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Complete Emergency Medical Response Services

Adapting Industrial Construction HSE Systems Hydrogen & Renewable Energy Projects

INTEGRATING HECA & BOW-TIE METHODS FOR SAFER PROJECT DELIVERY

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Who we are..

MEM HS, ESG & Emergency Services. is a dynamic company based in Vancouver & Seattle, that provides Workplace Health & Safety consulting and training services.

- **MEM HS, ESG & Emergency Services.** (MEM) and its group of companies are mining, oil/gas, Industrial and construction health safety, ESG and emergency services support specialists.
- MEM provides and specializes in project support, compliance oversite, contractor management execution and corporate governance globally.
- In the last 35 years I have worked with over 75 mining, oil/gas, EPCM's and major industrial clients globally.

"From Policy to Practice: Adapting Industrial Construction HSE Systems Hydrogen & Renewable Energy Projects"

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Rocco Meraglia, B.Ad., Dip OHS, CRSP

- Over 30 years experience in safety team building and workshops in courageous self leadership, Normalization of Deviance, Incident Root Cause Analysis and project management improvements.
- I have worked on some of the largest projects in the world. Including Ground Zero as the Hazardous Waste Removal Coordinator, Katrina Relief efforts, Mega Mining Construction Projects (Ekati Diamond Mine, Diavik Diamond Mine, Snap Lake Diamond Mine, Panama's Mina de Cobre, Ambatovy Nickel-Madagascar, Baro Alto Project), and Numerous Oil/Gas, Offshore, Renewable Energy and Power projects.
- Rocco has presented at international conferences on the topics of Root Cause Analysis, Safety Culture, Leadership, Teamwork, Wellness Programs, Hazard Recognition and Emergency Preparedness.

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Safety Share

- The *Hindenburg* disaster, which occurred on May 6, 1937, was caused by the ignition of the airship's flammable hydrogen gas.

- The most widely accepted theory is that an electrostatic spark ignited hydrogen that was leaking from the airship's rear.

Multiple Causality

The precise cause of the initial spark is debated, several key factors contributed to the disaster:

RCA Case Study as most incidents this disaster was preventable (absent & failed defense systems and organizational contributing factors):

- **Use of hydrogen:** The Hindenburg was designed to use non-flammable helium gas, but U.S. export restrictions against Nazi Germany forced its German operators to use highly flammable hydrogen instead.
- **Electrostatic discharge:** As the airship passed through a storm front, a static electrical charge likely built up on its outer surface. The craft had an insufficient design for dissipating this charge.
- **Hydrogen leak:** Investigators believe a leak developed in one of the hydrogen cells, possibly caused by a broken bracing wire that snapped during a sharp turn in the landing maneuver. This created a combustible mixture of hydrogen and air.
- **Grounding:** During the final moments of landing, the moist mooring ropes likely grounded the airship's metal frame. This created a spark when the electrical potential between the airship's fabric skin and the frame was equalized.
- **Flammable outer coating (a debated theory):** A less likely but plausible theory suggests that the airship's skin, which was coated in a highly flammable compound, was the primary fuel source for the fire. Critics of this idea, however, have demonstrated that the coating alone could not have fueled the fire's speed.

