Issue 26 Summer 2026

INSIGHT

Tank storage provides an essential interface between sea, road, rail and pipeline logistics.

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NAVIGATOR TERMINALS PROGRESSES CO_2 HUB DEVELOPMENT AT TEESSIDE

The quarterly magazine from the Tank Storage Association

Also in this issue, we examine the latest sector insights and highlight the initiatives shaping the future of bulk storage and energy infrastructure.

Insight is published by the Tank Storage Association, the voice of the UK's bulk storage and energy infrastructure sector.

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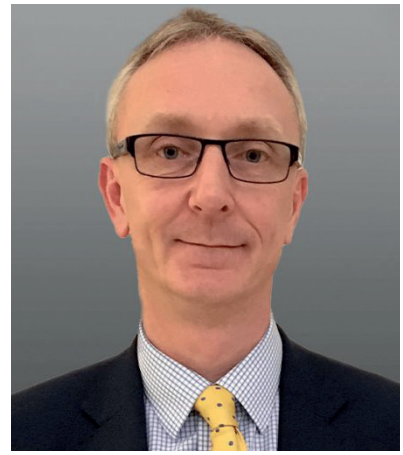


Peter Davidson
Chief Executive, TSA

Welcome to the summer issue of Insight. The bulk storage and energy infrastructure sector supports a complex network of stakeholders, including commercial businesses, residential consumers and international traders. Bulk storage terminals and tank farms are strategically located at ports, airports, logistics platforms and along rivers, canals, and pipelines. This vital infrastructure facilitates the efficient movement of products ,including animal feeds and fats, oils and molasses, transport and heating fuels, chemicals, and LNG, from producers to end-users. It also acts as a buffer during market fluctuations. In this issue, we spotlight the latest developments, forward-looking initiatives and innovations shaping the sector as it seizes opportunities ahead. I hope you enjoy this new edition of the magazine.

Contents

Navigator Terminals progresses CO_2 hub development at Teesside

Carbon capture is a critical pillar in the UK's transition to net zero, particularly for industrial sectors where direct electrification remains challenging.

This was underlined in the UK Government's CCUS Net Zero Investment Roadmap (2023) and has remained firmly in focus through recent consultations on the development of a competitive carbon capture, usage and storage (CCUS) market. The parallel consultation on non pipeline transport (NPT) for CO_2 further highlights the role that flexible, onshore infrastructure will play in enabling large scale deployment.

Navigator Terminals, which operates four strategically located terminals at Seal Sands, North Tees, the Thames and Windmill (South Wales), is closely following these policy developments as it progresses a CO_2 aggregation and logistics hub on Teesside.

The proposed hub is located within the established industrial and energy cluster at Seal Sands and North Tees, leveraging existing port infrastructure and deep water access. Pre-FEED studies are complete and planning consent secured, providing a robust technical and planning foundation as it moves into its next development phase.

Designed specifically to support non pipeline transportation, the hub is intended to aggregate CO_2 from a wide range of dispersed emitters before onward transport to offshore storage, helping address a key logistical challenge within the emerging CCUS value chain.

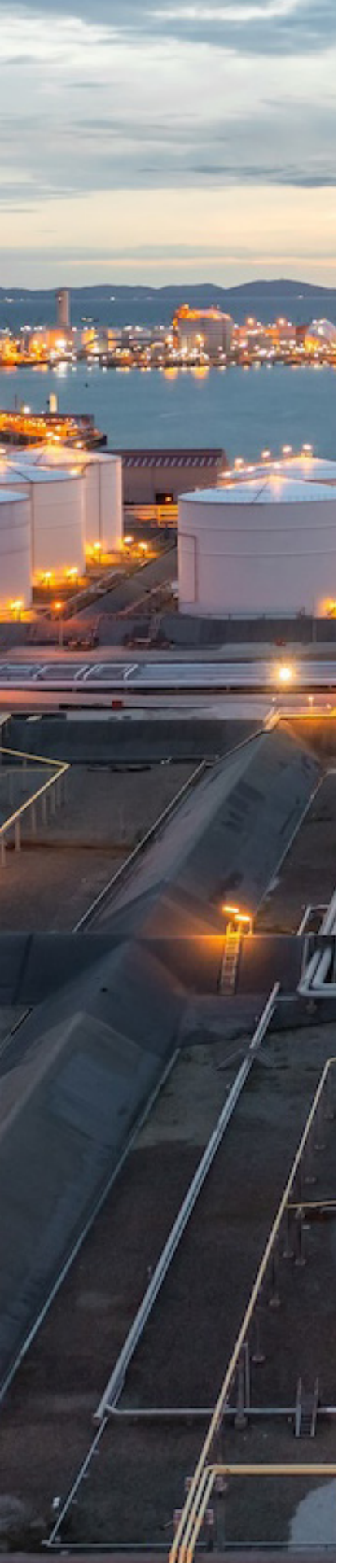
Matt Wilson, Head of New Energy Markets at Navigator Terminals, highlights the importance of infrastructure readiness and pragmatic delivery. He said: *"Carbon capture is not solely about offshore storage capacity, but also about addressing the practical challenges of aggregation, handling and transport onshore. We're focused on developing infrastructure that can genuinely support that system, building on locations and assets already embedded within the UK's industrial base."*

Its location provides proximity to the East Coast Cluster and Northern Endurance Partnership, positioning the hub to support future CO_2 flows as capture projects come forward at different scales and stages of maturity. The concept has been developed with flexibility and scalability in mind, allowing capacity to evolve in line with market demand and regulatory certainty.

