

A background image showing a blue wireframe globe centered over a light blue world map. The globe has a grid of latitude and longitude lines.

risk management and assessment for business

Practical HSE Risk Management – An Introduction to the Bow-tie Method

**Presentation to the International Conference for Achieving Health & Safety
Best Practice in Construction, Dubai, UAE, 26th- 27th February 2007**

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Purpose of presentation

- **Introduce bow-tie method**
- **Describe its practical uses and benefits**
- **Outline an example bow-tie**
- **Provide some tips for successful use**

History of bow-tie method

- **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)**

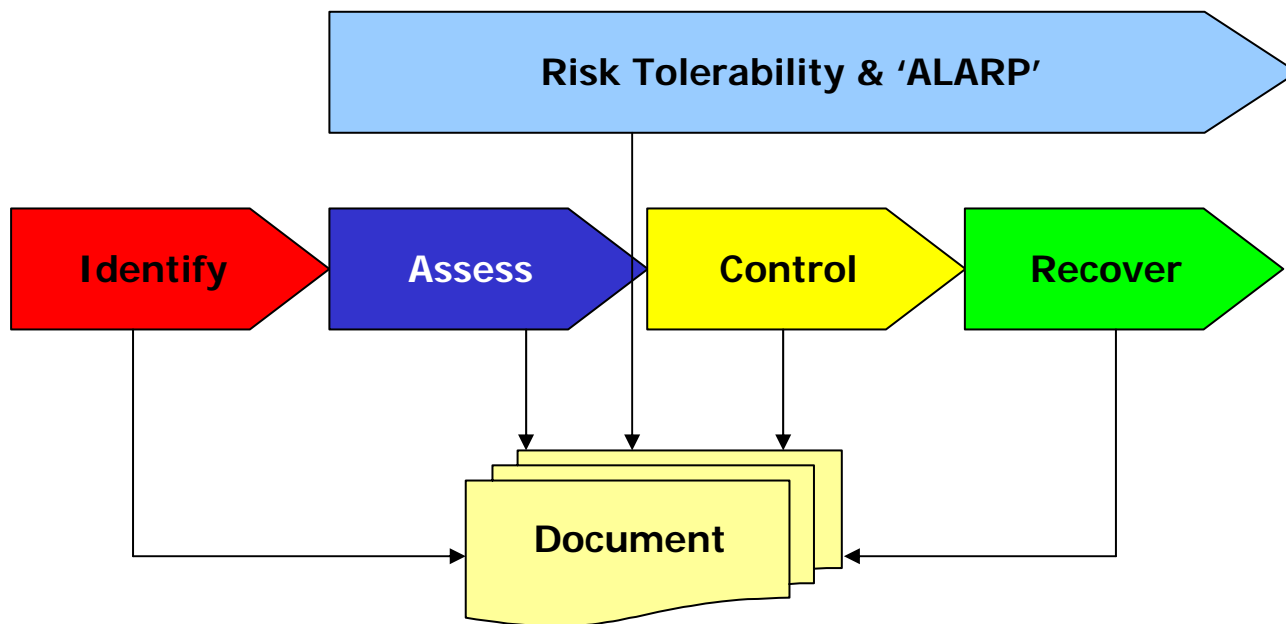
Risk evaluation & management



HSE Management System

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

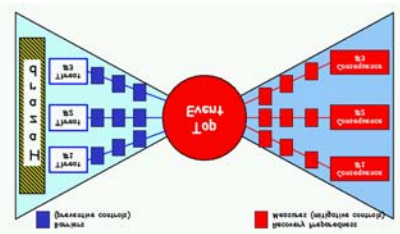
Basic risk evaluation & management model



Link with HSE-MS

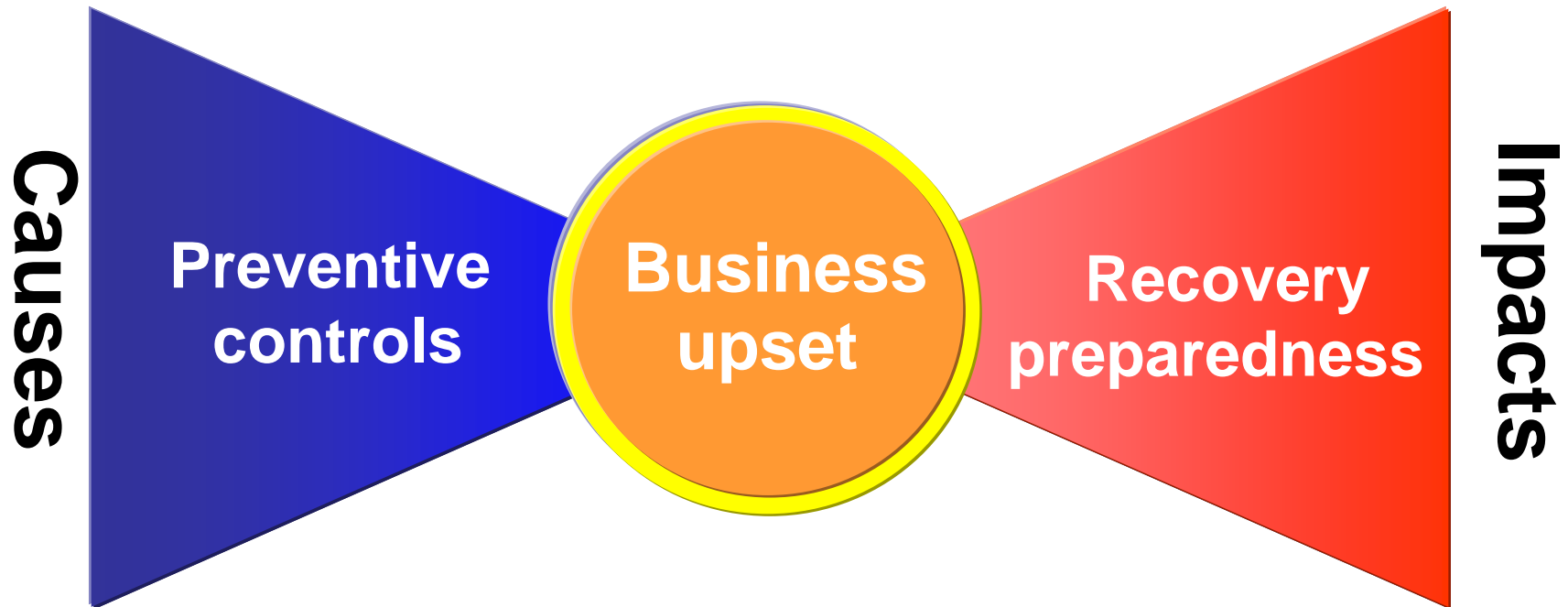
- Unlike traditional risk evaluation tools, the bow-tie method makes the link between risk controls and the HSE-MS:

