

9th Chemical Process Safety Sharing (CPSS)

The Use of Bow Ties in Process Safety Auditing

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Company: ERM





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2 BowTie Concepts

3 Advantages of BowTie in PSM

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5 ERM Experience



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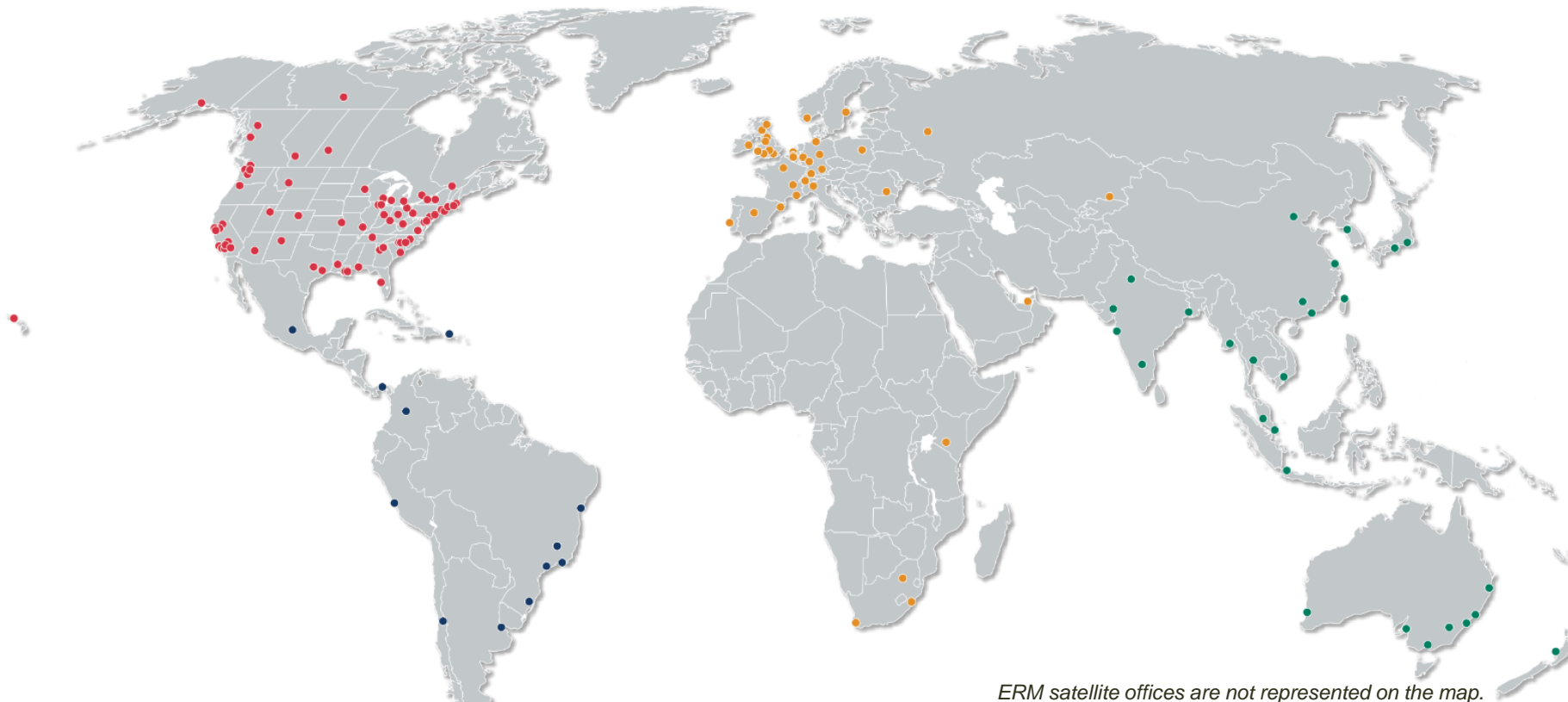




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 13 offices in 9 countries
 530+ professionals

EUROPE, MIDDLE EAST & AFRICA (EMEA)
 37 offices in 20 countries
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ASIA PACIFIC
 32 offices in 14 countries
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Corporate Sustainability and Climate Change

Partnering with leading organizations to address complex sustainability challenges, from climate change risk to human rights, by clarifying strategic direction, designing corporate programs, and enhancing transparency and the robustness of public disclosures.