Navigator is now actively engaging with potential emitters across multiple sectors, including energy from waste, sustainable aviation fuel and biomethane, to understand how CO_2 logistics can support their individual decarbonisation pathways. Wilson added: *"We're excited by the level of engagement we're seeing across the sector. From EfW and fuels through to bio based processes, there's clear momentum building Our role is to help provide the infrastructure that enables those projects to progress when the market and policy framework allows."*

Alongside CO_2 infrastructure, Navigator's New Energy Markets team is progressing opportunities across adjacent low carbon value chains where shared logistics, storage and port based capabilities can unlock long term value.

Navigator Terminals continues to develop commercial frameworks, engage with supply chain partners and participate in policy and industry discussions as the CCUS landscape matures. It views CO_2 aggregation and NPT as long term infrastructure challenges and is positioning its assets and expertise to support the next phase of UK industrial decarbonisation.



2026 Tank Storage Conference & Exhibition

The Tank Storage Association's Conference & Exhibition will return to the Coventry Building Society Arena on Thursday 17 September 2026 for its 25th edition. The UK's flagship event for the bulk storage and energy infrastructure sector provides one of the best opportunities for anyone interested in effective and safe bulk storage operations to come together to share knowledge and network. The conference programme will once again feature leading keynote speakers from government, regulators and industry, as well as subject experts offering delegates thought-provoking discussions and in-depth analyses on a range of key industry issues. Delegates will get the chance to delve deeper into up-to-the-minute topics relevant to the bulk storage and energy infrastructure sector, including the energy transition and the future of fuels, demand trends and supply infrastructure, safety and much more.

The exhibition will showcase a wide range of suppliers, technologies and services, providing attendees with the opportunity to explore innovative solutions and connect directly with industry providers.

Peter Davidson, CEO of the Tank Storage Association, said: *"With networking opportunities throughout the day, the event offers an ideal platform for professionals to build new relationships, strengthen existing partnerships and exchange ideas with peers from across the sector. As we mark the 25th edition of the conference and exhibition, it is an important moment to reflect on the sector's progress while also looking ahead to the challenges and opportunities shaping its future. This year's event will bring together key stakeholders to share insights, drive innovation and support the continued development of safe, efficient and sustainable bulk storage operations"*.

Registration is now open for delegates, with early booking recommended to secure a place at this key event for the sector.

The Tank Storage Association looks forward to welcoming members, exhibitors and delegates to the event in September. To stay connected until then, please contact the conference organisers on 01462 488232 or email tsa@tankstorage.org.uk.

For the latest news and updates, follow the Tank Storage Association on LinkedIn and Twitter. For more information about the event and to view the agenda, visit www.tankstorage.org.uk.

From assumptions to assurance: the new standard for managing low-integrity protection layers

Understanding the new ISA-84.91.03-2025 Standard

Standards such as IEC 61508 (functional safety of electronic systems) and IEC 61511 (functional safety for the process industry sector) have driven forward safety in the process industries for over 20 years. These standards focus primarily on ***High-Integrity Protection Layers (HI-PLs)*** like Safety Instrumented Systems (SIS) with associated reliability requirements defined by a Safety Integrity level (SIL). Adherence to these standards is recognised as a reliable way of protecting against major accidents.

The new ISA-84.91.03-2025 Standard does not aim to replace these standards but instead supplements them. It provides structured and clear guidance for ***Low-Integrity Protection Layers (LI-PLs)***, recognising that historically these systems have not been consistently defined or managed across the industry.

The standard requires a more formal approach to LI-PLs, including the use of independent, qualified personnel carrying out Functional Safety Assessments (FSAs) before implementation and after any significant changes.

Additionally, a documented Functional Requirement Specification (FRS) is needed for each LI-PL, which should clearly define the intended function of the layer, including components such as sensors and logic solver systems, response times and bypass capabilities.

One of the main aims of the new standard is to improve the management and assurance of these LI-PLs and ensure these systems are claimed appropriately within Risk Assessments. The level of risk reduction associated with these safeguards is often unvalidated and assumptions about reliability and effectiveness can differ between sites and organisations. This can result in 'overclaiming' the effectiveness of a LI-PL, giving a false sense of security.

Who does this effect?

UK operators across the process industries, particularly those regulated under Control of Major Accident Hazard (COMAH) regulations, should be aware of the new standard. For sites preparing a COMAH Safety Report submission, it is important that the justification of all protection layers credited in a risk assessment are clearly defined, assessed consistently and managed accordingly.

These standards are also relevant to safety professionals and engineers involved in major accident risk assessments. It also applies to those involved in alarm management, safety systems design and ongoing operation and maintenance.

What is the recommended approach?

A gap analysis should be conducted by existing sites to identify which LI-PLs are currently being credited in their risk assessments and ALARP demonstrations. This includes reviewing key areas such as LOPA studies, alarm management systems and assumptions around response times. Where LI-PLs are identified, a structured plan should be implemented to perform the assurance processes describe in ISA-84.91.03-2025. Improving documentation, ensuring LI-PLs are clearly defined, and refining assumptions used in risk assessments are key areas for focus.

Next steps

Implementing ISA-84.91.03-2025 offers an opportunity for greater consistency across how LI-PLs are managed, providing for more reliable risk assessments and delivering tangible improvements in process safety.

ESR Technology is on hand to support sites in implementing ISA-84.91.03-2025 by providing expert gap analysis, LOPA review, and independent FSAs tailored to Low-Integrity Protection Layers and have extensive experience supporting COMAH-regulated sites.

For more information, visit www.esrtechnology.com

ESR Technology
Quantifying Risk, Delivering Safety

Rebecca Chatfield - Marketing and Business Development Manager, Teamwork Security and Training Services

Rebecca Chatfield brings a strategic blend of marketing expertise and industry-specific knowledge to her role as Marketing and Business Development Manager at Teamwork Security and Training Services. A graduate with a degree in marketing, Rebecca has built her career at the intersection of communications, client engagement and operational insight.

