

Intelligent Safety:

How Predictive AI Is Shaping a Safer Oil & Gas Workforce



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Protect. Transform. Sustain.



Executive Summary

The Oil & Gas industry is a leader in safety maturity and has spent decades investing in safety, yet serious injuries and fatalities (SIFs) remain an unacceptable reality. Traditional approaches rely on lagging indicators and reactive responses, leaving teams to manage crises after they emerge. The constraint today is no longer data availability; it is the translation of data into timely, trusted and clear action at the front line.

Artificial Intelligence (AI), when applied with humans in mind, can change this equation. It shifts safety from hindsight to foresight, forecasting risks such as equipment failures, barrier degradations, and precursor events before they escalate into SIFs. The U.S. Department of Energy (DOE), in their [CESER Report on the Potential Benefits and Risks of Artificial Intelligence for Critical Energy Infrastructure](#) underscores this point: AI can help build an energy sector that is "safer, cleaner, more efficient, and more secure," aligning technology adoption with operational resilience. Importantly, AI is not a replacement for human judgment or interaction. It should be a functional, easy-to-use ally that surfaces clearer signals, enabling teams to act decisively within existing workflows that drive operational excellence. [DOE's strategy](#) reinforces this shift with "plans to harness the power of artificial intelligence with a focus on smart adoption, responsible use, and real-world impact that addresses our nation's greatest challenges."



The Growing Imperative for Predictive Safety

Oil & Gas facilities operate in volatile, high-consequence environments where unplanned events can cost lives, assets, and reputations. Reactive risk management, which is typically rooted in historical data and post-incident reviews, leaves organizations vulnerable. Predictive safety analytics shift the conversation from reporting to anticipating. As a [2025 study in World Scientific](#) News cites, "AI and machine learning models...significantly enhance safety in refining operations by predicting and mitigating risks" leveraging anomaly detection, predictive maintenance and real-time risk assessment.

In parallel, [OSHA's Using Leading Indicators to Improve Safety and Health Outcomes](#) emphasizes the pivot from lagging to leading indicators: "Leading indicators are proactive and preventive measures...a good safety and health program uses leading indicators to drive change and lagging indicators to measure effectiveness." OSHA's broader leading-indicators guidance reinforces this as an ongoing management discipline, not a one-time measurement exercise, by positioning leading indicators as a core mechanism for prevention and continuous improvement. This is precisely the discipline predictive analytics operationalizes – surfacing risk precursors early and tying them to clear actions before exposure escalates.

Similarly, the [National Safety Council's Using Data and AI to Gain Insights into Your Safety Program](#) highlights how AI-powered technologies can rapidly convert lagging indicators into actionable intelligence by "providing insights and identifying analytical trends that humans may not recognize," enabling earlier detection of SIF precursors and faster, more targeted intervention.

These advancements matter now more than ever in this volatile, high-risk industry facing workforce pressures, heightened major-accident prevention expectations (e.g., [U.S. EPA's Risk Management Program updates under the Safer Communities by Chemical Accident Prevention final rule](#)) regulatory scrutiny and the push for zero-harm. As Sal Magnone, Co-Founder of Machine61, notes, "The Oil & Gas industry is facing a generational knowledge transfer crisis. Experienced operators are retiring, and the people replacing them don't have 20-30 years of pattern recognition in their heads. AI should be positioned as a knowledge preservation and transfer mechanism, encoding what veterans intuitively know into models that help newer workers make better decisions faster, rather than relearning what long time operators already learned the hard way." AI thus becomes a mechanism for codifying operational knowledge, thereby enabling smarter decisions at the frontline.



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Transforming Risk Management in High-Hazard Operations

Traditional approaches rely on lagging indicators and post-event reviews – even in high-consequence environments – leaving teams reactive to crises. The constraint today is no longer data scarcity; it is reliable translation into timely human interaction. AI, when deployed as an accessible, easy-to-use predictive tool, changes this by surfacing high-fidelity signals that enable human teams to prevent escalation to SIFs.

