

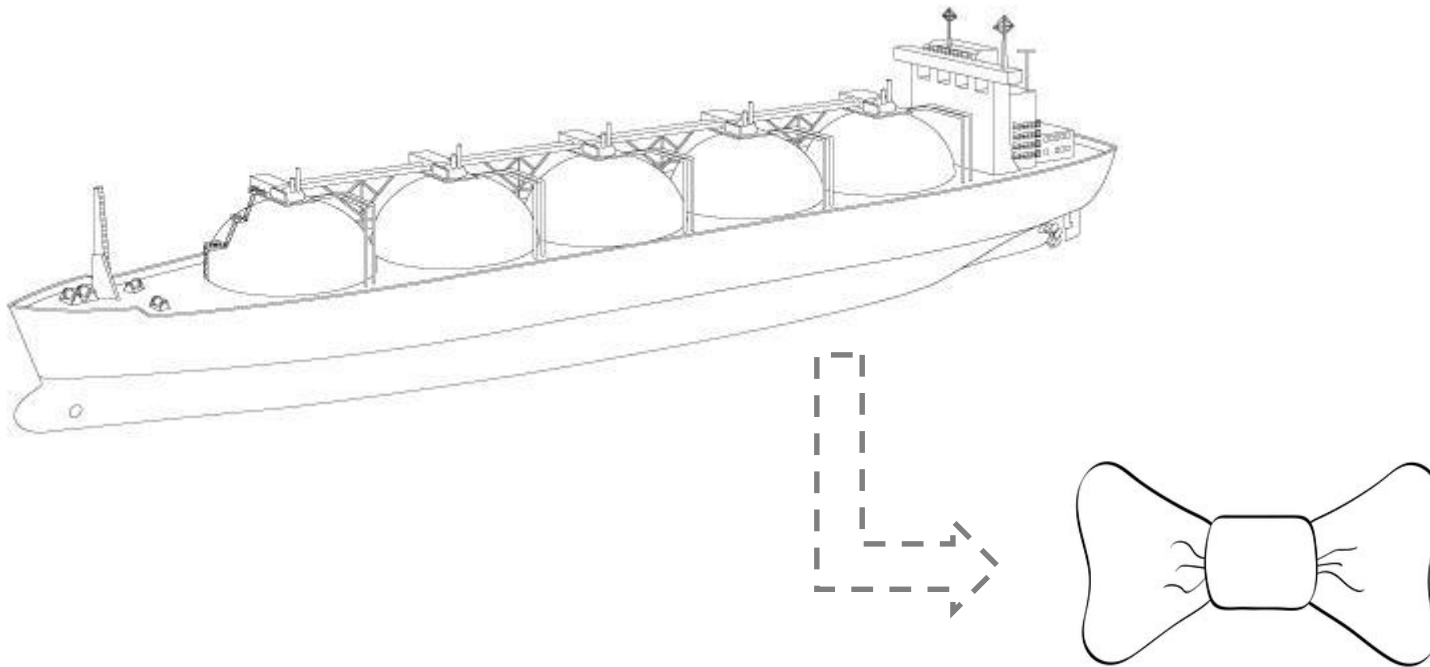
Bowtie Analysis

Practical uses, benefits and its application to LNG tanker operations

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Principal Engineer

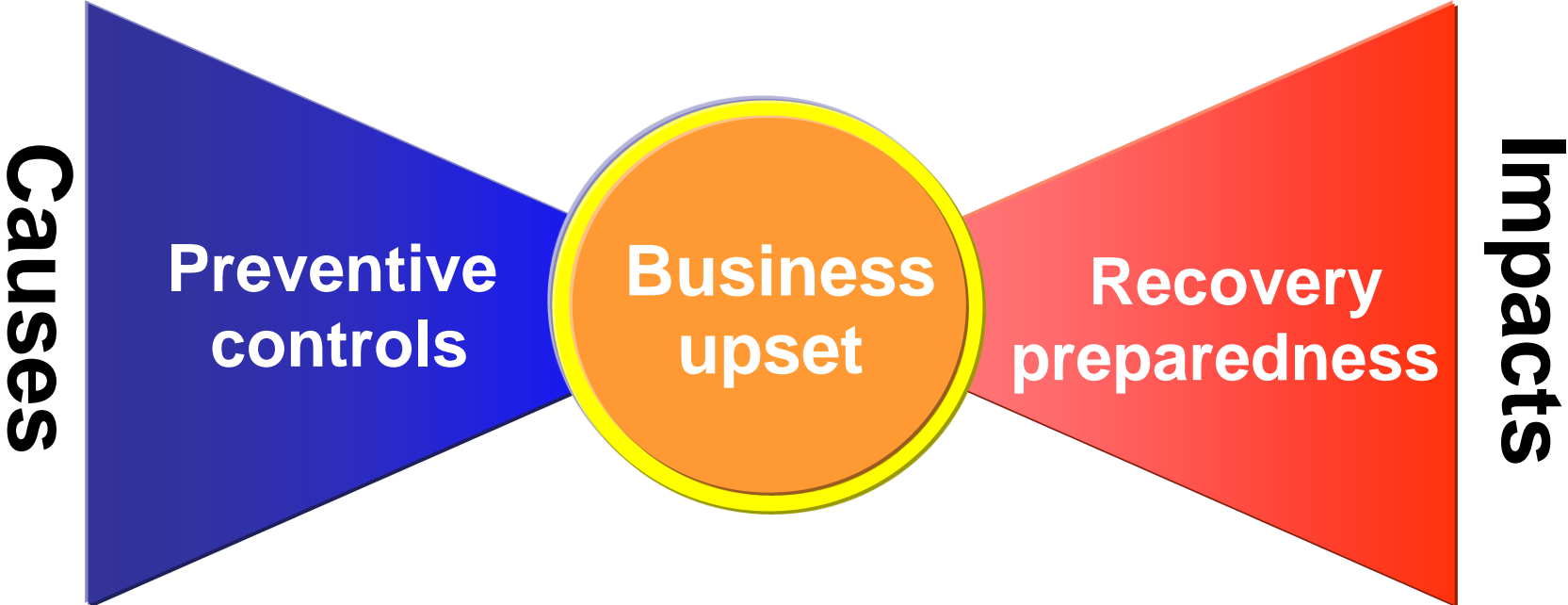
Purpose of Presentation

- Introduce bowtie methodology and its use as a risk assessment tool
- Discuss the practical uses, application and benefits of bowtie analysis, as observed cross-industry
- Provide a generic example of bowtie application for LNG tanker operations



Bowtie Diagram

Basic Structure



Bowtie Methodology

A short History...