Specialising in security risk management since 2015, she has developed a strong understanding of the challenges and regulatory landscape facing high-risk industries, including the tank storage sector. Her ability to translate complex security requirements into clear, client-focused solutions has become a defining strength of her work.

Rebecca joined Teamwork Security and Training Services in 2023 and plays a central role in shaping and delivering the company's marketing strategy to drive growth, strengthen partnerships and enhance its presence across the industry. Her approach combines data-driven insight with a genuine commitment to supporting clients in maintaining safe and compliant operations.

An active participant in industry events, Rebecca has attended the Tank Storage Association Conference for the past two years and values the opportunity it provides to connect with peers, share insights and stay ahead of emerging trends. She looks forward to returning for a third consecutive year this September, continuing to build relationships and contribute to the evolving conversation around safety, security and innovation in the sector.

Rebecca's dedication, industry knowledge and forward-thinking approach position her as a valuable voice within the security risk management community and a driving force behind Teamwork's continued success.

To learn more about Teamwork Security and Training Services
Call: 01752 425424
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Visit: teamwork-security.co.uk

ESTABLISHING NEW SAFETY RISK ASSESSMENT GOOD PRACTICE

The new guidance document from CDOIF 'Understanding Major Hazard Human Harm Risk Assessment (MHHHRA) for COMAH' is on the horizon which will shape the expectations for assessing risk posed to people in the high-hazard industry.

After years of preparation, discussion and refinement the brand new, highly anticipated guidance 'Understanding Major Hazard Human Harm Risk Assessment (MHHHRA) for COMAH', published by the Chemical and Downstream Oil Industries Forum (CDOIF) has arrived. It will apply to all COMAH facilities no matter the scale of their operations, making awareness and application of the guidance crucial to the future of industry.

At RAS, we are part of the CDOIF working group developing this guidance working with industry and the regulator. We have trialled the new assessment approach proposed by the CDOIF guidance as part of the development of the document at real work sites and so we are well placed to share our experiences.

We have worked hard to engage industry with the new guidance, speaking at conferences, webinars and trade association meetings across a range of sectors. It is our duty as process safety specialists to share our knowledge, spreading the message and helping the high-hazard industry to prepare for the new good practice. If you're unsure on what the new guidance means for you then read on, we've got your back.

What is the purpose of the guidance?

The production of the guidance reflected a lack of existing published good practice and an inconsistency of approach across various high hazard sectors and within the regulatory enforcement by the COMAH Competent Authority.

Development of the guidance began in 2021 by the CDOIF Risk Assessment Working Group which comprises of representatives from industry and the regulator. It aims to mitigate these inconsistencies and establish industry good practice on risk assessment for major hazards and providing operators, third parties and regulators with a common agreed methodology contained in a single reference. Due to the collaboration of industry and regulator in development, the compliance with the guidelines will be expected and enforced, reinforcing the need to keep up to date with its progress.

What do you need to do to comply with the new guidance?

The guidance provides a structured approach to MHHHRA across industry, splitting it into 4 main sections: the identification of major accident hazard scenarios, analysis, assessment, and the ALARP demonstration. Each section is then further broken into its guiding principles and a suggested methodology to achieve industry good practice. It provides a framework for the operator of

a COMAH establishment, or their risk assessment practitioner, to undertake a suitable and sufficient risk assessment of major accidents under the COMAH regulations. The guidance is adequately detailed to act as a practical guide and provides worked examples of how to apply the suggested approach. Applying the methodology outlined in the CDOIF guidance will ensure that major accident hazard scenarios are given sufficient scrutiny and that risks are managed to level that is As Low As Reasonably Practicable. The MHHHRA guideline is applicable to preparing a risk assessment from scratch, or when reviewing and updating an existing assessment.

One aspect to a human harm risk assessment which is enforced within the new guidance is the reinforcement and emphasis of the definition of major accident from the COMAH regulations, which is broader than just fatality events. Under the COMAH 2015 regulations a major accident is defined as:

"an occurrence such as a major emission, fire, or explosion resulting from uncontrolled developments in the course of the operation of any establishment to which these Regulations apply and leading to serious danger to human health or the environment (whether immediate or delayed) inside or outside the establishment, and involving one or more dangerous substances."

Based on this definition, assessments must consider the potential for serious permanent health effects, in addition to fatalities. This may broaden the scope of major hazard risk assessments for some facilities, as there is a common misconception that such assessments should only consider potential fatalities.

To comply with changes such as these in the new guidance will not mean to start from scratch. We suggest using a gap analysis to review your current compliance of your risk assessment of potential harm to people against the guidance. This would illustrate the work that would need to be done to meet the established good practice. Due to the level of detail in the MHHHRA guidance, it is not anticipated that compliance will happen overnight. It will be a longer-term process of gradually working towards the good practice in a pragmatic way that makes sense for your operations and your unique risk profile.

When will the new guidance be published?

The CDOIF working group has completed a comprehensive consultation process with industry, getting their views on inputs on the draft guidance. We thank those of you who made your voices heard.

Now that the consultation process is complete, the working group is in the process of reviewing the MHHHRA guidance in line with the comments received, with the intention of publishing the new guidance in Q2 2026.

Once published, the new guidance will stand as an established checkpoint for good practice and, therefore, there will be an expectation from the regulator to meet the guidance.

How we can help

RAS have been involved in developing the new CDOIF guidance and therefore, we are already familiar with the content, and we have practical insights from trialling the guidance across a range of different facilities. We can support to identify next steps for you moving forward and manage regulatory expectations as you progress in your journey to comply with the MHHHRA guidance.

If you would like to get in touch, please email us enquires@ras.ltd.uk or go to our website: ras.ltd.uk.