Operational Performance

Helping global organizations mitigate risk, grow revenues, and manage costs by optimizing and transforming EHS functions to connect deeply to operations, integrating data-driven approaches, and delivering managed services.

Safety Services

Encouraging clients to move beyond traditional compliance and corrective programs so that they can maximize the return on their investments in safety - to safeguard lives, protect assets and strengthen reputation.

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Helping clients mitigate environmental, social and governance (ESG) and sustainability risks to maximize and protect value throughout their investment lifecycle by delivering insight-driven, commercially-focused due diligence.

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Capital Project Delivery

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Liability Portfolio Management and Remediation

Managing risks through strategic approaches, digital applications and best-fit technical methods that identify, assess and manage environmental liabilities. Actively engage with clients to understand and respond to their specific and evolving needs and obligations through an end-to-end integration of site investigation, remediation, decommissioning and retirement.

Product Stewardship

Helping clients bring products to market safely, sustainably, and in compliance with global regulations, in a way that also meets their business goals and satisfies key stakeholders.



We work across a range of sectors, focusing on the industries where we have seen the greatest sustainability challenges.

Oil & Gas	Chemical	Manufacturing	Power	Mining/Metals	TMT	Other
<ul style="list-style-type: none"> ■ New market entry ■ Exploration and production ■ Capital project support ■ Sustainable operational excellence ■ Asset retirement 	<ul style="list-style-type: none"> ■ Product stewardship ■ Maintenance of cost control ■ Delays due to non-technical risk ■ Safety program performance 	<ul style="list-style-type: none"> ■ Product Sustainability ■ Merger, acquisition and divestitures ■ Compliance assurance ■ Remediation portfolio management of retiring assets 	<ul style="list-style-type: none"> ■ Site Selection ■ Impact assessments ■ Licensing and permitting ■ Compliance assurance ■ Safety ■ Asset retirement obligations 	<ul style="list-style-type: none"> ■ New market entry ■ Capital project support ■ Sustainable operational excellence ■ Closure of commodity mineral and metals refining 	<ul style="list-style-type: none"> ■ Merger, acquisition and divestitures ■ Development of management systems ■ Improvement of operational performance of supply chain ■ Data management and cyber security 	<p>Includes:</p> <ul style="list-style-type: none"> ■ Pharmaceutical ■ Financial Services ■ Government ■ Legal ■ Transportation ■ Real Estate



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§ 1910.119 Process safety management of highly hazardous chemicals.

Purpose. This section contains requirements for preventing or minimizing the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals. These releases may result in toxic, fire or explosion hazards.

