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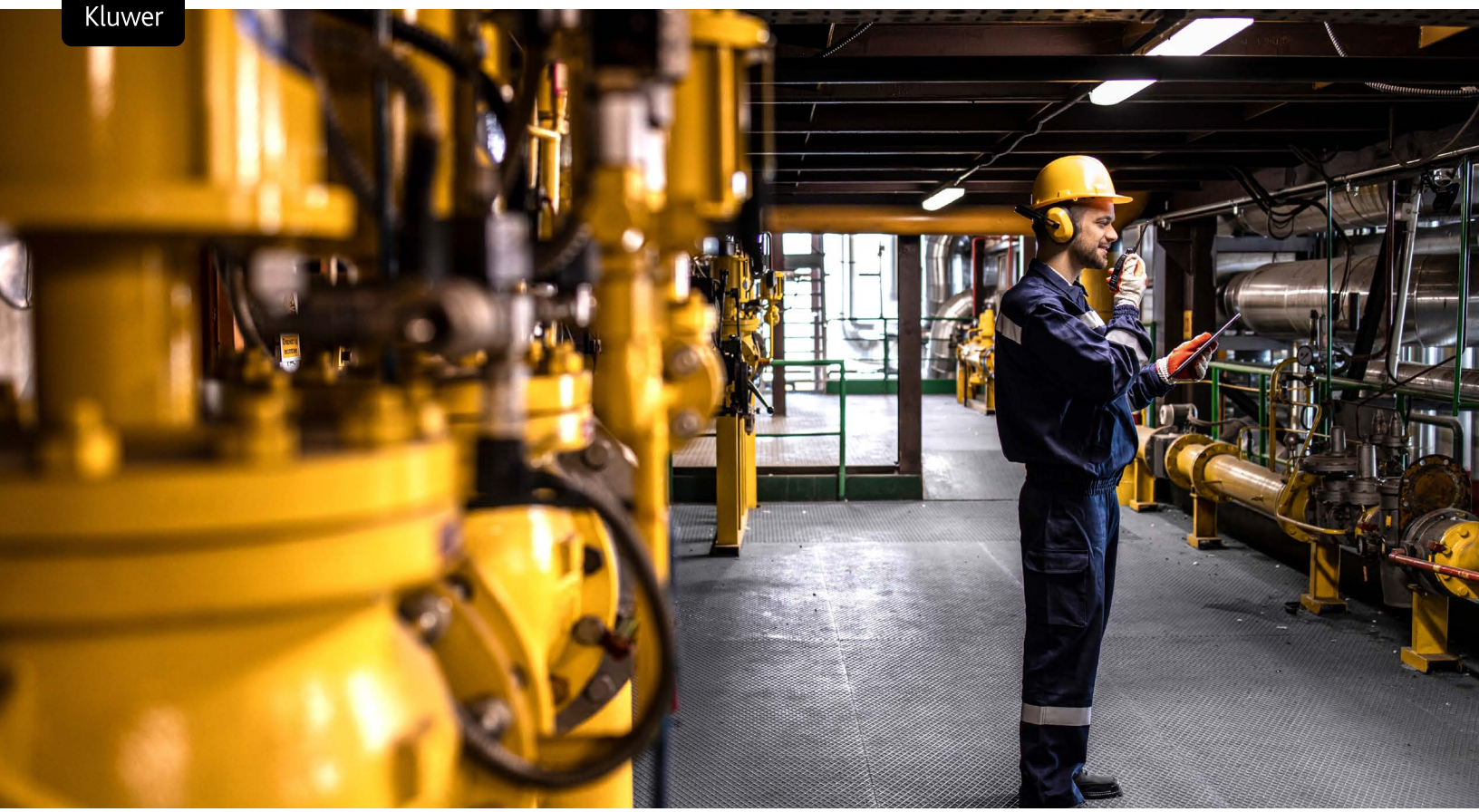