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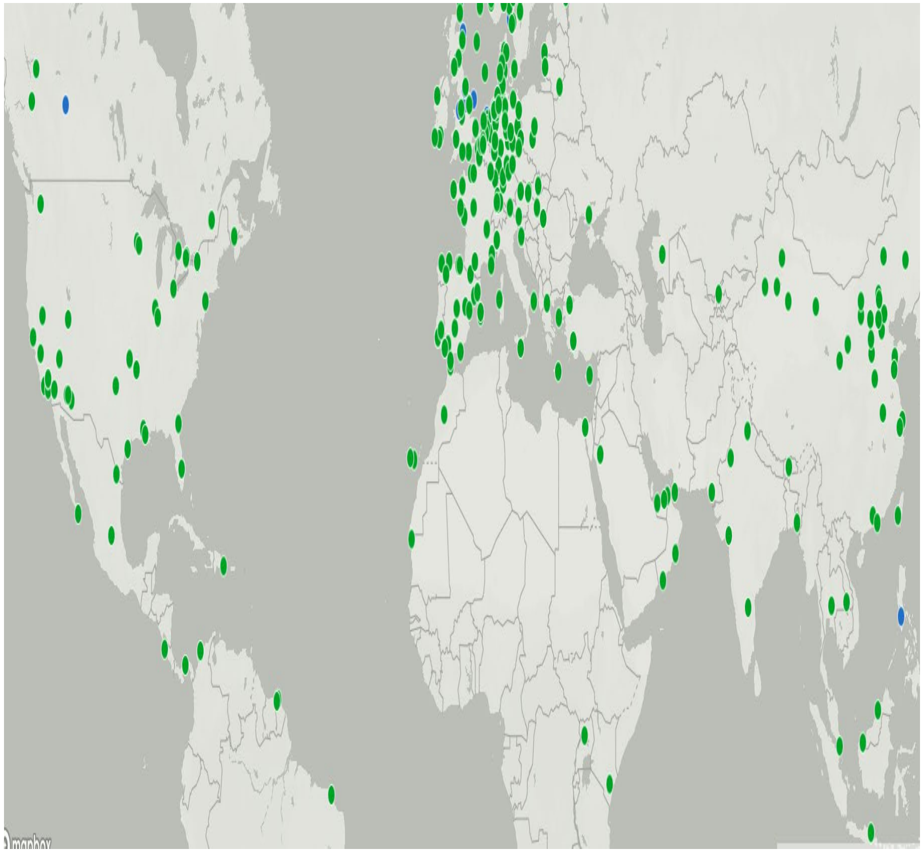
Projects

- Recent large-scale hydrogen construction projects include the NEOM Green Hydrogen Project in Saudi Arabia, which has reached 80% completion and is a joint venture between NEOM, ACWA Power, and Air Products.
- In the US, construction is underway for the Matagorda eFuels Facility in Texas, producing green hydrogen and e-methanol, with expected commercial operations in 2027.
- Europe is also seeing significant activity, with the Lysekil Green Hydrogen Plant in Sweden starting construction in early 2023 and the UK signing contracts for its first ten green hydrogen projects in mid-2025.



Major International Project

- **Hyrasia One (Kazakhstan)**: Backed by Germany's Svevind Energy Group, this project in the Mangystau region is planned to generate up to two million tons of green hydrogen annually using vast wind and solar capacity.
- **HIF USA – Matagorda eFuels Facility (USA)**: This project uses wind energy and electrolysis to produce green hydrogen, which is then synthesized with captured CO_2 to create e-fuels. Environmental permits were granted in April 2023, with a goal of commencing commercial operations in 2027.
- Projects in Europe
- **Lysekil Green Hydrogen Plant (Sweden)**: Construction began in Q1 2023 for this 200MW to 500MW facility in Lysekil, with completion expected in Q4 2024.
- **UK's First 10 Green Hydrogen Projects**: In July 2025, the UK signed contracts for its first ten green hydrogen projects, which are expected to provide a significant boost to jobs and construction.
- **Stuttgart-Münster Hydrogen Power Plant (Germany)**: Construction of this hydrogen power plant started in Q1 2023, with an expected completion in Q1 2026.
- **Morgen & Trafigura's West Wales Project (UK)**: This is one of the projects included in the UK's initial ten contracts, focusing on green hydrogen production.
- Other Developments
- **Morocco Approves Mega Projects**: In March 2025, Morocco approved green hydrogen mega-projects, underscoring the region's growing commitment to green hydrogen initiatives.
- **South Africa's Green Hydrogen Landscape**: South Africa is actively developing its green hydrogen sector, with projects like the Saldanha Green Hydrogen Project and the HySHiFT Renewable Hydrogen Project.
- **HS2 Construction Site (UK)**: The High-Speed rail project (HS2) in London is also utilizing hydrogen fuel cells to power its construction sites, demonstrating the technology's integration into large-scale construction.

WAC 296-24-31505, gaseous and liquefied hydrogen systems

General Hydrogen Safety Principles

- **Flammability:** Hydrogen is highly flammable and forms explosive mixtures with air, requiring a very low oxygen level (less than 1%) in systems and careful control of potential ignition sources.
- **Ventilation:** Adequate ventilation is crucial to prevent the accumulation of hydrogen and to ensure the safe release of gases.
- **Grounding:** All equipment must be grounded to prevent static electricity buildup, which could ignite hydrogen.
- **Training:** Personnel handling hydrogen must be trained on its properties, hazards, safety procedures, and emergency response.