- Exact origins of bow-tie methodology are hazy – believed to originate from ICI in the late 1970's
- Royal Dutch/Shell Group first major company to integrate bow-ties fully into business practices
- Use of bow-ties now widely spread between companies, industries, countries and from industry to regulator, e.g.:
 - Abu Dhabi National Oil Company (ADNOC)
 - UK Health and Safety Executive
 - French Government
 - Australian State Regulator
 - Land Transport Safety Authority of New Zealand
 - International standards (e.g. ISO 17776:2000)
 - International Association of Drilling Contractors (IADC)

Risk Evaluation and Management

HSE Management System



An **HSE-MS** is a structured set of controls for managing HSE risk in a business

Where do Bowties fit in?

TABLE 4.3 - OTHER LISTED OCCURRENCES BY SCENARIO

SCENARIO	OTHER LISTED OCCURRENCES	SCENARIO	OTHER LISTED OCCURRENCES
1.1.1	...	1.1.1	...
1.1.2	...	1.1.2	...
1.1.3	...	1.1.3	...
1.1.4	...	1.1.4	...
1.1.5	...	1.1.5	...
1.1.6	...	1.1.6	...
1.1.7	...	1.1.7	...
1.1.8	...	1.1.8	...
1.1.9	...	1.1.9	...
1.1.10	...	1.1.10	...
1.1.11	...	1.1.11	...
1.1.12	...	1.1.12	...
1.1.13	...	1.1.13	...
1.1.14	...	1.1.14	...
1.1.15	...	1.1.15	...
1.1.16	...	1.1.16	...
1.1.17	...	1.1.17	...
1.1.18	...	1.1.18	...
1.1.19	...	1.1.19	...
1.1.20	...	1.1.20	...
1.1.21	...	1.1.21	...
1.1.22	...	1.1.22	...
1.1.23	...	1.1.23	...
1.1.24	...	1.1.24	...
1.1.25	...	1.1.25	...
1.1.26	...	1.1.26	...
1.1.27	...	1.1.27	...
1.1.28	...	1.1.28	...
1.1.29	...	1.1.29	...
1.1.30	...	1.1.30	...
1.1.31	...	1.1.31	...
1.1.32	...	1.1.32	...
1.1.33	...	1.1.33	...
1.1.34	...	1.1.34	...
1.1.35	...	1.1.35	...
1.1.36	...	1.1.36	...
1.1.37	...	1.1.37	...
1.1.38	...	1.1.38	...
1.1.39	...	1.1.39	...
1.1.40	...	1.1.40	...
1.1.41	...	1.1.41	...
1.1.42	...	1.1.42	...
1.1.43	...	1.1.43	...
1.1.44	...	1.1.44	...
1.1.45	...	1.1.45	...
1.1.46	...	1.1.46	...
1.1.47	...	1.1.47	...
1.1.48	...	1.1.48	...
1.1.49	...	1.1.49	...
1.1.50	...	1.1.50	...

Identify Hazards

Table 4.5 - Hazards and Effects Register

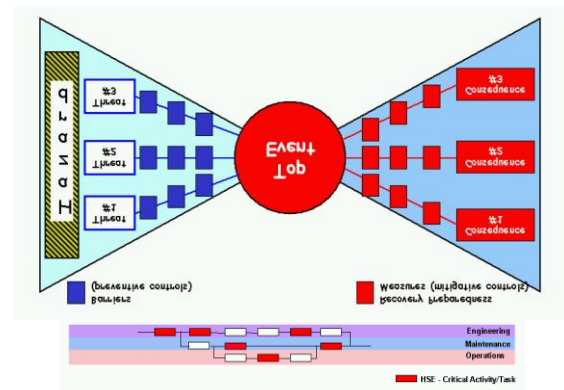
HAZARD NO.	HAZARD SOURCE (CAUSE)	HAZARD EVENT	CONSEQUENCES	RISK RATING	CONTROL	COMMENTS
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7
8
9
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Develop Risk Scenario



Severity	CONSEQUENCE				FREQUENCY				
	People	Assets	Environment	Reputation	A Never heard of in industry	B Has occurred in industry	C Has occurred in company	D Occurs several times per year in company	E Occurs several times per year at location
0	No injury	No damage	No effect	No impact	Manage for Continuous Improvement				
1	Slight injury	Slight damage	Slight effect	Slight impact					
2	Minor injury	Minor damage	Minor effect	Limited impact	incorporate risk reduction measures				
3	Major injury	Localized damage	Localized effect	Considerable impact					
4	1-3 fatalities	Major damage	Major effect	National impact	Intolerable				
5	Multiple fatalities	Extensive damage	Massive effect	International impact					