Insight Brief

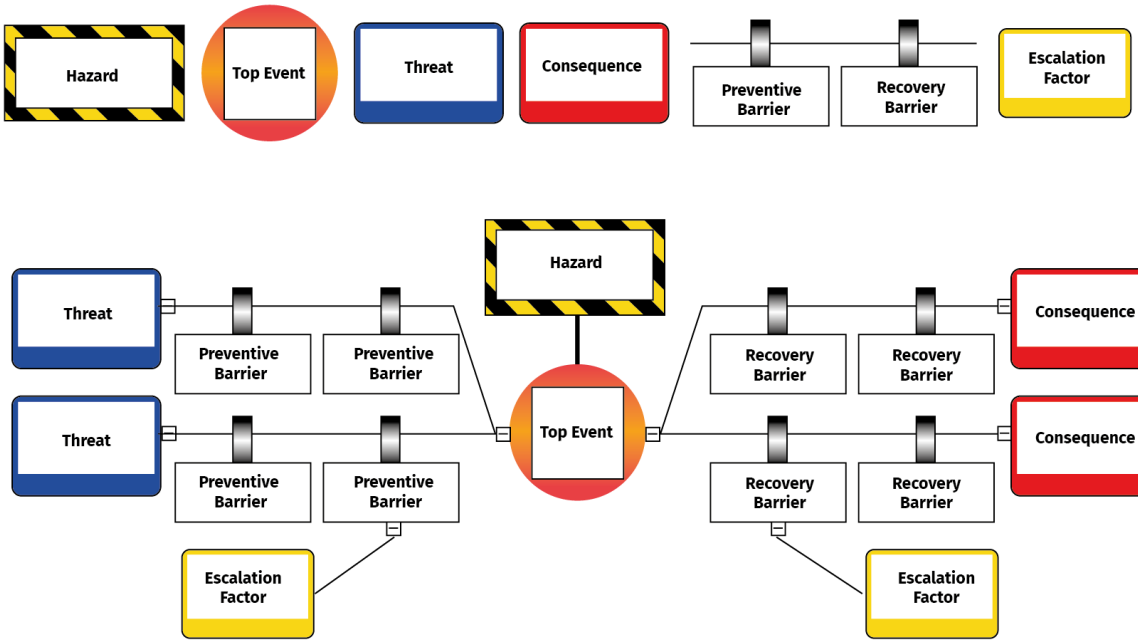
Why bowtie risk assessment diagrams are back at the center of safety

Bowtie analysis helps organizations better understand and manage critical risks, but only when it is applied with clear intent. At Wolters Kluwer Enablon's SPF26 event in Houston, product experts explained how bowtie diagrams provide a single, easy-to-understand visualization that separates preventive and mitigative risk management. They examined detailed identification of safety-critical tasks that make barriers visible, understandable, and owned before weak signals turn into serious events.

Developing bowties as a "risk language"

Bowtie analysis is intended to help organizations meaningfully discuss risk scenarios, hazards, consequences, and barriers. Bowties provide a "pane of glass" view of risk and associated risk mitigating controls which can be effectively and efficiently communicated to executives and the front line. Bowties also serve as a training tool to inform about risk and explain how to maintain controls.

To develop a bowtie, it's necessary to first understand the major operational and working hazards within your organization. Rather than attempting to capture every high-risk or serious scenario, bowties should be used to identify the highest significant outcomes such as occupational safety exposures, fall from height, use of cranes, loss of containment, etc. Information should be collected from current processes like hazard identification and risk assessments then used in your bowties.



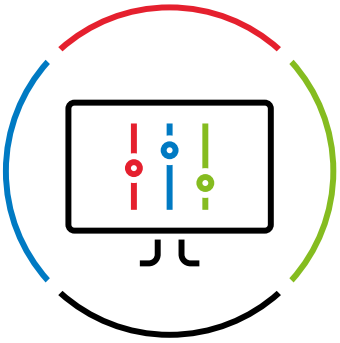
After identifying a hazard to capture in a bowtie, note that the top event is typically where risk control is most likely to be lost. Threats appear on the left side of a bowtie diagram and scenarios developed from other hazard analyses are aggregated. It's best to avoid generic naming of threats and instead explicitly define these to get value in the next step where you identify specific assets or equipment that may be a part of these threats. You then need to identify a class or specific piece of equipment associated with a risk and potential hazard, but identifying every piece of equipment in a particular unit may not be necessary.

