

# Practical Application of Bowtie Analysis

Enhancing Traditional PHA

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## Purpose of Presentation

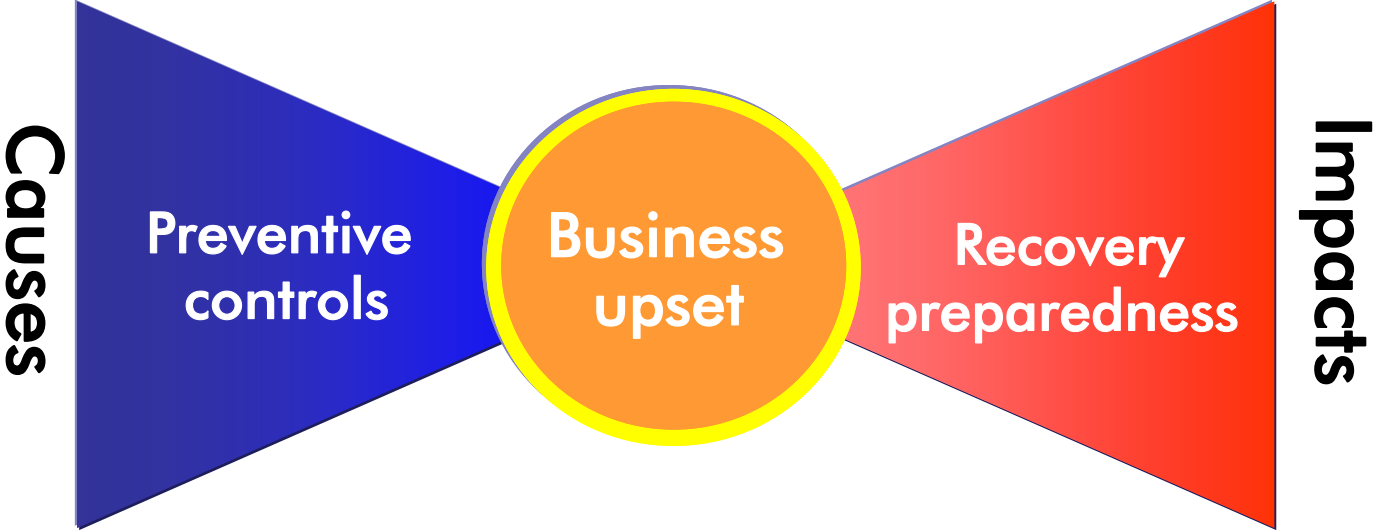
- Introduce bowtie methodology and its use as a risk assessment tool
- Discuss the practical application and benefits of bowtie analysis, as observed cross-industry
- Compare and contrast bowtie methodology, and its 'place' within the risk management process, with the more established HAZOP process



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# 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)

# Typical Risk Management Process; Where do Bowties fit in?

## Identify Hazards

Ref. No.	Hazard Category
<b>H-01 Hydrocarbons (Unrefined)</b>	
H-01 001	Liquid Natural Gases (LNGs)
H-01 002	Condensate
H-01 003	Hydrocarbon gas
H-01 004	Crude (oil)
<b>H-02 Hydrocarbons (Refined)</b>	
H-02 001	Liquefied Petroleum Gases (e.g. Propane)
H-02 002	Gasoline's (naphtha)
H-02 003	Gas Oils (Diesel Fuels / Heating Oils)
H-02 004	Lubricating Oil Base Stocks
H-02 005	Waxes and Related Products
H-02 006	Bitumens and Bitumen Derivatives
<b>H-03 Explosives</b>	
H-03 001	Commercial Explosive Material
<b>H-04 Pressure</b>	
H-04 001	Gas under Pressure
H-04 002	Liquid under Pressure
H-04 003	Vacuum
<b>H-05 Differences in Height</b>	
H-05 001	Personnel at Height >2m
H-05 002	Personnel at Height 0m-2m
H-05 003	Objects Overhead
H-05 004	Ground / Slope Stability

## Develop Risk Scenario

Scenario	Event	Initiator	Preventive	Control	Consequence	Severity	Frequency	Risk
H-01 001	Liquefied Petroleum Gases (LPG) release	Faulty valve	Safety valve	Pressure relief valve	Fire	Severe	Once per year	High

## Assess Risk

Severity	Frequency	Consequences				Increasing likelihood								
		A	B	C	D	E	F	G	H	I				
5	No injury or health effect	No damage	No effect	No impact	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor
4	Slight injury or health effect	Slight damage	Slight effect	Slight impact	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor
3	Major injury or health effect	Major damage	Major effect	Major impact	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor
2	Minor injury or health effect	Minor damage	Minor effect	Minor impact	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor
1	FTC or up to 3 fatalities	Human damage	Human effect	Human impact	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor	Minor