As Nicholas Lee, Executive Director and CEO of Fujitsu Intelligence, puts it, "Agentic AI co-workers act as persistent digital safety partners, continuously monitoring operations, learning from incidents, and surfacing precursor risks across assets and safety barriers. By providing foresight, they shift safety from reactive response to proactive prevention, giving frontline operators and HSE teams earlier, clearer signals to intervene before incidents escalate." This is the essence of shifting from reactive to proactive prevention.



Organizations with complex, high-risk operations have revealed a set of recurring practices that enable AI to translate prediction into prevention.

1

Reactive risk management is obsolete.

Predictive analytics powered by AI transforms safety and reliability from hindsight to foresight, enabling energy leaders to anticipate threats before they materialize. At dss+, we see this shift as essential in Oil & Gas where serious injuries and fatalities (SIFs) remain an unacceptable risk. World Oil reports operators across the upstream sector accelerating adoption of predictive maintenance platforms to anticipate failures, modernize aging assets, and strengthen operational resilience, signaling a structural shift toward early warning intelligence across the industry.

2

AI-driven insights deliver measurable impact.

By anticipating failures before they occur, predictive analytics cuts downtime, lowers incident rates, and optimizes maintenance. [Shell, for example, achieved a 20% reduction in downtime](#) - saving an estimated \$25 million annually - after adopting predictive maintenance tools in its refinery operations. This is the kind of value that protects lives, assets, and reputation.

3

Operational excellence requires intelligence, not just automation.

[Equinor demonstrates this shift at scale](#): by using AI to generate thousands of development scenarios and uncovering a previously unseen option that saved \$12 million on the Johan Sverdrup Phase 3 project, AI became a decision engine - not another dashboard.

4

AI must be deployed as a meaningful, frontline tool – not a black box.

AI delivers results when predictions are timely, actionable, and embedded in daily workflows. When insights come with clear owners and simple playbooks - reinforced through coaching - frontline teams trust the signals, act decisively, and avoid alert fatigue. [Chevron and Honeywell](#) are showing how to make AI a trusted, frontline tool by integrating AI assisted alarm guidance into the Experion DCS, where operators receive specific, guided actions in real time. This approach turns predictions into consistent operator behavior and reduces the cognitive load that fuels alert fatigue.



Real-World Use Cases Delivering Impact

Industry leaders are already realizing measurable reductions in SIF exposure through targeted AI applications.

- **Predictive Maintenance for Rotating Equipment:** In refineries, AI analyzes sensor data to forecast failures in compressors, pumps, and turbines. To make these models scalable and comparable across sites, many operators align reliability and maintenance data definitions (failure modes, downtime, maintenance actions) to recognized industry taxonomies such as ISO 14224, improving signal quality and trust in the resulting recommendations. One Gulf Coast refinery integrated predictive risk scoring into maintenance workflows, mitigating two incipient bearing failures before trips occurred. Near-miss reports declined in double digits, flaring events decreased, and operators reported higher trust due to fewer, more actionable alerts.

- **Computer Vision for Hazard Detection and Compliance:** AI-powered vision systems monitor for unsafe behaviors, PPE non-compliance, and red-zone intrusions in real time. At PKN Orlen, a major petroleum player, [an AI system delivered a 75% reduction in workplace incidents within 16 weeks, alongside 95% PPE compliance and a 35% drop in unsafe behaviors.](#)

Similar deployments in offshore and refining settings have increased near-miss reporting (revealing hidden risks) while slashing actual events through proactive alerts.

- **Permit-to-Work (PTW) and Barrier Management Integration:** Companies like [Sphera](#), a sustainability and operational risk and software platform provider, is using predictive risk scoring factors live conditions (e.g., barrier health, environmental factors) into PTW approvals and confined-space decisions. This ensures mitigations occur before work begins, reducing exposure to high-energy tasks that could escalate to SIFs.

These examples demonstrate how AI excels when scoped to specific, high-consequence decisions, preventing escalation rather than merely documenting it.

What Sets Successful Transformation Apart

Industry leaders are already realizing measurable reductions in SIF exposure through targeted AI applications. Technology alone falls short without addressing the “last mile,” which requires human adoption and change. Leading organizations pair AI with human-centered change.

