensure safety is at the fore front during testing of hydrogen technologies. Adopting Risktec's bowtie approach will minimise the risks to all stakeholders and help ensure these technologies are designed and tested in a manner which will allow the industry to scale rapidly, while integrating safely. Working with Risktec on the ITEG project has helped EMEC refine its established processes and ensure that EMEC continues to be leading in its safety protocols for its staff, local community and the renewable industry. EMEC can continue to provide world class R&D facilities at scale to showcase the real-time benefits across a variety of energy vectors within their test facilities.

The approach adopted for ITEG aims to demonstrate a solution for grid export limitations faced in remote communities which can be replicated. This approach is innovative both technically and from the perspective of proportionate risk management. ITEG will therefore serve as a model both for similar island/coastal communities, and other systems/facilities exploiting the many benefits of green hydrogen.

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