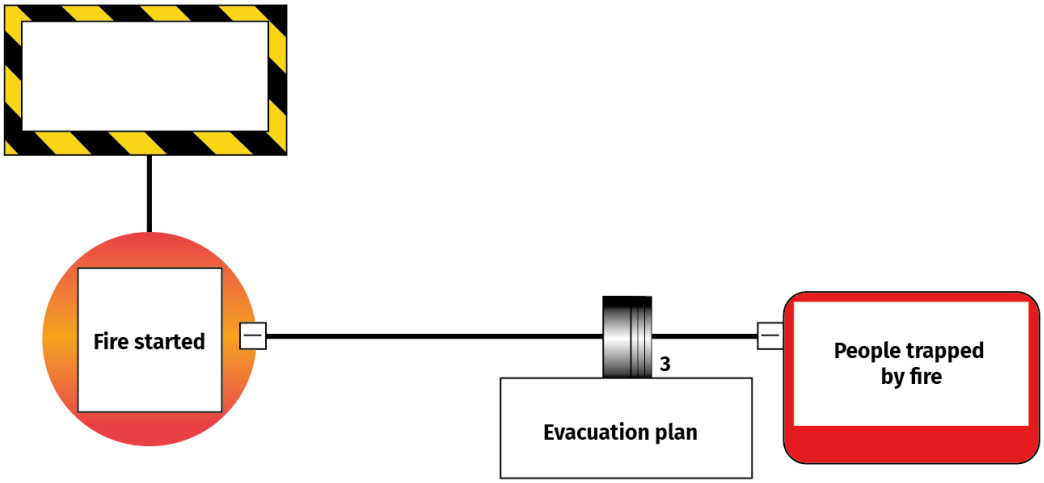
Consequences are what can conceivably occur if the top event happens, and these appear on the right side of the bowtie diagram.

Again, avoid being too generic when describing consequences as they should reflect an actual and specific impact.

Preventive and mitigative barriers

Barriers appear on both sides of a bowtie diagram and are shown as boxes on the lines leading to each threat or consequence. Preventive barriers intended to avoid a threat becoming an event appear on the left (threats) side. Mitigative barriers appear on the right (consequences) side. Most organizations spend time on preventive barriers to ensure there is a high degree of independence rather than relying too heavily on multiple administrative controls.