RAS

Safe | Smart | Sustainable

Wood joins the TSA, strengthening storage tank capability across the UK and Ireland

Wood has joined the Tank Storage Association (TSA) as an Associate Member in March 2026, reinforcing its long standing commitment to the bulk liquid storage and energy infrastructure sector.

The move brings one of the industry's most experienced tank specialists into the TSA community at a time when terminals face increasing expectations around safety, resilience, asset integrity and adaptation for the energy transition.

Operating from its Ellesmere Port office in Cheshire, Wood's tankage business delivers integrated storage tank solutions across the UK and Ireland, supporting operators throughout the full asset lifecycle. With over 40 years of dedicated tank expertise, the business is recognised for safe, technically assured delivery across projects ranging from small, discrete repairs through to large, multi tank new build developments.

Wood's tankage capabilities span inspection and assessment, concept and feasibility studies, detailed engineering design, and construction and maintenance of fixed and floating roof tanks. Services are delivered in accordance with leading international standards including API, EN and EEMUA, supported by in house qualified engineers and robust project controls. This integrated approach helps clients extend asset life, reduce downtime and maintain operational assurance across both legacy and evolving fuel infrastructure.

The Ellesmere Port team has extensive experience delivering multi scale projects in live COMAH environments, often working alongside terminal operators to plan, engineer and execute scopes that maintain safety, quality and schedule certainty. This capability is particularly valuable as terminals adapt existing assets for new fuels, decarbonisation initiatives and changing regulatory requirements.

Beyond tankage, Wood brings the strength of a global consulting and engineering organisation. Its wider service offering spans consultancy, engineering, projects and operations across energy and material industries. This includes front end concept development, FEED, EPC/EPCm delivery, asset integrity, commissioning, operations and maintenance, and support for energy transition technologies such as hydrogen, carbon capture and low carbon fuels.

By joining the TSA, Wood aims to collaborate closely with terminal owners, operators and supply chain partners, sharing best practice and contributing to the continued improvement of standards across the bulk storage sector.

Wood Operation Director Andrew Edmondson said: "I'm pleased to see Wood welcomed as an Associate Member of the TSA. Having spent years in this space, I know how important proven experience, strong standards, and safe delivery really are. From our Cheshire base, we bring decades of storage tank expertise to support operators across the full asset lifecycle, and TSA membership is a natural fit for what we do and how we do it. We're looking forward to collaborating with TSA members and continuing to raise the bar across the bulk storage sector".

For more information, visit https://www.woodgroup.com/

Are we really measuring tank cleaning, or just estimating it?

Tank cleaning is often described as controlled, yet in practice it still relies heavily on estimation. Decisions on progress and completion are typically based on experience, visual inspection, and preset schedules rather than measurement.

This raises critical questions. How clean is clean enough? When should the process stop? And how can that decision be demonstrated with confidence?

These are not just operational issues. They directly affect cost, time, and recovery outcomes. At Ambipar, the position is straightforward – without real time measurement, there is no true control.

From estimated outcomes to engineered results

Testing is not missing from tank cleaning. It is used too late. When applied only at the end, it confirms decisions already made, with no impact on performance, duration, or recovery. The shift is to bring testing into the process itself.

This is the principle behind the BLABO automatic tank cleaning system. By integrating portable laboratory testing into live operations, it turns measurement into a real time control tool. Data actively guides the process, enabling faster optimisation, improved recovery, and a move from estimated outcomes to engineered results. This is supported by a controlled, closed loop process that minimises variability. Measured changes reflect actual tank conditions, not fluctuations in method, allowing confident optimisation rather than conservative management.

Focused data, immediate impact

Control does not come from more data, but from the right data at the right time.

Within the BLABO methodology, we focus on a defined set of operational indicators that directly drive performance:

- Bottom sediment and water, measured against recognised API standards, to quantify progress,
- Oil and water separation efficiency, ensuring optimal recovery,
- Density measurements, providing clarity on product quality,
- Wash media condition, maintaining effectiveness,
- Contaminant reduction trends, giving real time visibility, and
- Identification of diminishing returns, signalling when to stop.
- Individually, these metrics provide insight. Together, they enable decisions that directly influence cost, duration, and outcome.

Commercial outcomes that matter

The impact is not theoretical. On a recent heavy fuel oil tank project, a 14-day programme was reduced to 7 days through continuous measurement and adjustment. Completion was defined by verified achievement of specification. From approximately 1,000 cubic metres of heavy fuel oil, the operation produced only seven 200 litre drums of solid waste. This reflects not just efficiency, but control.

Embedding real time measurement delivers clear commercial benefits:

- Reduced project durations through continuous optimisation
- Lower operational costs by eliminating unnecessary cleaning time
- Increased hydrocarbon recovery, preserving asset value
- Reduced waste volumes, cutting disposal costs and environmental impact
- Clear, auditable verification of compliance

A shift that redefines the question

Tank cleaning has long depended on estimation. Under increasing pressure on cost, time, and sustainability, that is no longer enough. Embedding measurement into the process replaces assumption with control, enabling optimisation and auditable results. At Ambipar, this is a shift in mindset. The question is no longer how long it will take, but how much value can be recovered, how quickly it can be verified, and how soon operations can resume. That is when tank cleaning becomes an engineered process, not an estimated one.

For more information, please contact info@ambipar.ie

ambipar

NEW ERA, NEW CHALLENGES: SAFEGUARDING TANKS IN THE AGE OF BIOFUELS

Joao Azevedo and Michael Harrison from Sherwin-Williams explain how biofuel adoption is driving changes in tank storage and refining practices, and how updated testing methods reflect real-world storage conditions.

From renewable diesel to sustainable aviation fuel, biofuels are at the centre of the global shift towards more sustainable transport. And with the demand growing all the time, refiners are racing to ensure their facilities and infrastructure are able to serve this burgeoning sector.