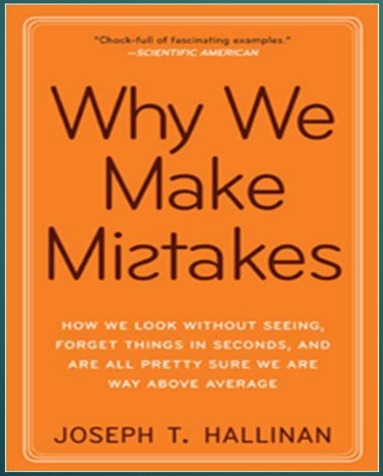
WAC 296-24-31503 (Gaseous Hydrogen Systems):

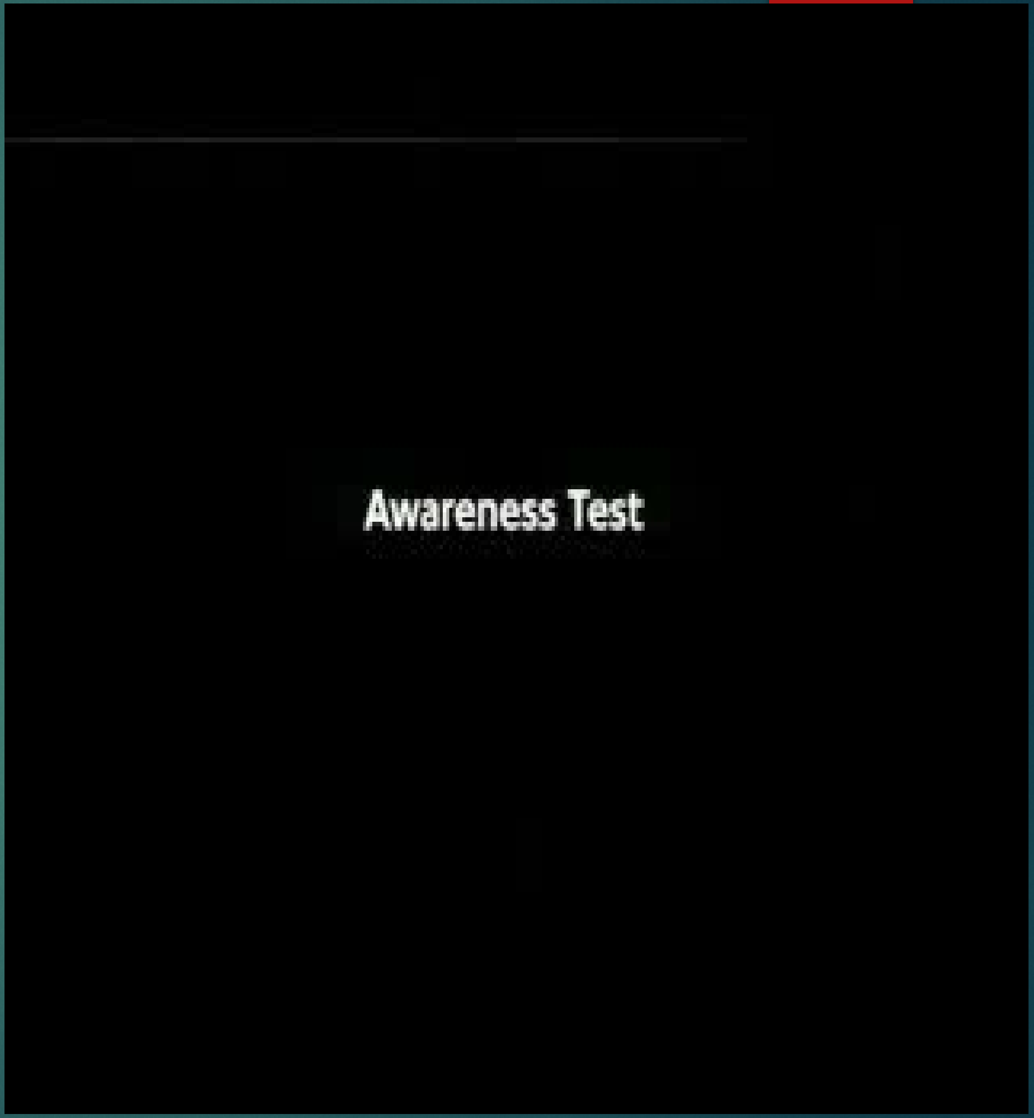
- Requires systems to be designed with adequate ventilation, explosion venting, and elimination of ignition sources.
- Demands that hydrogen containers meet specific codes, such as the ASME Boiler and Pressure Vessel Code, and be supported on firm foundations.
- Requires a 15-foot clearance around containers to be free of dry vegetation and combustible material.
- **WAC 296-24-31505 (Liquefied Hydrogen Systems):** Specifies that storage containers must be accessible, protected from electrical and flammable lines, and vented to the outdoors at a minimum elevation of 25 feet.
- Mandates that a qualified person be present during mobile supply unit unloading.
- Requires securing mobile liquefied hydrogen supply units to prevent movement and maintaining all equipment in safe operating condition.
- Key Safety Practices
- **Purging:** Before introducing hydrogen, systems must be purged with an inert gas like nitrogen to remove oxygen and prevent an explosive atmosphere.
- **Venting:**
- During initial fills, gases like hydrogen, air, or purge gases must be safely and efficiently released through proper venting.
- **Grounding and Bonding:** Secure bonding clamps must be attached to equipment, such as liquid hydrogen trailers, to maintain grounding and prevent static discharge.
- **Maintenance:** Systems must be maintained in safe operating condition according to regulatory requirements.