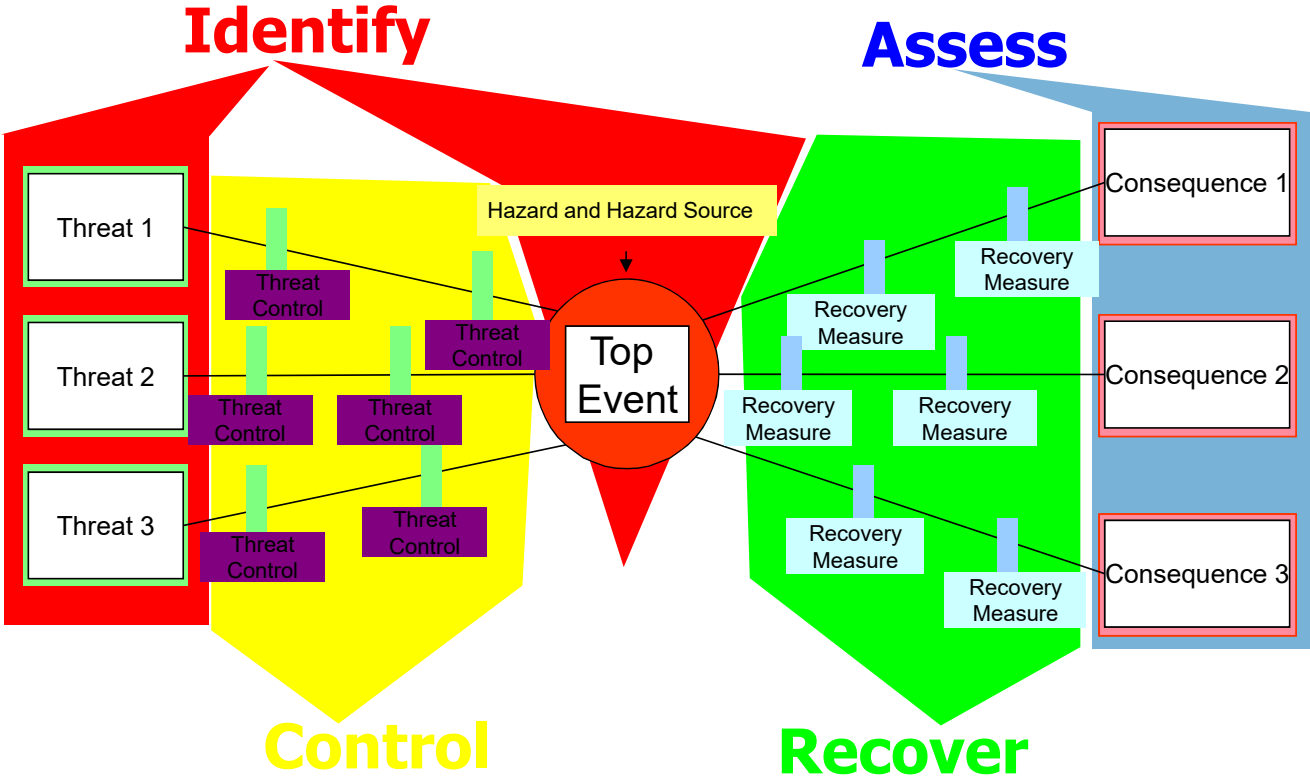
## Bowtie Analysis



## Risk Management Process

# Bowtie Diagram

An Overview...