One area in need of attention is fuel tank linings. For decades, organisations have used specialised coatings to protect the interior of crude storage tanks from corrosion. Yet unlike conventional fossil fuels, biofuel feedstocks contain aggressive new compounds. Traditional long-term testing methods have identified that these compounds pose significant challenges to traditional tank linings, however, these tests fail to reflect the real-world reality of the biofuels business model.

Here, Joao Azevedo and Michael Harrison from Sherwin-Williams explain how biofuel adoption is driving changes in tank storage and refining practices, and how updated testing methods reflect real-world storage conditions.

Corrosion protection considerations

With the global shift towards more sustainable transport taking hold, biofuel demand is set to expand by 38 billion litres in the period 2023 to 2028. That's a near 30% increase from the last two five-year periods.[1]

This growing market is in the process of building the protocols and practices it needs to operate safely, effectively, and profitably. One important area is biofuel storage, and the appropriate methods needed to protect expensive infrastructure from corrosion.

For years, the fossil fuel production sector has used specialised coatings to perform this function, and the expectation is that biofuel operators will follow suit.

However, there are a number of sector-specific considerations. While finished biofuels are chemically identical to traditional fuels, bio-feedstocks, such as recycled cooking oil, are more aggressive in nature, presenting a risk of degradation.

These lipid-based bio-feedstocks are "living substances" that decompose into aggressive fatty acids during storage, particularly at high temperatures. With prolonged storage these fatty acids will increase in the bulk liquid, further compounding the corrosion risk and damage to internal linings.

In addition, operators face challenges during the vapour stage. Because

exposing bio-feedstocks to air at high temperatures can lead to rancidification, or the formation of corrosive organic acids (including acetic and formic acid) and aldehydes.

Evolution of testing methods

Biofuel adoption, then, is driving a change in how refiners think about and assess, storage tank lining.

Traditional long-term testing methods for fossil fuel, for example, evaluate tank corrosion after six months of exposure. When this approach was utilised in the biofuel arena, it revealed significant damage to traditional tank linings.

But the method was not reflective of the real-world conditions of this emerging industry. Biofuel tanks are regularly replenished, with the turnaround of feedstocks in storage typically being less than three weeks. A new method of cyclic testing, developed by Sherwin-Williams, incorporates regular inspections and the partial replacement of feedstocks on a monthly basis. Compared to traditional long-term storage tests, this provides a much better simulation of realistic storage and replenishment cycles and, therefore, more accurate and reliable data on coating durability and performance

This new method is currently being tested in a comparative study, with the first six monthly results demonstrating that uncoated panels show pitting corrosion during the vapour phase and at the bottom. Such updated testing methods have enhanced accuracy in predicting real-world outcomes, which means refiners can now consider a broader range of lining materials. And test results are driving the development of next generation, high performance bio-feedstock tank linings.

The potential economic benefits are clear. By investing in infrastructure protection, facility owners can maximise the use of existing tanks, and embrace this new, rapidly expanding market. It all adds up to greater reliability and confidence for refiners and storage operators alike.

The view ahead

Biofuel adoption is gaining fast momentum, but their distinct chemical behaviour is challenging the traditional approach to tank lining corrosion protection.

Early assumptions about long-term degradation ignored the way biofuel feedstock tanks are used in practice, and ended up overstating the risks.

With cyclic testing, which mirrors real-world feedstock storage conditions, the industry can now better evaluate tank lining performance, confidently protect their biofuels infrastructure, and help support the wider adoption of biofuels as a sustainable energy source.

References

- IEA Bioenergy. (2024) IEA Renewables 2023 – Biofuel and Biogas Forecasts. Available at: https://www.ieabioenergy.com/blog/publications/iea-renewables-2023-biofuel-and-biogas-forecasts/

Portbury builds on success of Green Days project

Colleagues at UM Terminals' Portbury facility have been busy transforming a green space within the site.

The half-acre plot already boasted three cherry trees and a small pond, but a team including operator David "Titchmarsh" Richards and site supervisor Tom Rowe have been busy planting hundreds of additional trees. The pair were joined during April for the day by Dr Nigel Jones, UM Group's Sustainability, Quality & Technical Manager, and UM administrator Louisa Brown. The initiative followed a series of Green Days last year at UM Terminals' sites in Liverpool, Hull and Portbury, although the latter is unique in having its own green oasis, something that is highly unusual at UK ports.

As part of the Green Days campaign, Louisa reached out to the Woodland Trust, which has since provided the company with hundreds of trees and plants including Spanish Broom, Common Dogwood, European Mountain Ash, Common Hawthorn, Sea-buckthorn and Wild Cowslip flowers. Meanwhile, the Richard Davis Memorial Pond, named in memory of the former Portbury site controller who died last year and was responsible for planting the cherry trees 30 years ago, is also going from strength to strength. The pond now contains lily pads, spiral rushes and oxygen weed, as well as half a dozen fish, while the water is kept circulating by a solar powered oxygen pump. There is also a much-loved vegetable plot, tended by David Richards, which so far boasts strawberry plants, onions, lettuce, tomatoes and chilli peppers. A further delight is the variety of wildlife being spotted in the UM green space including red and roe deer, up to six at a time, pheasants, rabbits, greenfinches, goldfinches, blue tits, sparrows, ducks, while a frequent visitor during night shifts is a local fox.

Tom said: "We are extremely fortunate to have the green space within the site and it has been a delight to play a part in this initiative. Dave, who we've all nicknamed 'Titchmarsh', has been a real driving force in transforming the space. It was also lovely to be able to name the pond after Richard Davis, who was responsible for planting the original cherry trees 30 years ago."