Human Factors Impact

Average of five (5) errors per hour

1. Most of us are fairly sure of our own ability to get something done.
2. Some of the same qualities that make us efficient also make us error-prone (autonomous skills, pattern recognition)
3. Multi-tasking is a bad idea; in fact can we multitask?





Context & Drivers - Adapting Industrial Construction HSE Systems

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HYDROGEN & RENEWABLE ENERGY PROJECTS GROWING RAPIDLY.

TRADITIONAL CONSTRUCTION HSE MUST ADAPT TO HIGH-ENERGY HAZARDS.

COMPLEX MULTI-DISCIPLINARY TEAMS REQUIRE STRONGER ALIGNMENT.

REGULATORY FRAMEWORKS STILL EMERGING FOR HYDROGEN.

Hydrogen-Specific Hazards

Highly flammable with wide ignition range.

Invisible flames, rapid dispersion in air.

Material embrittlement risks.

Construction risks: Any Hotworks, commissioning, storage/transfer systems.

Adapting HSE Systems

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LEVERAGE PROVEN FRAMEWORKS: POLICY → STANDARDS → PROCEDURES → RISK MANAGEMENT TOOLS (RISK RUNNER, ADAPTIVE BOE TIES)

INTEGRATE HYDROGEN-SPECIFIC HAZARD CONTROLS.

FOCUS ON PTD

ENHANCED PERMIT-TO-WORK SYSTEMS FOR IGNITION SOURCES.

ENHANCED DIGITAL SYSTEM AUTOMATES AND VERIFIES MORE RIGOROUS SAFETY CONTROLS

SPECIALIZED PPE, GAS DETECTION & MODIFIED EMERGENCY RESPONSE.

High-Energy Control (HECA)

Focuses on catastrophic high-energy hazards.

Identifies scenarios like storage rupture, pipeline breach.

Defines critical controls and verification protocols.