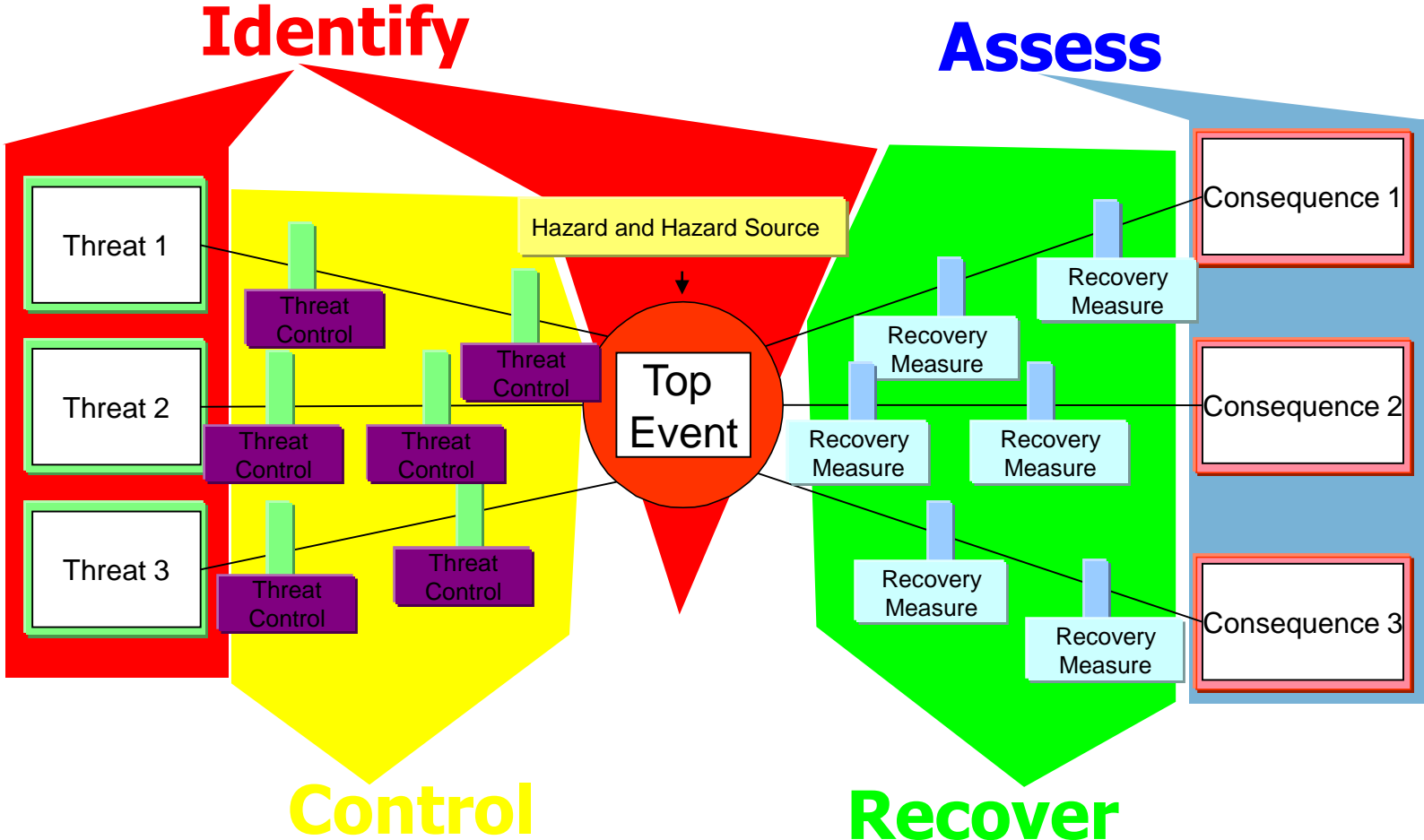
Assess Risk



Detailed Analysis of Significant Risks

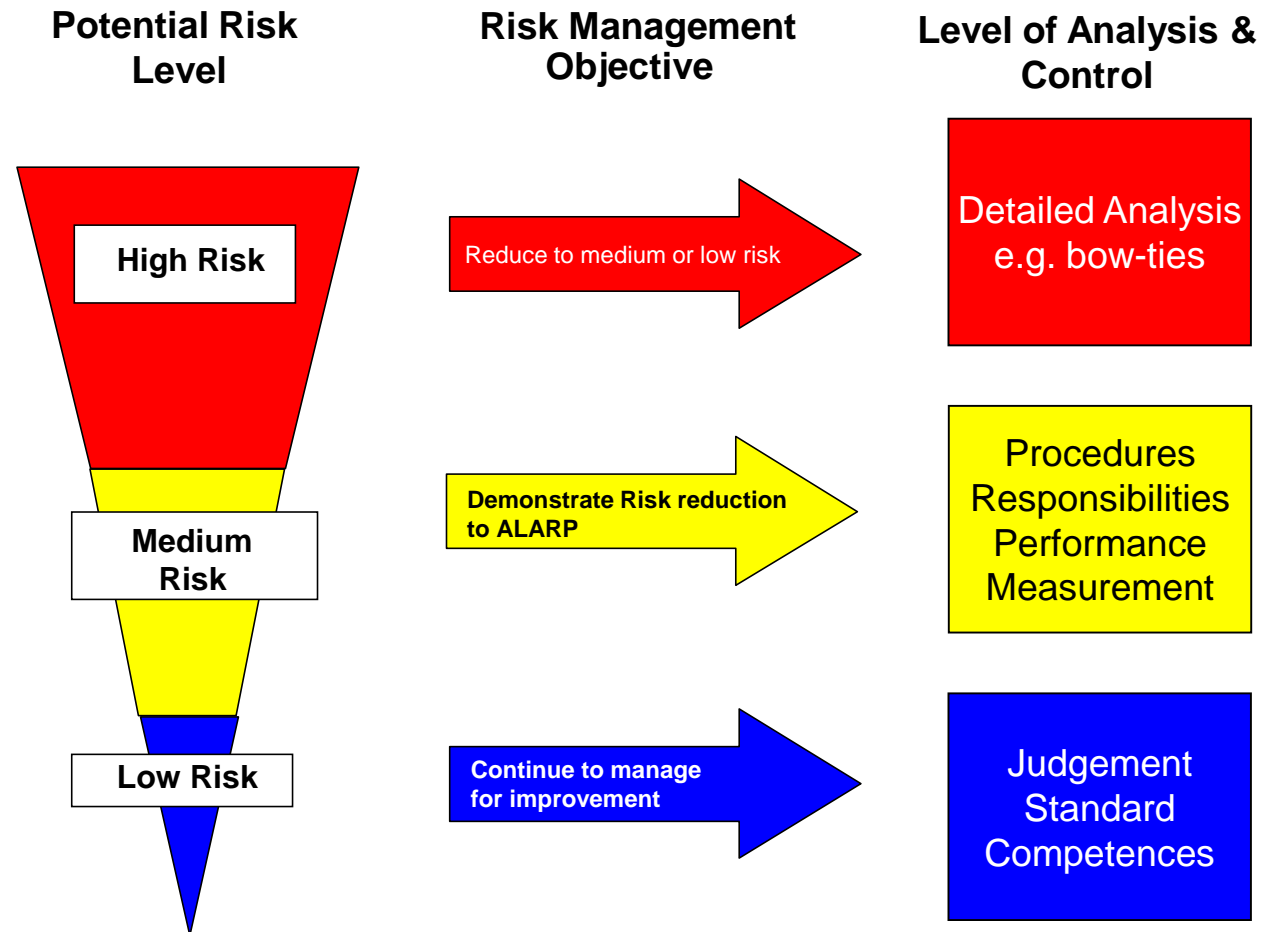
Bowtie Diagram

An Overview...



Bowtie Diagram

Typical Application



But method is equally applicable to routine risks as major risks

Practical Uses of Bowtie

Logical structured approach

What are our major risks? Do we have any gaps in risk control?

Communication

How do we engage non-risk specialists?

Formal demonstration

Can we really demonstrate control of our risks?

Specific risks

Are these risks properly understood and controlled?

Critical roles

Do our people know what is expected of them?

Competencies

Are competence and control requirements aligned?

Procedures

Are they complete and effective?