Louisa said: "Nigel and I enjoyed joining Tom and Dave earlier this month to help plant the additional trees kindly donated to us by the Woodland Trust. By continuing to transform this area, we will enhance biodiversity, address climate change, and establish new habitats for wildlife."

Thanks to projects such as this one, the Woodland Trust has been able to plant more than 68.5 million trees since the charity started life in 1972, working in partnership with thousands of businesses, landowners, schools and local authorities.

Tree Facts

1. Planting trees is essential for maintaining a healthy environment and supporting biodiversity, combating climate change and improving human wellbeing.
2. 13% of the UK is forest land, a significant decrease due to deforestation. The UK must plant 1.5 million hectares of additional woodland by 2050 to meet the carbon neutral target, or the impact could be irreversible.
3. Trees boost our physical and mental health as well as keeping atmosphere rich in oxygen.

For more information about the work of the Woodland Trust, visit https://www.woodlandtrust.org.uk/

UM's Tom Rowe and Dr Nigel Jones

LEVERAGING INHERENT SAFETY TO REDUCE THE RISKS OF BATTERY ENERGY STORAGE SYSTEMS

Cairn Risk Consulting (Cairn Risk) joined the TSA in July 2025 to further increase their cross-organisation collaboration and sharing of good practice. Our article for the Winter Insight magazine provided key insights into the application of process safety good practice for hydrogen projects, particularly the importance and benefit of designing in inherent safety.

This article explores the application of process safety to lithium-ion Battery Energy Storage System (BESS) facilities. It highlights the particular importance of applying inherent safety principles to reduce the residual risk associated with off-the-shelf products from BESS Original Equipment Manufacturers (OEM).

As BESS are being proposed for deployment in the built environment close to large populations of, potentially vulnerable, people, it is critical that designers, developers, communities and local planning authorities are aware of the associated hazards and the means of reducing risk to people and the environment by applying inherent safety principles during conceptual design.

The need for BESS

The intermittent nature of renewable energy sources such as solar and wind, which often do not generate energy concurrently with peak demands on the electricity grid, means that significant energy storage capacity is required to meet net zero targets. Due to their availability, scalability, flexibility in storage duration and fast response time; batteries are the current forerunner in fulfilling that requirement.

The battery technology currently dominating the BESS market, accounting for 90% of installed BESS globally, is lithium-ion (Li-ion).

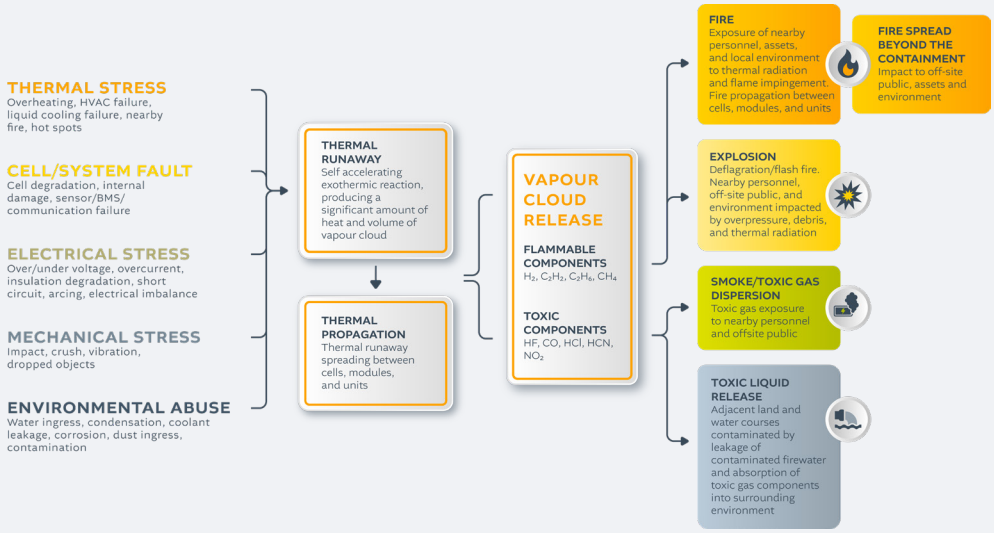
Despite the benefits of Li-ion BESS, they present significant safety concerns. This article focuses on the process hazards posed by BESS. Whilst other hazards are present, including electrical hazards, these are better understood and more difficult to address through inherent safety.

BESS hazards

The hazards associated with Li-ion BESS, summarised in Figure 1, are mainly associated with thermal runaway, a self-sustaining and accelerating exothermic reaction occurring in the battery cells, which can be caused by numerous faults and abuse methods.

The significant heat produced by thermal runaway, in excess of 500 °C, can cause the reaction to propagate across adjacent cells and spread throughout a battery unit, a process called thermal propagation.

Figure 1: Battery Energy Storage System hazards



Off-gases produced during thermal runaway form a flammable and toxic vapour cloud. Whilst the composition varies depending on cell chemistry, state of charge, and other factors, major components typically include hydrogen, methane and other hydrocarbons, hydrogen fluoride and carbon monoxide. The vapour cloud will also entrain droplets of the liquid electrolyte, which contains Volatile Organic Compounds (VOC).