Commitment

Understand hazards

Manage risk

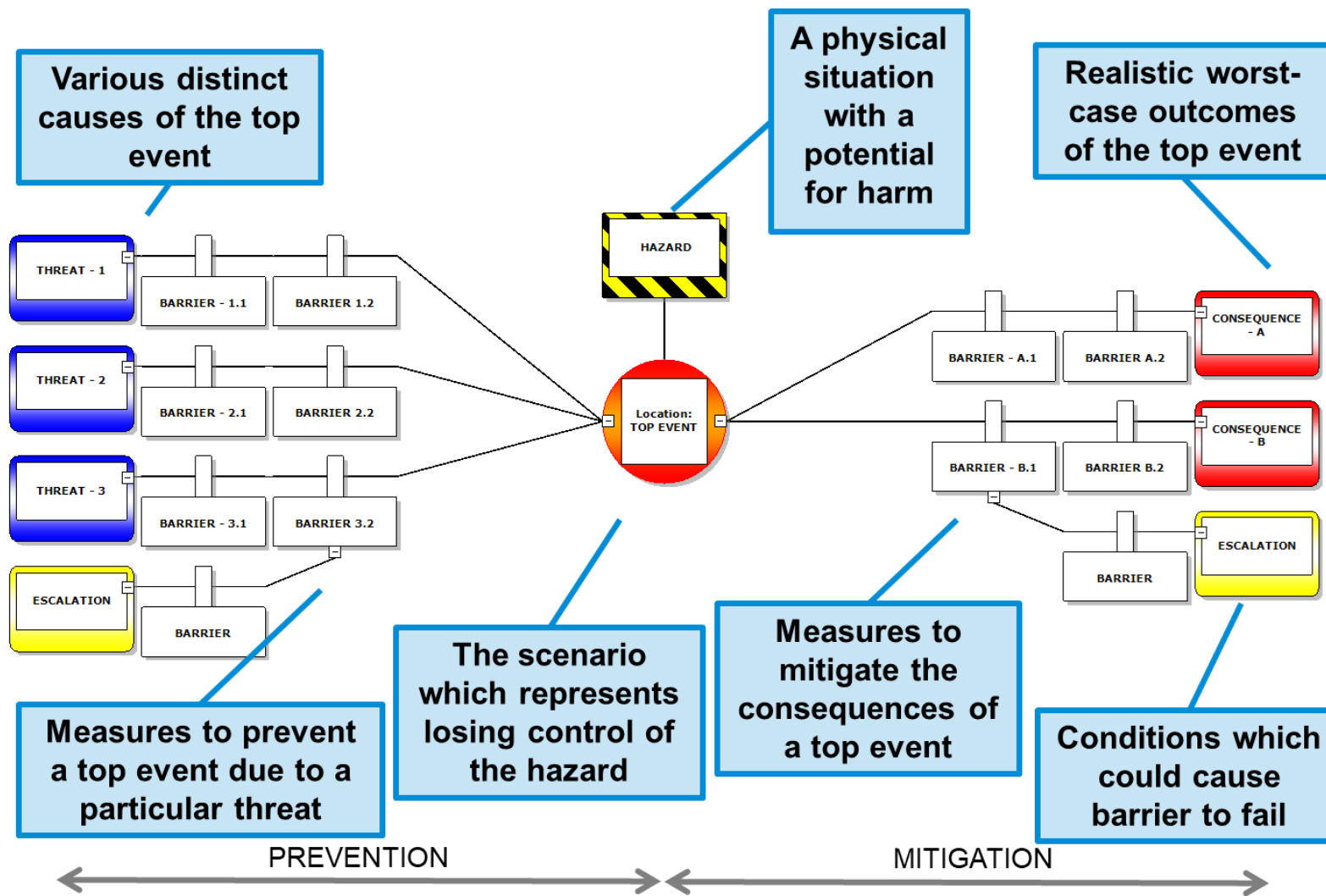
Learn from experience

Article 5

General obligations of the operator

1. Member States shall ensure that the operator is obliged to take all necessary measures to prevent major accidents and to limit their consequences for human health and the environment.

What is a BowTie?





ERM BowTie Golden Rules



Rule 1	Know what you want to achieve
Rule 2	No numbers
Rule 3	The top event is when you lose control of the hazard
Rule 4	Threats are causes of the top event
Rule 5	Consequences are discrete credible worst-case outcomes of the top event
Rule 6	A barrier must have an effect and must be tangible
Rule 7	Only show escalations where this adds value
Rule 8	Human error is not a generic threat
Rule 9	Involve stakeholders
Rule 10	Break any of these rules sooner than do anything outright barbarous





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Advantages of Bowties in Process Safety Mgmt.



- **Effective communication:** The simple representation of the safety processes makes them ideal to use in Safety Cases and Reports.
- **ALARP reviews:** They are an effective and visual way of representing the risk management process and provide a strong starting point for ALARP reviews.
- **Identification of Safety Critical Elements:** Bowties offer a systematic way to identify safety critical elements (SCEs) and activities and then to use this information to develop the SCEs and associated performance standards
- **Workforce engagement:** Bowties are powerful in engaging the workforce. The development and refining of bowties should include the workforce who then take ownership of the bowties. Bowties are a great basis for training and explaining the importance of safety critical equipment/activities
- **Communication with management:** Bowties provide a framework for process safety conversations with senior management whose main focus is an overview rather than detailed analysis of processes. They may also be used as part of the safety induction process for new managers.