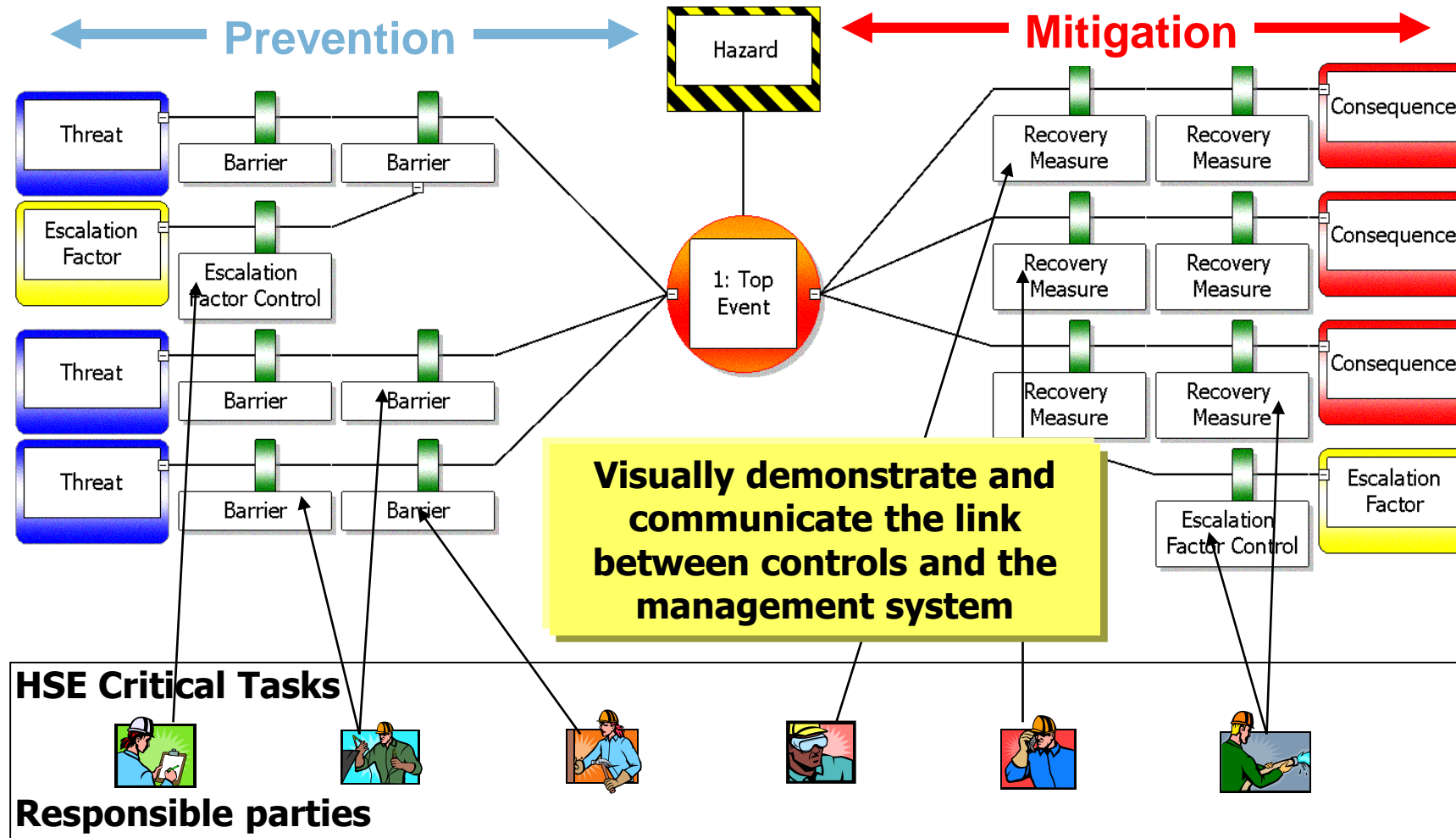
Auditing

How can we focus audits on what really matters?

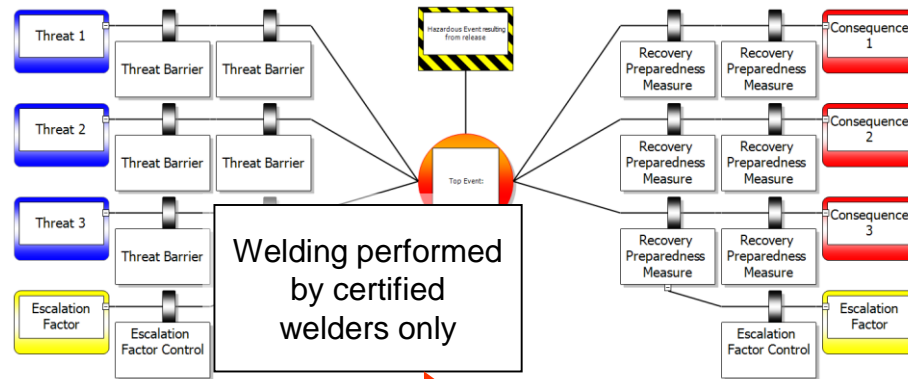
Critical systems and performance standards

What are they?

Bowtie and HSE Critical Tasks



Bowtie and Operator Competencies



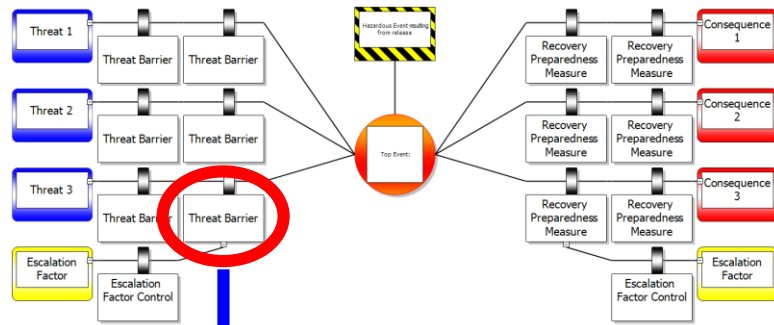
Verify that competence and control requirements are aligned

Job Title: **Lead Production Operator (OPF)** JG: 7

Building Block	Skill Element	A	K	S	M	Building Block	Skill Element	A	K	S	M
Process System Description						Equipment Operation Description					
	Describe purpose of system						Describe purpose of equipment				
	Provide sketch of product flow						Identify pressures, temperatures, flow rates				
	Identify process parameters					Equipment Readings					
Equipment Identification						Equipment Availability Optimisation					
	Identify subsurface completion equipment						Execute maintenance				
	Identify surface equipment						Control running hours				
	Identify facilities equipment						Analyse equipment failure				
	Identify safety systems					Rotating Equipment					
Facilities (and Wells) Configuration						Static Equipment					
	Identify line-up						Describe different rotating equipment				
	Identify availability of production system						Perform rotating equipment maintenance				
	Take levels of production tanks						Analyse and correct machinery faults				
	Calculate tank capacity						Maintain equipment history				
Production Flow Regulation						Failure Analysis					
	Identify production capacity						Apply condition monitoring techniques				
	Select well production						Analyse faults				
	Produce wells and facilities						Control trouble shooting				
Product Delivery Commitments						Energy Consumption					
	Communicate with marketing						Identify energy consumption				
	Plan production										
	Produce at require**										