Bow-Tie Critical Control Method

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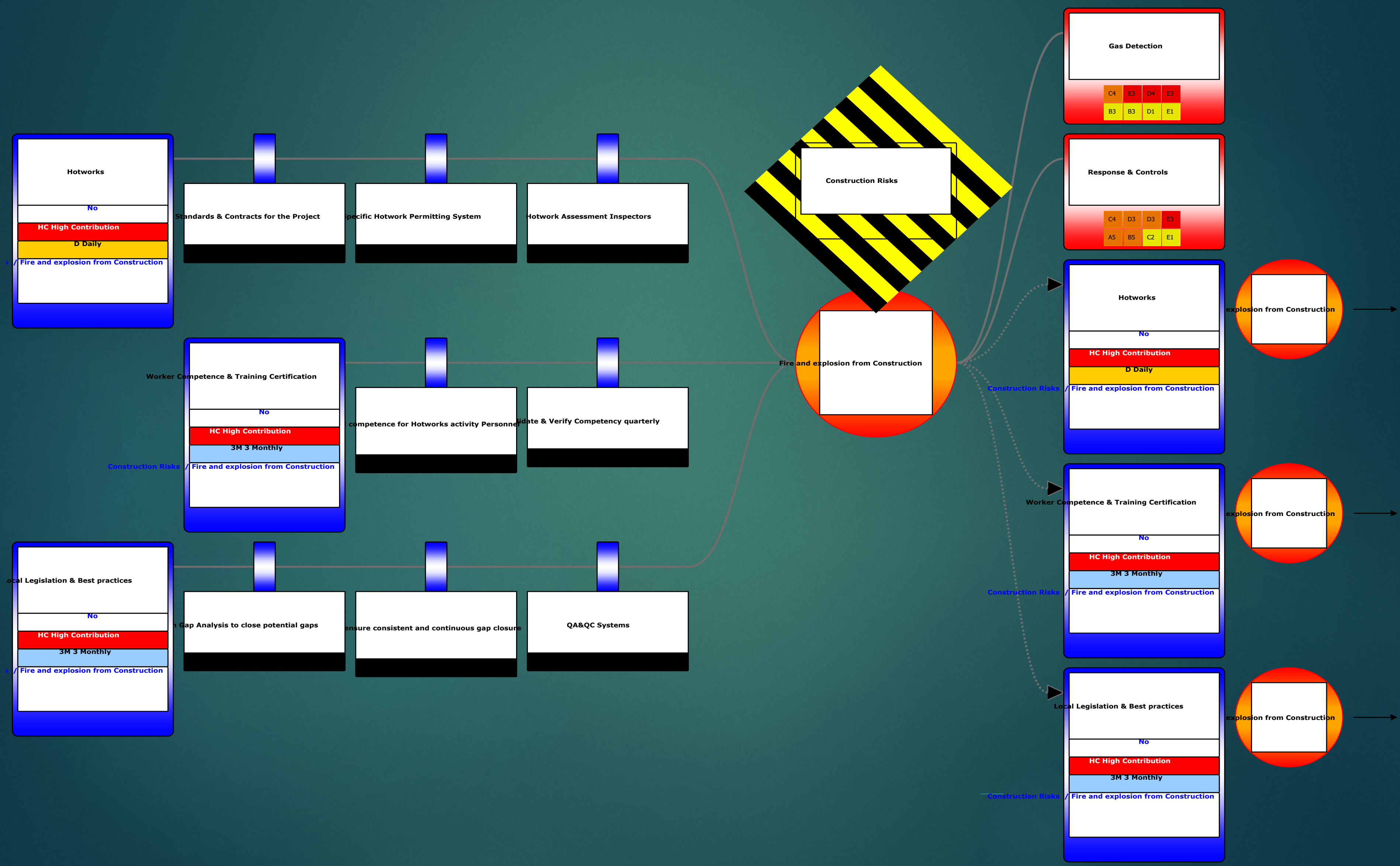
Visualizes hazard pathways from causes → event → consequences.

Maps out controls across both prevention and mitigation.

Example: Hydrogen leak during commissioning.

Bow Tie or Risk Rummer Risk Assessment



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Leadership Engagement

- Visible leadership commitment critical.
- Participate in risk reviews and site engagement.
- Model safety-first behaviors.
- Allocate resources for hydrogen-specific training.

Contractor Selection & Alignment

Multi-disciplinary projects bring varied HSE cultures.

Align contractors to a common HSE framework.

Conduct joint hazard reviews with hydrogen focus.

Shared critical control verification routines.

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Lessons Learned from High-Risk Sectors

Oil & Gas, Mining, Nuclear provide strong lessons.

→

Major hazard control disciplines transferable.

→

Incident learning systems critical.

↓

Behavioral engagement models reduce risk.

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Reducing Incident Potential

HECA + Bow-Tie deliver structured hazard control.

Leadership & contractor alignment strengthen culture.

Cross-sector learnings reduce incident probability.

Case Example

Scenario: High-pressure hydrogen line commissioning.

Controls: HECA, Bow-Tie mapping, leadership-led contractor review.

Outcome: Risks minimized, incident-free start-up.

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Key Takeaways

Hydrogen introduces unique high-energy hazards.

HECA & Bow-Tie strengthen traditional HSE systems.

Leadership and contractor alignment are essential.

Human Factor,

Cross-sector learnings accelerate safe project delivery.

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Q&A

QUESTIONS, INSIGHTS, DISCUSSION.

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