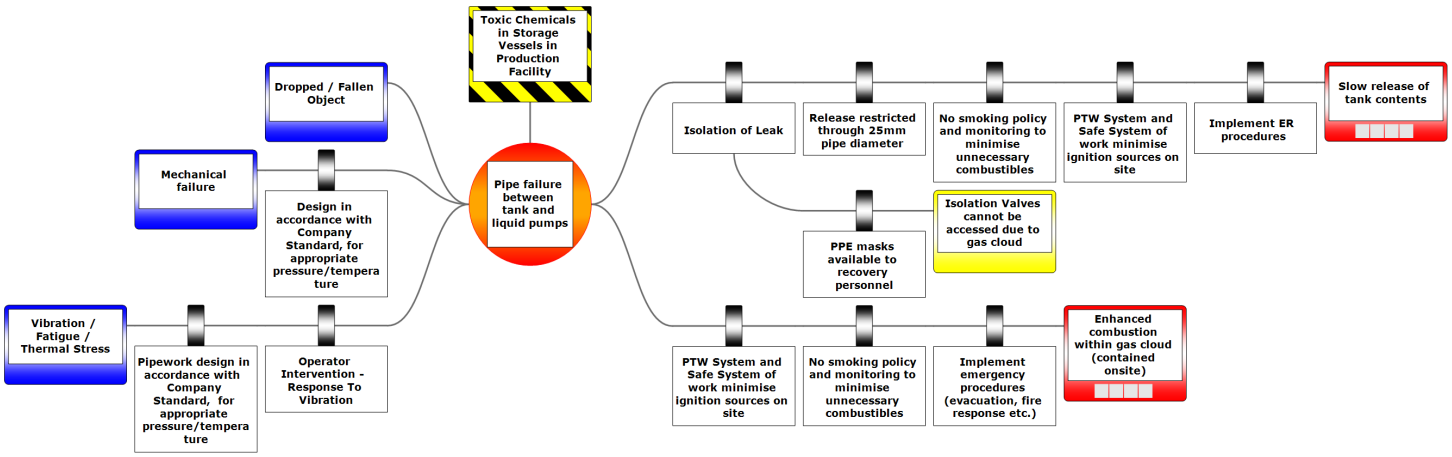


It's important to list barriers on the mitigation side, but these are often not as effective as preventive barriers. One of the challenges with bowties is knowing how well a barrier functions. The highest degree of barrier-resilience understanding happens on the day you develop a bowtie. To keep that knowledge evergreen, however, it's necessary to connect audit data, reliability data, and training information to understand if the barrier will continue to work. Traditionally this has been a challenge as most barriers weaken over time. Ideally, each should be independent and rely on different control systems and people.

Escalations, or barrier defeaters

Escalations are also called "defeating factors" because they impede a barrier from working. Human error can be an escalation, as well as the failure of maintenance activities and other mechanisms that impact mechanical equipment. When building a bowtie, only use escalations that show where barriers can fail.

Avoid identifying "human error" as an escalation since it doesn't explicitly explain how a barrier failed or was defeated. For example, say there is a shutdown system that acts as a barrier to prevent a tank fire if pump valves are not reset after maintenance. Instead of simply listing "human error" as an escalation that can defeat the shutdown system, be specific and list "failure to reset pump valves after maintenance" as the escalation factor.



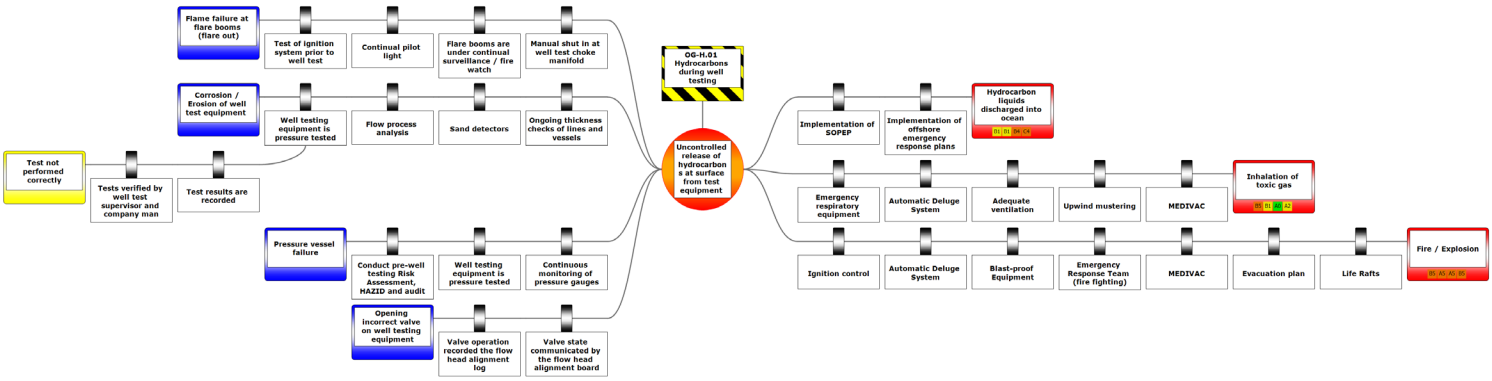
Bowtie example: Chemicals

Consider a production facility storing toxic chemicals in tank vessels feeding a liquid pump system. The top event, where control is lost, is a pipe failure between the tank and the pumps.