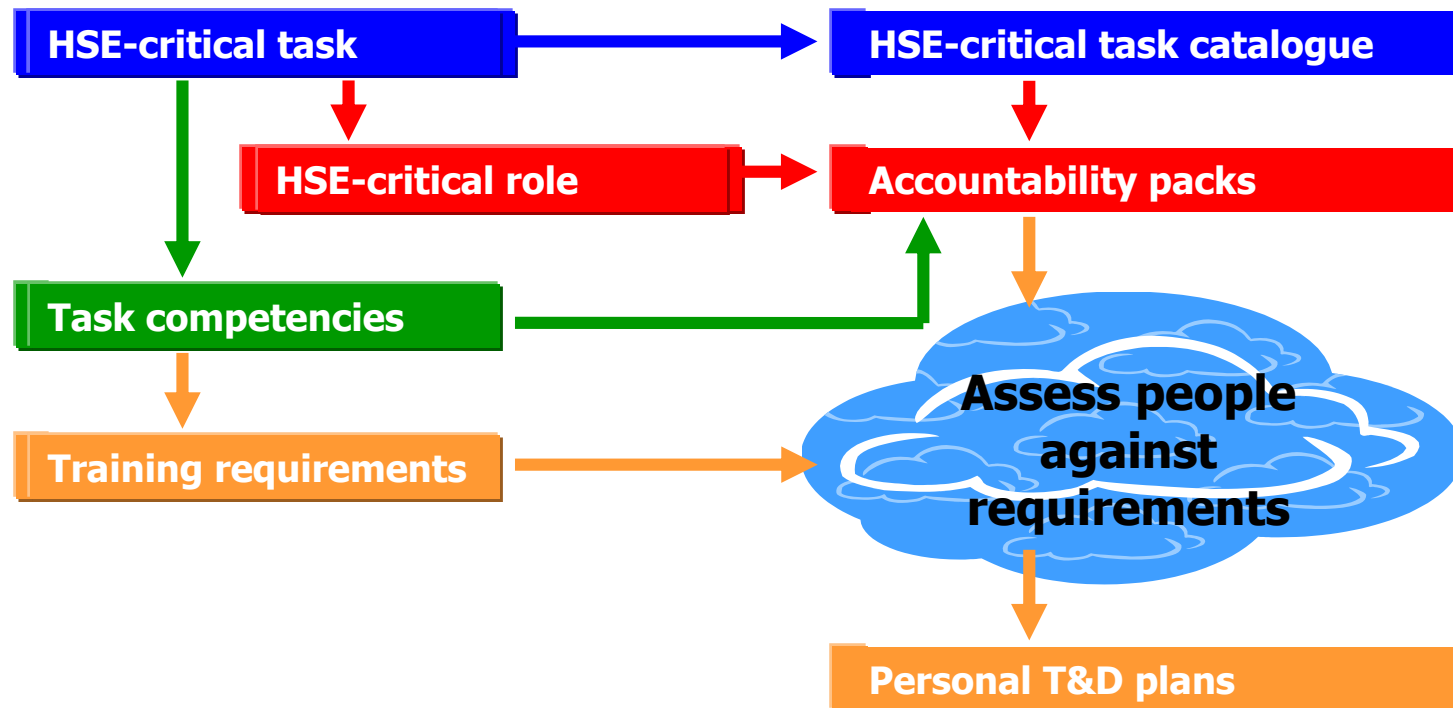
Typical Competence Assurance System Job Profile

Bowtie and Training & Development



Competent people provide resilience against major risks

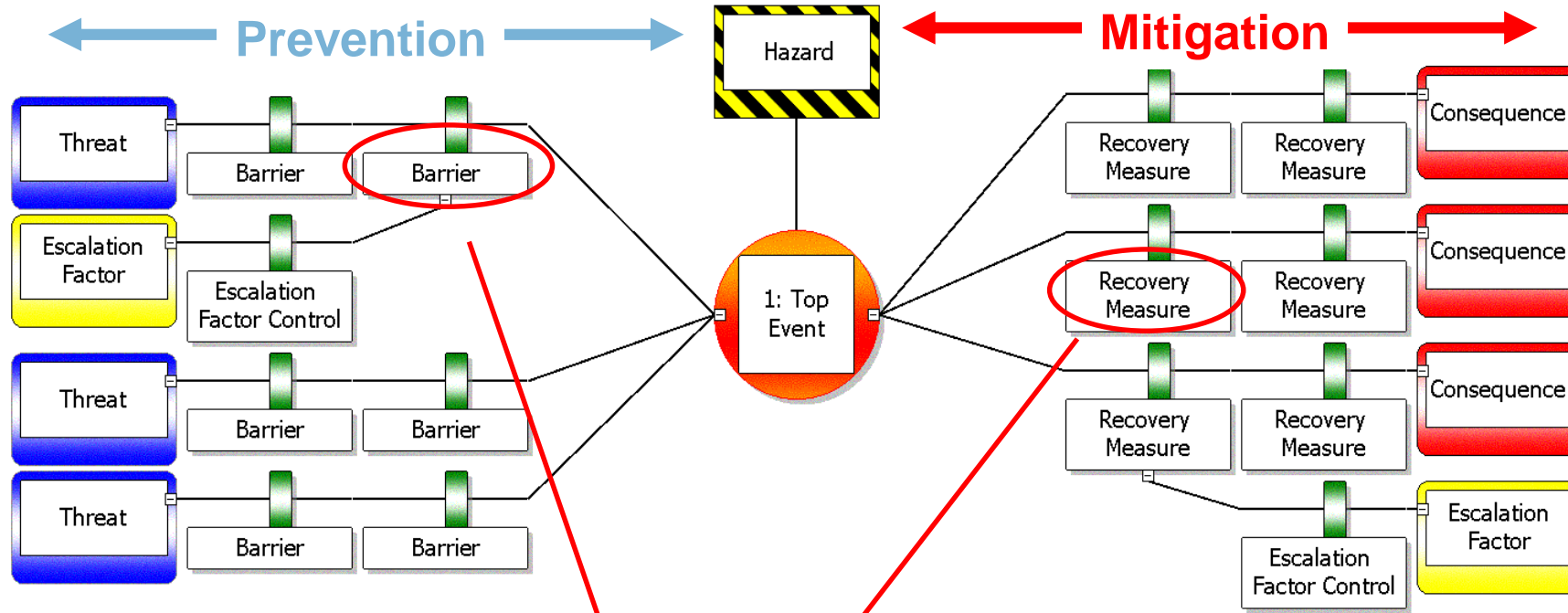
...to ensure each risk control works...