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Process Safety Auditing



- A tool to identify weaknesses and gaps in process safety management systems and potentially latent failures in the basis of safety
- give assurance to stakeholders that risks are being managed effectively
- Process safety auditing needs to be systematic and independent.
- Auditing should be performed against a particular set of standards or requirements.
- The output of an audit should include a plan to address deficiencies and a follow-up assurance review



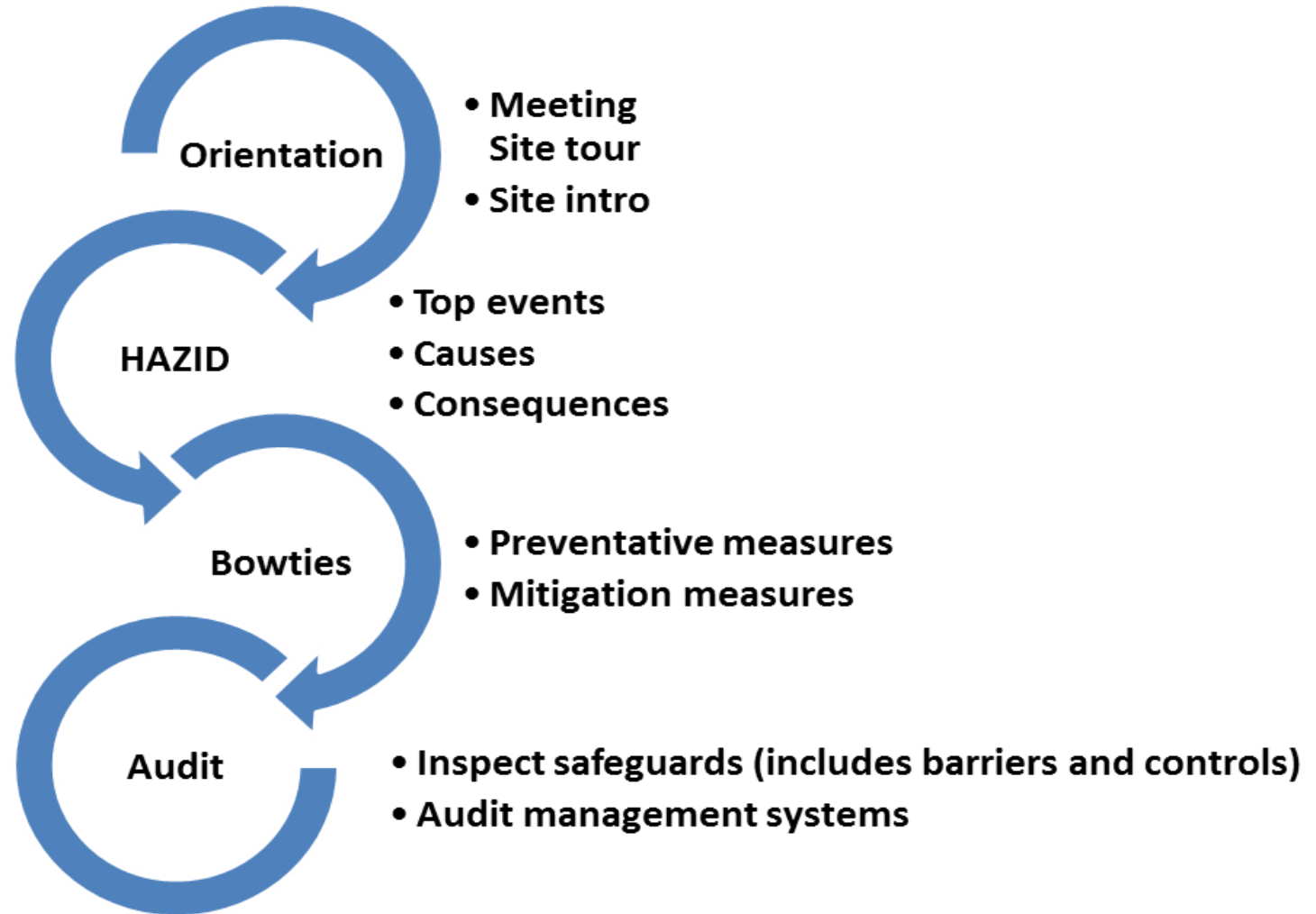
Audit Preparation



- Development of pre-populated bowties for several credible top events based on basic process and procedural information supplied by the client
- During the audit preparation phase, these pre-populated bowties are used to begin to plan the audit activities and to consider potential threats and consequences. Early in the site phase these bowties are further refined and elaborated during a bowtie workshop involving relevant site stakeholders drawn from process technology, process engineering, operations, maintenance and safety, health & environment (SHE).
- The final bowties developed during this session, capture the relationships between a set of credible top events, threats and consequences, and the barriers claimed to be in place on that site, and serve as a blueprint to further guide the evidence gathering and interrogation phase of the audit, as described in *Table 2* below. Specifically these activities are tailored to confirm the presence and assess the robustness of the claimed barriers, and in this context it is noted that the approach works well with the assessment of both hard engineered barriers and softer human factors / procedural barriers.



Generic Audit Program



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Advantages of Using Bowtie for PSM Audit



- **Structured audit but less restrictive**
- **More like a journey with the site staff than a traditional audit against a specific checklist of criteria**
- **Training while auditing**
- **Greater scrutiny on barriers**
- **Helps auditee to understand the relevance of the questions during audit**
- **Overall, increase the value of the audit such that it becomes much more than simply a ‘compliance’ exercise.**



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ERM Experience



- ERM worked with one of the world's leading supplier of Food, Home and Personal Care products over a period of three years to give assurance to the business that the process safety related hazards associated with its sites are being identified and managed effectively
- The program is underpinned by Company's PSM Standard CCPS Risk Based Process Safety Guidance