The consequences of thermal runaway have unique characteristics:

- Fires involving battery cells, particularly in utility-scale BESS installations, are extremely difficult to fully extinguish. It is possible to extinguish the flames using media such as inert gases and water but cooling the cells to their core is a challenge, particularly when the cells are tightly packed as they are in BESS.
- Due to insufficient cooling following deployment of fire suppression systems, thermal runaway, which can persist in the absence of oxygen, is likely to continue, and the fire may then reignite later. These characteristics have led to good practice being to oversee a controlled burn if a BESS does ignite, rather than to actively fight the fire.
- Explosions are a prevalent consequence following thermal runaway because BESS containers/ cabinets are confined spaces, tightly packed with battery modules with very limited void space. Whilst standards such as NFPA 855[1] require explosion prevention systems, explosions may still occur throughout the course of a major BESS incident. For example, after deployment of a fire suppressant that extinguishes flames but does not inhibit thermal runaway, or if an incident persists past the survivability limits of the explosion prevention system. Note: Major BESS incidents can occur over several days and may restart days or weeks afterwards.
- Toxic gases have well established tools and techniques for evaluation. However, the full composition of BESS off-gases is often unknown and the effects of all individual components, and their combinations, on people are not fully understood. Some first responders who have inhaled off-gases have spent significant time in intensive care and have not responded as expected to standard treatment.
- Fire water run-off from adjacent equipment cooling may contain entrained off-gases that could cause environmental harm if there is a pathway available from source to receptors. Secondary and tertiary containment for fire water is often inadequately considered or addressed for BESS facilities.

Widespread application of BESS

Due to their flexibility, BESS are being proposed for multiple, diverse applications, including:

- Co-location with renewable energy generation plants;
- Co-location with substations;
- Standalone in commercial settings; and
- Standalone in residential settings.

Therefore, despite BESS' major hazard potential, they can be located within the built environment near vulnerable receptors.

Additionally, many organisations developing BESS projects are familiar with hazards associated with electrical infrastructure but are not as knowledgeable about BESS' process hazards (fire, explosion, toxic gases).

In the UK, HSE, EA /NRW /SEPA and Fire and Rescue Services are not statutory consultees for BESS development planning applications. Therefore, it is highly likely that insufficient process safety knowledge and expertise will be applied during the planning and consenting process. BESS do not fall within Hazardous Substances Consent, COMAH or environmental permitting (EPR /EASR) regulatory frameworks.

The current regulatory environment means that there is a high risk of BESS developments being built and operated without sufficient consideration of the associated safety risks. BESS residual risk can be significantly reduced by designing in inherent safety in the early stages of development.

BESS Project Inherent Safety

The key inherent safety considerations for BESS projects can be summarised as:

- Minimise hazard potential by reducing capacity, either overall battery capacity, or the capacity of individual units /cabinets that are proven through destructive testing to prevent propagation of fire and thermal runaway. Battery model and manufacturer should be selected based on compliance with latest safety standards (e.g.

IEC 62619[2], IEC 62933-5-2[3]) and provision of large scale fire testing reports following methodologies such as UL 9540A[4] or CSA TS-800:24[5] to provide a full understanding of the inherited risks.

- Separate people and environment from the hazards:
  - On and off-site;
  - Occupied buildings;
  - Off-site receptors, taking into account their sensitivity to harm.
- Consider prevailing wind direction, ensuring sensitive receptors and occupied buildings are located upwind, so far as is reasonably practicable.
- Maintain safe distance between adjacent BESS enclosures.
- Separate assets and flammable exposures from BESS enclosures.
- Consider build-up of unignited off-gas released during major thermal runaway event, minimising confinement and congestion which would encourage explosions.
- Orientate any exhaust outlets and deflagration panels away from exposures, notably public ways, emergency access /egress routes and occupied buildings.
- Provide adequate emergency access and egress routes, considering the foreseeable range of wind directions.
- Consider contaminated water run-off, ensuring any water run-off generated during a thermal incident can be adequately contained to protect the surrounding environment.

Applying the above inherent safety considerations during conceptual design significantly reduces BESS project risks and costs by:

1. Reducing the residual risk gap that requires passive (e.g. air-tight buildings) and active (e.g. external gas detection and building ventilation shutdown) engineering measures to demonstrate risk has been reduced to As Low As Reasonably Practicable (ALARP).
2. Reducing the reliance on robust emergency response preparedness to reduce residual risk to ALARP, which may require evacuation of nearby populations within a target emergency response time.
3. Reducing the requirement for significant volumes of firewater as a means of preventing fire propagation, which is costly, has significant spatial requirements and requires additional inspection and maintenance.
4. Reducing the need for expensive design rework if the need to revise the site and plant layout is identified later than conceptual design.
5. Increasing the likelihood of positive and successful engagement with local planning authorities, Fire and Rescue Services, regulators and local communities.

Learning from experience

Having supported over fifteen BESS projects over the past four years, Cairn Risk has gained extensive practical experience of the benefits available from the application of inherent safety as early as possible in the design process.

Figure 2 illustrates the important considerations required at Hazard Study 1 during the conceptual design phase, including determination of the hazard potential and assessing site location and layout. Such considerations are essential in embedding inherent safety in the conceptual design.

Taking the hazard of toxic off-gas dispersion as an example through Hazard Studies 1 to 3:

- In Hazard Study 1, toxic gas dispersion would be identified as a major hazard. The proximity of the site location, and proposed BESS layout within the site, would be assessed relative to identified nearby receptors. The conceptual site location and layout should maximise the distance between BESS and sensitive receptors, locate the BESS downwind of receptors where possible, and ensure the conceptual design meets Relevant Good Practice (RGP).
- In Hazard Study 2, consequence modelling and assessment would be conducted to determine the hazardous extent of toxic gas dispersion by evaluating the concentrations of components of interest against human harm criteria. Sensitive receptors should be located outside of the toxic hazardous extent relative to potential serious harm or fatality for normal and vulnerable populations assessed on a hazard basis, i.e., before accounting for likelihood of occurrence and any Risk Reduction Measures (RRM).
- In Hazard Study 3, if it is required to demonstrate through semi-quantitative analysis that the risk to nearby receptors from toxic off-gas impact is ALARP, a more detailed assessment would be conducted considering initiating

faults and RRMs in place to prevent thermal runaway /fire and mitigate the consequences. This may be done using BowTie analysis, Failure Modes and Effects Analysis (FMEA), or other. However, if Hazard Study 1 and Hazard Study 2 are sufficient in demonstrating that the risk has been reduced to ALARP, such a detailed assessment may not be necessary, providing time and cost savings.