...use Competency Mgmt System

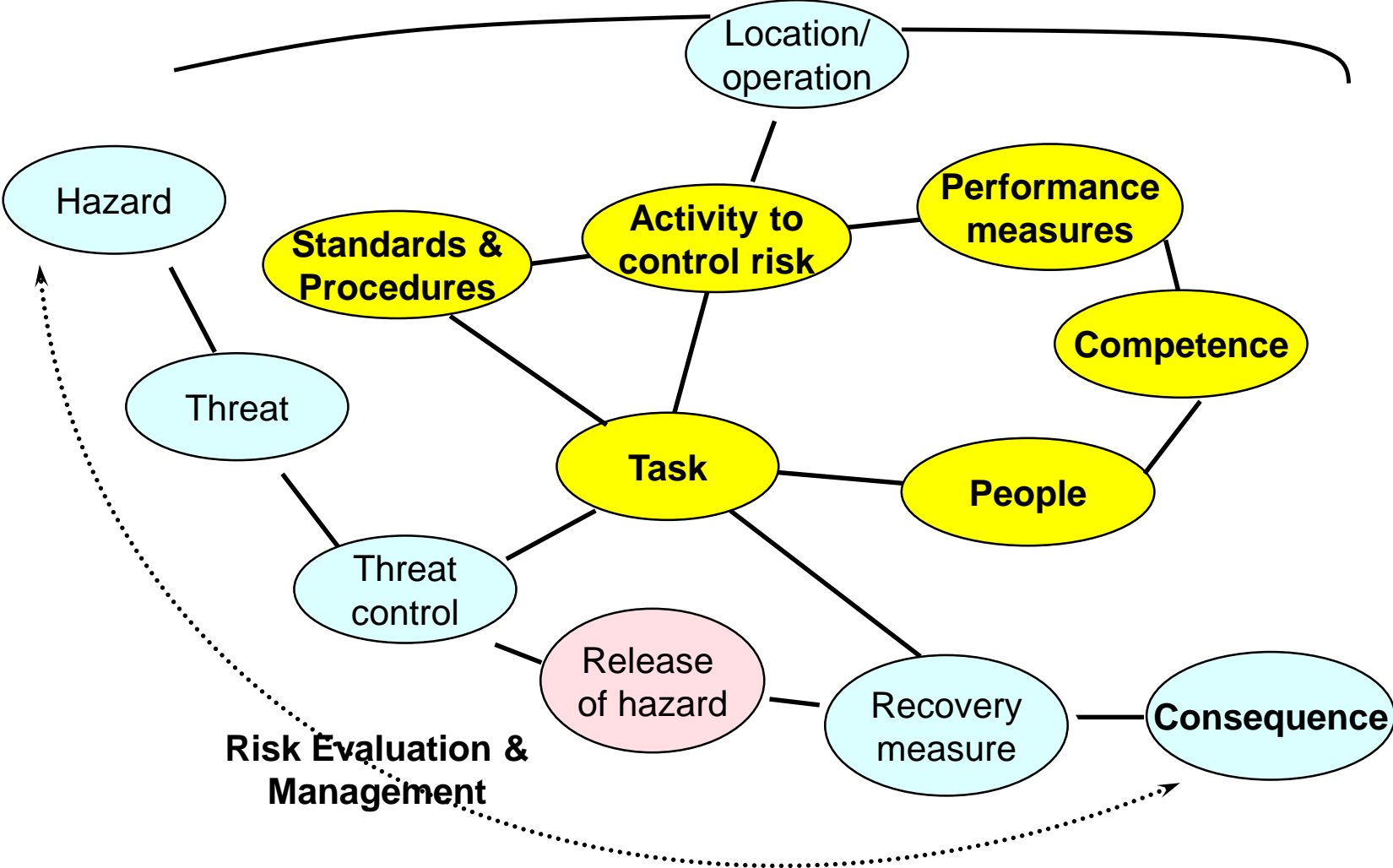


Critical Systems



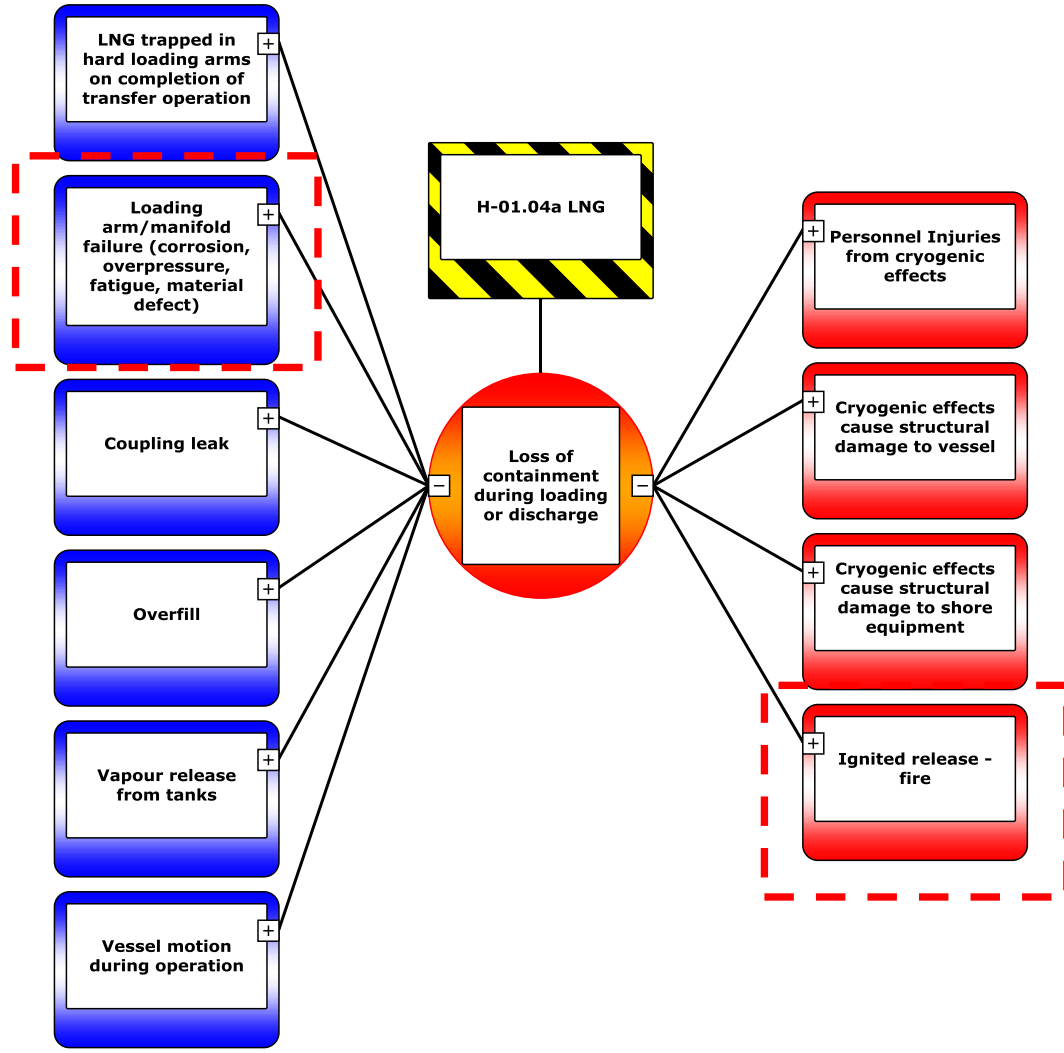
Total Hazard Control

In the end you must have all connections in place for effective hazard control



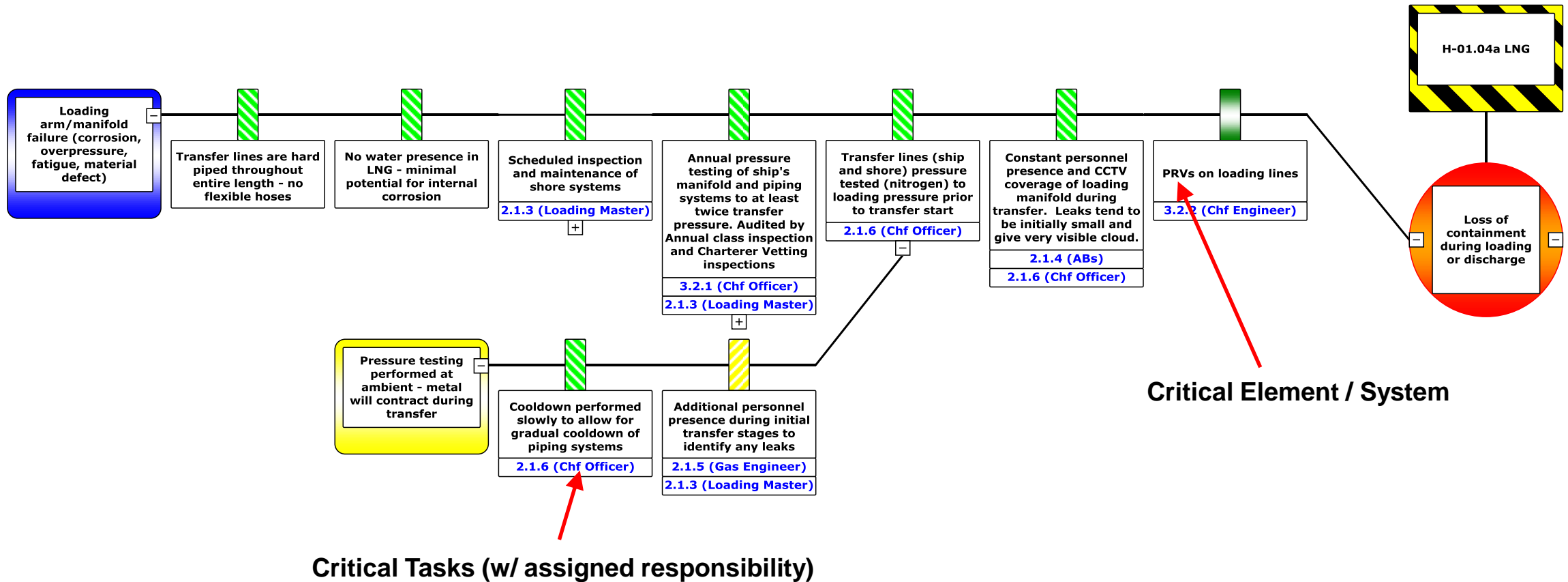
Example Bowtie; LNG Tanker operations

Example 1: LNG; Loss of Containment during Loading or Discharge



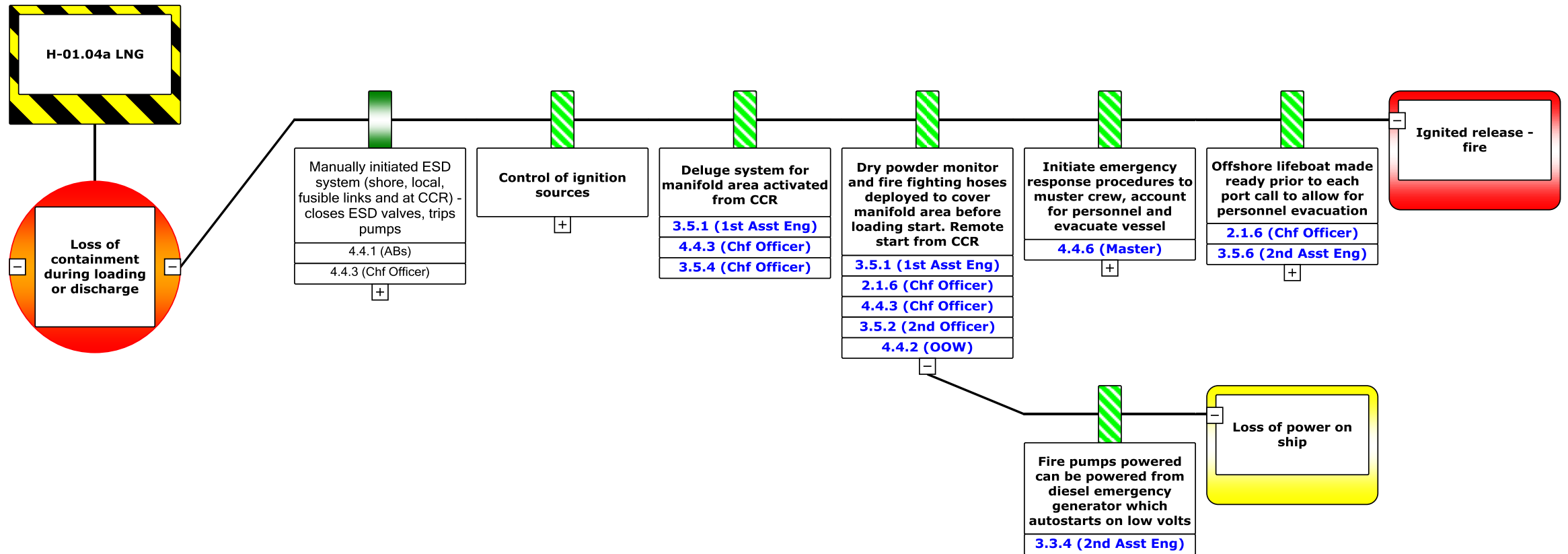
Example Bowtie; LNG Tanker operations

Example 1: LNG; Loss of Containment during Loading or Discharge



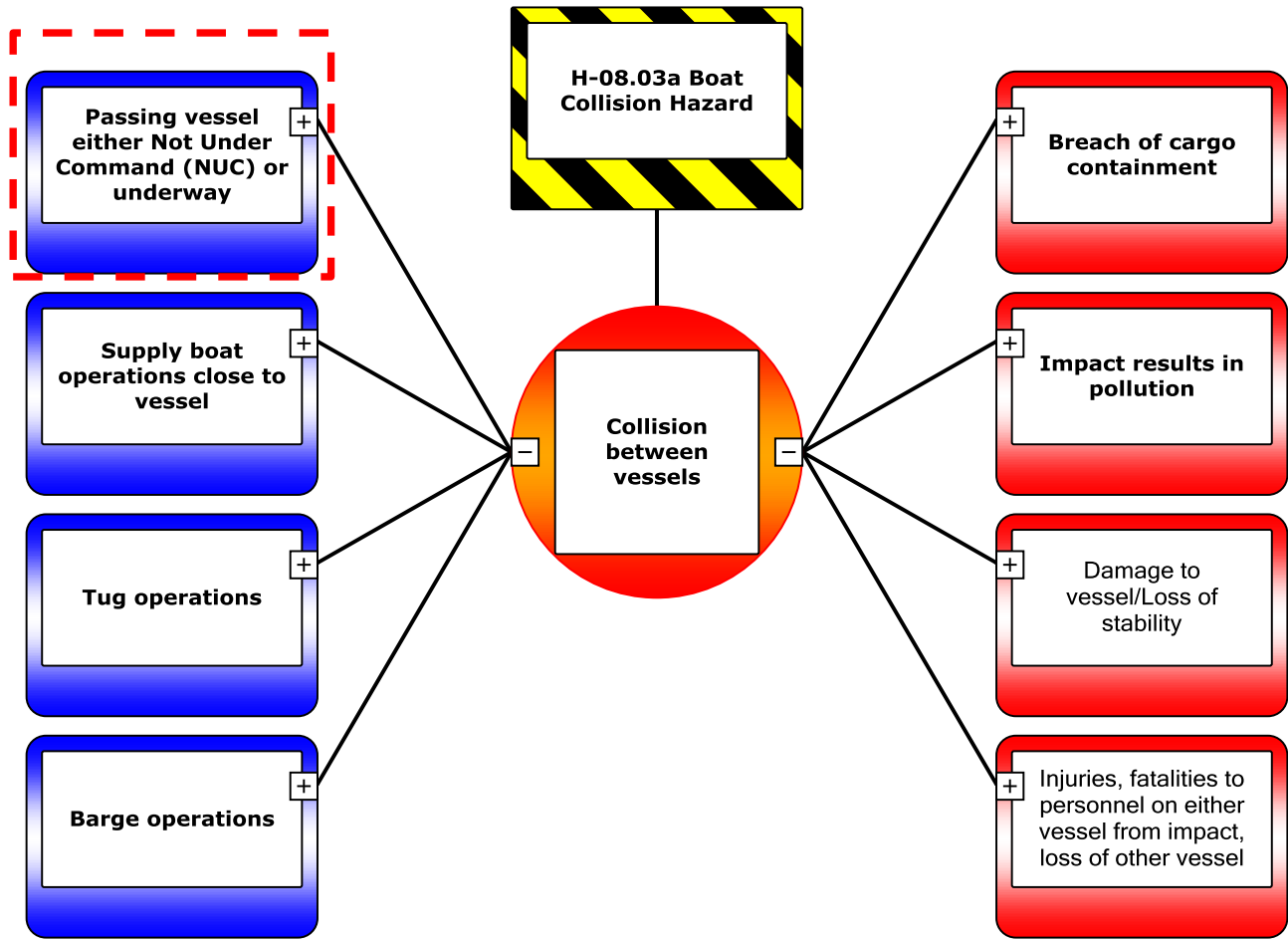
Example Bowtie; LNG Tanker operations

Example 1: LNG; Loss of Containment during Loading or Discharge



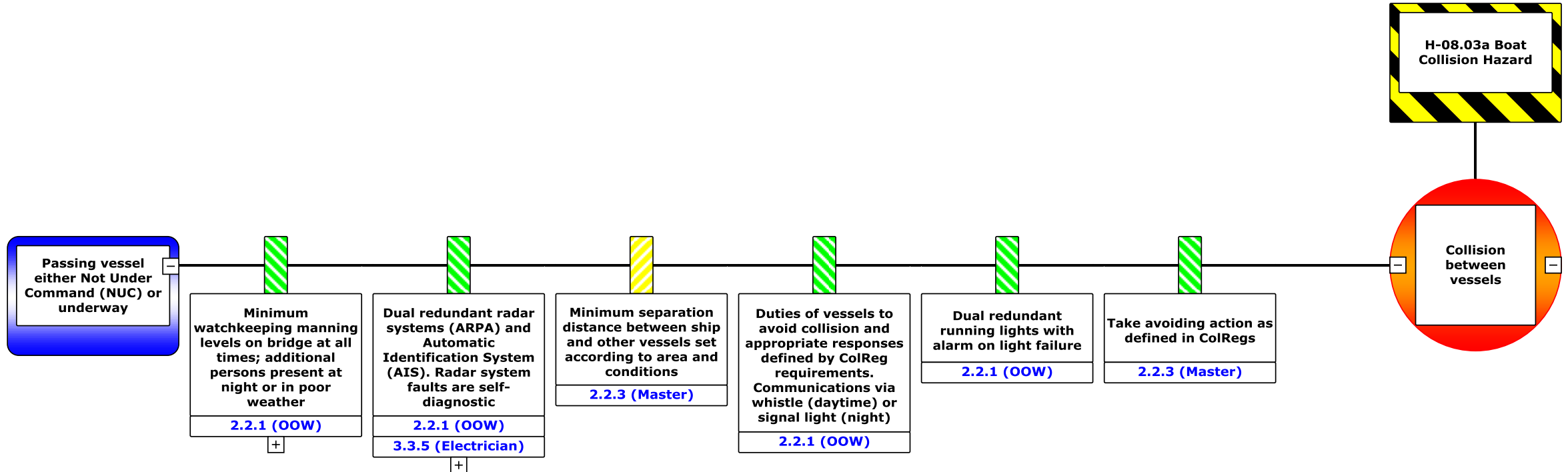
Example Bowtie; LNG Tanker operations

Example 2: Boat Collision; Collision between vessels



Example Bowtie; LNG Tanker operations

Example 2: Boat Collision; Collision between vessels