- 1 Start with decisions (e.g., “Do we proceed with this permit?”), not tools
- 2 Define clear pathways: triggers and thresholds, owner, clear actions, timeboxes, and escalation points
- 3 Embed coaching, leader standard work, and micro-trainings into the work process
- 4 Govern with KPIs linking alerts to actions to outcomes (e.g., incidents avoided)
- 5 Sustain human capability and knowledge transfer, so that AI strengthens worker capabilities

As James Joseph, Senior Finance Executive, Enterprise SaaS and Energy Technology, observes, “In highly technical industries, AI fails less from hallucinations than from neglect. Subscriptions often persist even as engagement drops and implementations effectively fail in practice. Sustained value requires an explicit operating model: continuous training, active engineering ownership, and behavioral conditioning that keeps the tool embedded in real operations, not merely licensed.” This underscores why human-centered change and governance must accompany any predictive analytics program.

[OSHA's leading-indicator guidance](#) makes the governance point explicit: proactive measures “prevent workplace injuries and illnesses, reduce costs associated with incidents, and improve productivity and overall organizational performance,” especially when built into everyday decision-making. In process safety, this governance is most effective when it is anchored to established indicator frameworks, linking leading indicators (barrier health and precursor conditions) to lagging outcomes and management review cadences. [API RP 754 \(3rd ed., 2021\)](#) provides the downstream benchmark by formalizing a tiered continuum of leading and lagging indicators, enabling operators to diagnose weaknesses and intervene earlier.

For upstream and broader operator applicability, [IOGP's Process Safety Recommended Practice on KPIs \(Report 456, 3rd ed., 2023\)](#) similarly emphasizes consistent definitions and actionable leading indicators, including measures tied to barrier performance. [CCPS guidance on process safety metrics \(2022 update\)](#) complements both by offering practical implementation guidance - how to select, deploy, and continuously improve metrics so alerts reliably translate into interventions, learning, and sustained risk reduction.



What You Can Do This Quarter to Operationalize Prediction

As AI evolves, the future of safety in Oil & Gas belongs to operators who treat prediction as a management system.

To activate prediction-driven prevention, you can take these five steps now to turn foresight into action:

1. **Name five risk-critical decisions** (by unit/shift) where predictive signals would change outcomes.
2. **Assign a single accountable owner** for each decision and agree the pre-committed response playbook.
3. **Measure progress, not just accuracy.** Track alert → action → mitigated risk.
4. **Reduce noise.** Prune or consolidate overlapping alerts; design a simple taxonomy that all levels of the organization understand.
5. **Drive consistent application through coaching.** Practice a repeatable rhythm that equips supervisors and operators to act on predictive insights reliably.

What Good Looks Like In 90-120 Days

Organizations often see the following changes within a single quarter when they launch with a tight scope and clear outcomes.

- **Fewer surprises.** High-risk alerts surface earlier; near miss reports decline where mitigations are applied.
- **Cleaner turnarounds.** Remaining Useful Life (RUL) informs pre work; spares and crews are pre positioned; variance narrows.
- **Safer work windows.** PTW approvals factor live risk signals; barrier impairments are resolved faster.
- **Trust in the signal.** Console operators and field teams report fewer, clearer alerts with explicit actions; adherence rises.

When insights reliably become action, risks will reliably decline. AI will not replace people, rather it will empower them to prevent harm before it occurs, protecting lives and advancing operational excellence.



Where dss+ Connects Prediction to Prevention

At dss+, we help Oil & Gas leaders bridge the gap from AI insights to frontline action. Our approach combines domain expertise in high-hazard operations with proprietary tools like [dss+360](#), which connects predictive intelligence to execution systems (DCS, CMMS, PTW). We focus on the decisions that drive risk by embedding predictions, redesigning workflows and coaching teams for adoption. The outcome will prove measurable drops in downtime, identify SIF precursors, and build resilient performance.

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About dss⁺

dss⁺ is the operational transformation partner for complex and high-hazard industries. Driven by our purpose, we help organisations achieve breakthroughs in safety, performance and sustainability that build business endurance and ensure long-term success. We engage deeply within organisations to empower teams to shift mindsets, shape cultures, and establish the capabilities required at every level. We combine technical expertise and operational experience with a people-centred approach and data-driven insights. Additional information is available at www.consultdss.com.



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