Three threats could lead to the top event: mechanical failure, a design mismatch with operating pressure or temperature, and vibration or fatigue on the pipework. Each has its own preventive barriers, engineering standards, operator response protocols, and inspection routines.

If the pipe fails despite preventive barriers in place, two consequences follow: a slow release of tank contents, and possible combustion within the resulting gas cloud. Mitigative barriers include isolating the leak, restricting release rate, controlling ignition sources, and executing emergency response procedures.

This example also shows why specificity matters when creating escalation factors. One barrier, isolating the leak, depends on reaching the isolation valves. If a gas cloud has already formed, responders may not be able to reach them safely. "Isolation valves cannot be accessed due to gas cloud" exactly specifies how the barrier fails and points to a fix, such as remote-operated valves. Identifying a factor as "human error" tells you nothing actionable.



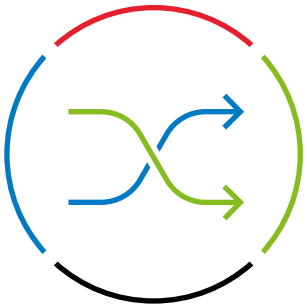
Bowtie example: Oil & Gas

Consider an offshore well-testing operation. The top event is an uncontrolled release of hydrocarbons from test equipment.

Several threats could lead to the top event: flame failure at the flare booms, corrosion or erosion of well-testing equipment, tests not performed correctly, pressure vessel failure, and the wrong valve being opened on test equipment. Each threat carries layered preventive barriers, from continual pilot lights and sand detectors to pressure testing, HAZID audits, and logged valve-state communication.

If the release occurs despite preventive barriers in place, three consequences follow: hydrocarbon liquid discharge into the ocean, inhalation of toxic gas, and fire or explosion. Mitigative barriers range from spill response plans and automatic deluge systems to upwind mustering, MEDIVAC readiness, and evacuation plans.

This example shows how bowties scale with complexity. Where a single-pipe failure scenario might need a handful of barriers, a multi-hazard operation like well testing calls for barriers layered across mechanical integrity, human procedure, and emergency response, each independently capable of stopping the chain before it reaches a catastrophic outcome.



The benefits of bowtie diagrams

Beyond mapping individual scenarios, bowtie diagrams deliver additional value that includes:

A shared risk language across the business. Traditional risk assessments and HAZOP reports are thorough but often too complex for operators and decision-makers to consistently interpret. Bowties translate that complexity into a single, structured picture that both frontline teams and management can read the same way. Visualizations can be tailored by audience: frontline operators see detailed technical information, such as the tech number of a specific pressure safety valve, while management gains a high-level view focused on key decisions and actions.

Visibility into risk that would otherwise stay buried. Consolidating scenario data into a bowtie form surfaces patterns that are easy to miss when hazard assessments live in separate documents. Organizations gain a clear view of which scenarios need management attention, ongoing updates on scenarios pending mitigation, and earlier warning when a barrier loses effectiveness, before it fails outright.

Faster, more confident decisions. Bowties organize information and accelerate the ability to act on it. Where multiple disconnected assessment methods once made it difficult to see the full risk picture, a single structured framework shortens the path from identifying a risk to deciding what to do about it.

A bridge from prevention to investigation. Because a bowtie maps a scenario's full anatomy, threats, barriers, consequences, and escalation factors, that structure becomes the foundation for investigating what happened if and when an incident occurs. Proactive risk assessment and reactive investigation work from the same map instead of starting from scratch.

To learn how to obtain these benefits of bowtie diagrams and start fully visualizing risk:

Request a Demo →

About BowTieXP and IncidentXP

BowTieXP and IncidentXP, part of Wolters Kluwer Enablon, are barrier-based risk management and incident investigation software. BowTieXP visualizes how organizations manage risk through clear, structured bowtie diagrams. IncidentXP builds directly on those same bowties to analyze real occurrences, connecting proactive risk assessment and reactive investigation in one system.