- Auditing is a fundamental part of the program, and the approach described previously has been adopted, although as its function is expanded beyond auditing to include hazard identification, awareness raising and competence building elements; the term PSM Technical Visit is used.



Conclusion



- ERM has developed a methodology for process safety auditing based around bowties which help both the auditors and auditees define the scope of the audit and to focus on those aspects of the process design, operation and maintenance that are central to maintaining a good level of safety and ensuring the risk is ALARP.
- The bowtie process provides a good visualisation and communication tool demonstrating to auditees potential vulnerabilities in their basis of safety, where the focus of their process safety efforts should lie, and to management that the audit process is crucial to maintaining a high level of process safety.
- ERM worked with a large Company on its sites worldwide using the bowtie process safety audit technique to provide assurance to the Board that process safety risks are being managed effectively.



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Thank you



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The business of sustainability





Generic Audit Program



- **Day 1: Discussion of information from site and process plant visit**

The first day on site allows the audit procedure to be described and a general exchange of information with site. The afternoon consists of a walk round of the process areas with appropriate staff to review location, layout of process plant, hazardous material storage, occupied buildings etc.

- **Day 2: Review of bowties with appropriate site participants**

This is a classroom day when the pre-populated bowties are reviewed in detail and modified to reflect the actual equipment and practices on site. There are also discussions with staff on the strength of the barriers claimed.

Generic Audit Program

- Day 3 and 4: Review of actions from bowties and review of process safety elements including deep dive discussions as appropriate

These days comprise more traditional “audit activities” where each of the elements are examined through interview, discussion and document / records review and evaluated against applicable regulatory requirements, corporate standards and generally accepted good practice. A particular feature of this phase of the audit is the testing of the presence and strength of the barriers previously claimed in the bowties

- Day 5: Presentation of findings and discussion with site.

The findings are presented in easy to read format comprising a closing presentation and a set of recommendations in a spreadsheet against the regulations reviewed.



Thank you for your attention