Case Study Example

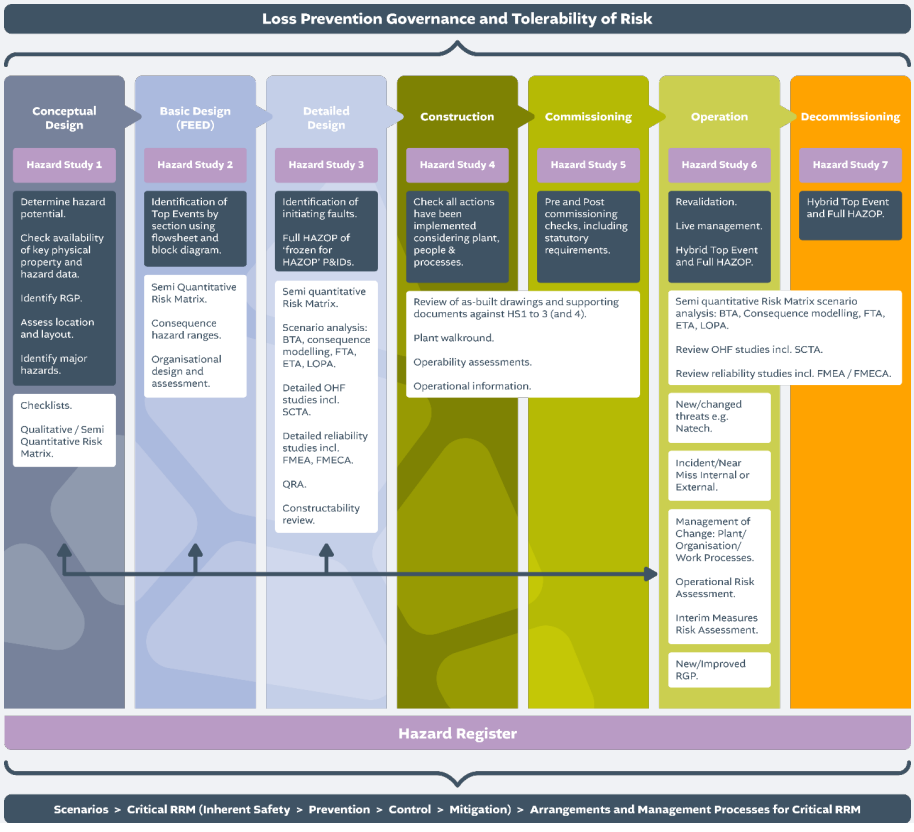
During 2025 and 2026, Cairn Risk provided Process Safety Management (PSM) support during the detailed design phase of a circa 1 MWh BESS in a commercial setting. Many design parameters were fixed by the time Cairn Risk's support to the project began but, working with our client, Cairn Risk's findings and advice facilitated the following:

- Substitution of a brick wall for a louvred fence round the BESS compound boundary, which enables greater dispersion of off-gases and combustion products and reduces the risk of explosions.
- Selection of alternative battery technology which complies with the latest internationally recognised standards in BESS safety.
- Micro-siting of the BESS to maximise the distance from occupied buildings.
- Orientation of battery exhaust outlets to direct off-gases and combustion products away from occupied buildings, in line with the prevailing wind direction.
- Development of a robust emergency response plan, which identifies target evacuation times for adjacent buildings and guidance on determining the suitability of using buildings further away to shelter in place.

The above design changes and administrative controls were instrumental in demonstrating that the risk of the BESS have been reduced to ALARP.

Note: The above design aspects could have been incorporated at conceptual design if a Hazard Study 1 had been conducted. Additionally, a Hazard Study 1 could have identified a more suitable location for the BESS which would reduce the reliance on robust emergency response preparedness to demonstrate ALARP.

Figure 2: Lifecycle and multi-stage hazard studies



BTA	Bow Tie Analysis
ETA	Event Tree Analysis
FEED	Front End Engineering Design
FMEA	Failure Mode and Effects Analysis
FMECA	Failure Mode and Effects Criticality Analysis
FTA	Fault Tree Analysis
HAZOP	Hazard and Operability Study
LOPA	Layers of Protection Analysis
OHF	Organisational and Human Factors
P&ID	Piping and Instrumentation Diagram
Natech	Technological incidents caused by natural events e.g. flooding, wildfires
QRA	Quantitative Risk Assessment
RGP	Relevant Good Practice
RRM	Risk Reduction Measure(s)
SCTA	Safety Critical Task Analysis

Key Messages

Our key messages for process safety good practice application for BESS facilities are:

1. Inherent safety principles can and should be applied during conceptual design.
2. The earlier the location and layout are evaluated, the greater the opportunity to reduce project risks (process safety, wider HSSE, budget, timescale, feasibility) and costs.
3. Site location, layout, and overall design must account for the uncertainty in risks being inherited from off-the-shelf products, even if they comply with latest codes and standards.
4. Minimising hazard potential reduces the need for additional risk reduction measures to reduce residual risk.
5. Minimising hazard potential combined with early regulator and wider stakeholder engagement will ease planning and permitting, including community engagement.

References

[1] NFPA 855, Standard for the Installation of Stationary Energy Storage Systems, 2026

[2] IEC 62619:2022, Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications

[3] IEC 62933-5-2:2025, Electrical energy storage (EES) systems - Part 5-2: Safety requirements for grid-integrated EES systems - Electrochemical-based systems

[4] UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, 6th Edition, 2026

[5] CSA TS-800:24, Large-scale fire test (LSFT) procedure, 2024

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