Benefits of Bowtie Analysis

- Goes beyond usual risk assessment 'snapshot' and highlights links between risk controls and management system
- Helps to ensure that risks are **managed** rather than just analysed
- Forces a comprehensive and **structured** approach to risk assessment
- Excellent for **communicating** risk issues to non-specialists
- **Ownership** – involves people, gains buy-in, practical approach
- **Operations** – assigns responsibility for hazard controls and links to asset integrity
- **All risks** – not just HSE
- **Risk reduction** - identifies where resources should be focussed for risk reduction, i.e. prevention or mitigation

Limitations of Bowtie Analysis

- Qualitative – does not replace QRA
- Does not replace techniques like or HAZOP or FMECA
- Depends on experience of personnel and active participation
- Ensure controls in bowtie are truly independent
- Not obvious which controls are most important
- Use as a communication tool (simple bowtie) vs complete demonstration of hazard management (detailed bowtie) – potential conflict

But if you want to remove mystique of risk management and obtain insights into your risk controls that are easy to understand and easy to communicate, there is no better method than bowties

Summary

- The Bowtie Diagram is a user-friendly, graphical illustration of how hazards are controlled, supporting a complete and comprehensive approach to risk management
 - Linkage to HSE Management Systems;
 - Assigning Critical Tasks, Procedures, Competencies
 - Identifying Safety Critical Equipment, Processes
- The total methodology demonstrates not only what controls are in place today, but why they will still be there tomorrow.
- Bowtie controls link into all aspects of our management systems

Questions?