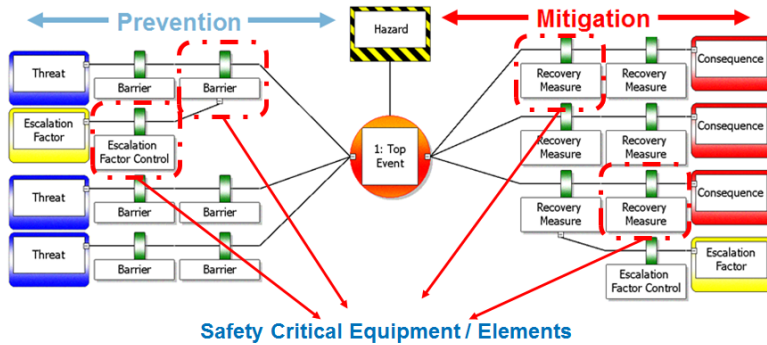


## Practical Uses of Bowtie

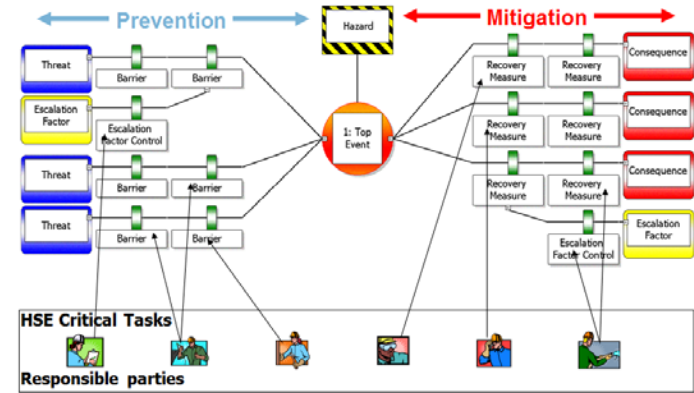
<b>Communication</b>	<b>How do we engage non-risk specialists?</b>
<b>Formal demonstration</b>	<b>Can we really demonstrate control of our risks?</b>
<b>Specific risks</b>	<b>Are these non-routine activities/ problematic areas, and their inherent risks properly understood and controlled?</b>
<b>Critical roles</b>	<b>Do our people know what is expected of them?</b>
<b>Competencies</b>	<b>Are competence and control requirements aligned?</b>
<b>Procedures</b>	<b>Are they complete and effective?</b>
<b>Auditing</b>	<b>How can we focus audits on what really matters?</b>
<b>Critical systems and performance standards</b>	<b>What are they?</b>

# Bowtie and the HSE Management System

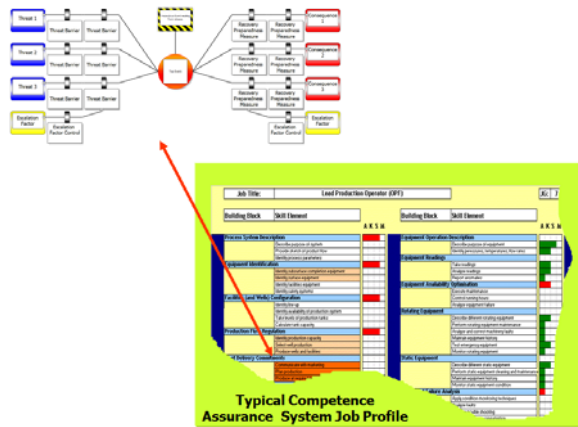
## HSE / Safety Critical Equipment



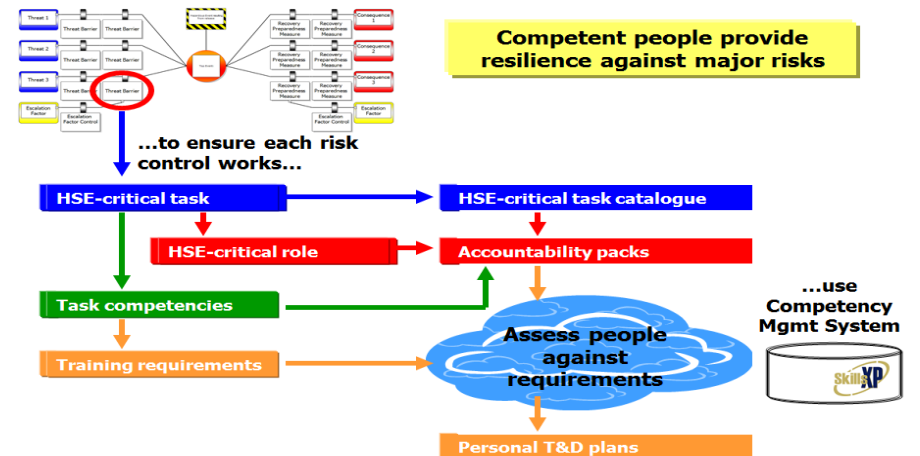
## HSE Critical Tasks



## Operator Competencies



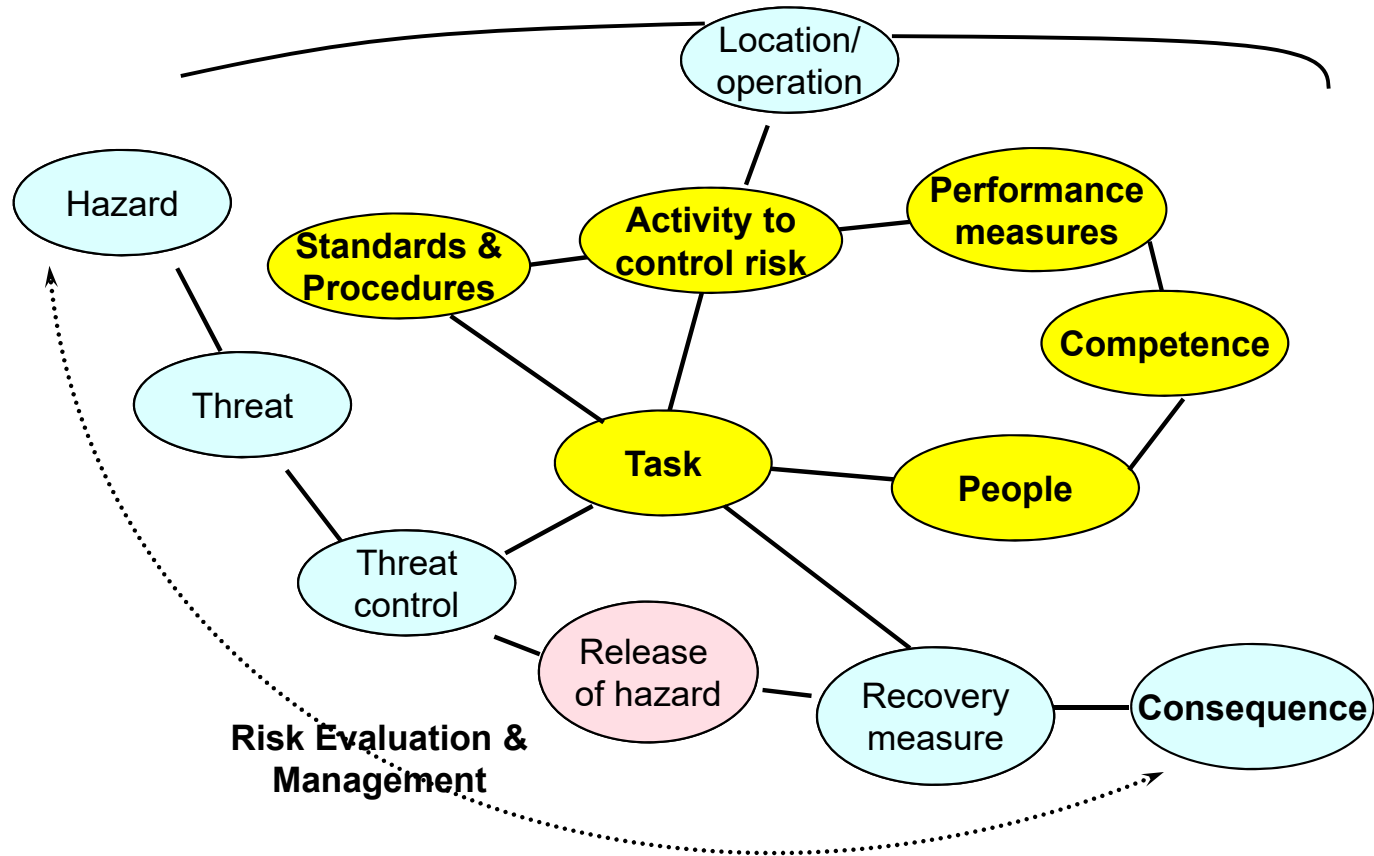
## Training and Development





# Total Hazard Control

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



## 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



## HAZOP vs. Bowtie; Key Differences

- **Graphical Representation** : Allows for a much clearer, easier to understand representation of the risks and how they are managed.
- **Flexibility**: Bowties are a very flexible method, and in addition to looking at process risks (which is generally where HAZOPs are employed), are also applied to a far wider range of risks including logistics, construction, security, etc.
- **Barrier Identification**: HAZOPs tend to concentrate on the engineered safeguards in place , whereas Bowties will consider a wider range of safeguards e.g. training & competency, external protection, inspection & maintenance, etc.
- **Internal vs. External**: HAZOPs tend to concentrate on what is happening inside the process, whereas Bowties allow for consideration of external events as well e.g. external impact, weather, human error etc.
- **Preventative vs. Mitigative**: HAZOPs end to concentrate on the preventative safeguards employed to stop a sequence from happening; Bowties allow for a more thorough consideration also of the mitigative controls.

## HAZOP vs. Bowtie; Key Differences

- **Representation of Risk:** HAZOPs tend to stop with the static representation of risk. Bowties allow for a deeper interrogation of the safeguards, to ask not only what is there, but why it will still work in the future.
- **Demonstration through HSE MS:** Bowtie barriers can be hot-linked to external information e.g. operating procedures, to allow for personnel to interrogate further if required
- **'Live' Risk:** Bowties can be linked to 'live' information from maintenance management systems e.g. SAP, to show a live picture of the risk management status indicating barrier status (on- or off-line).

None of this is intended to say the Bowties should replace HAZOP. They are **complementary** tools. There is nothing better than HAZOP for ensuring that process systems are designed fit for purpose. Bowties follow on from this to allow for a through life picture, applicable to all levels of personnel, that can be applied to all risks.

# Questions?