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					
1	Slight injury	Slight damage	Slight effect	Slight impact					
2	Minor injury	Minor damage	Minor effect	Limited impact					
3	Major injury	Localised damage	Localised effect	Considerable impact					
4	1-3 fatalities	Major damage	Major effect	National impact					
5	Multiple fatalities	Extensive damage	Massive effect	International impact					

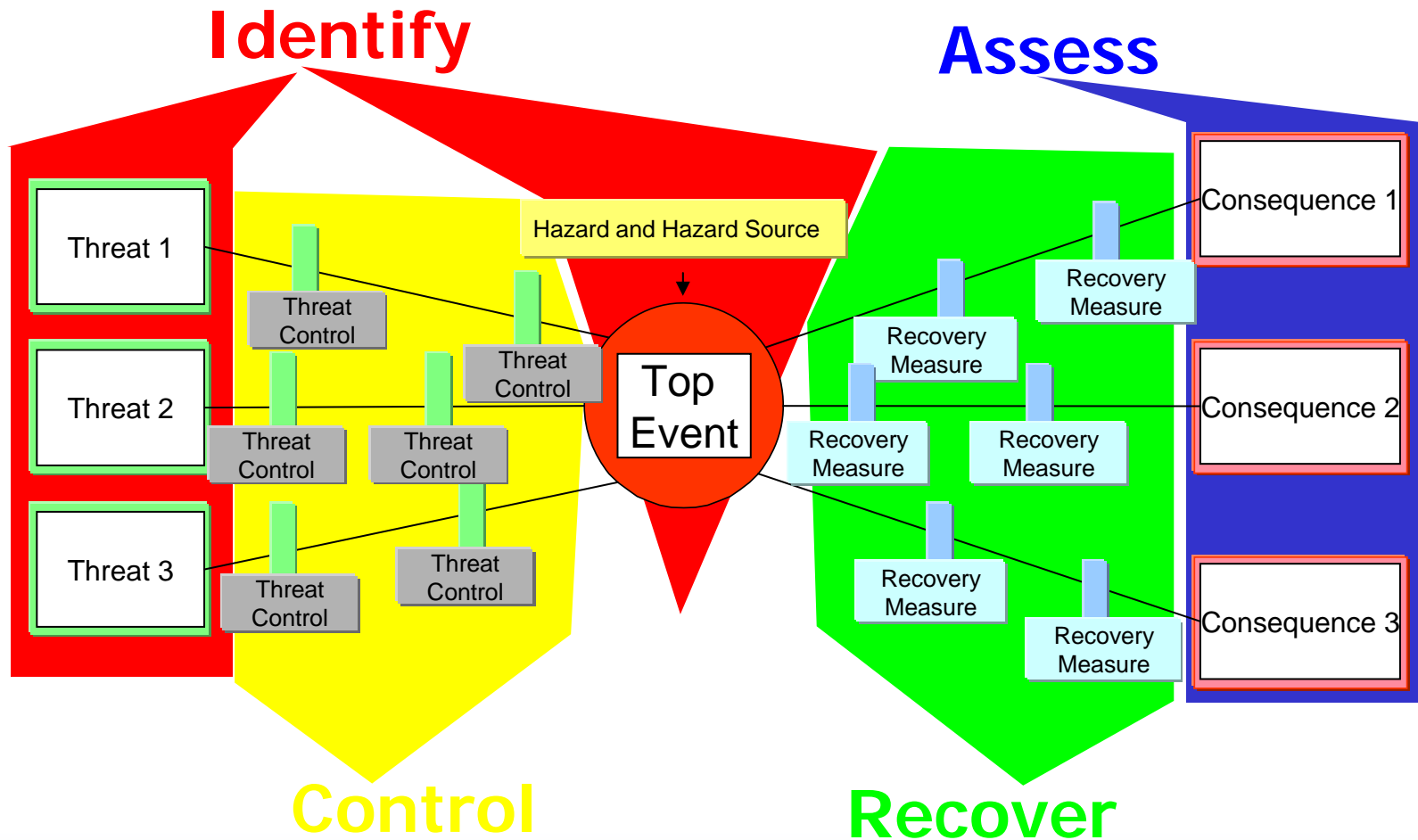


- Links are made via HSE-critical roles and responsibilities, HSE critical procedures, HSE critical equipment and systems, etc. identified on the bow-tie diagram

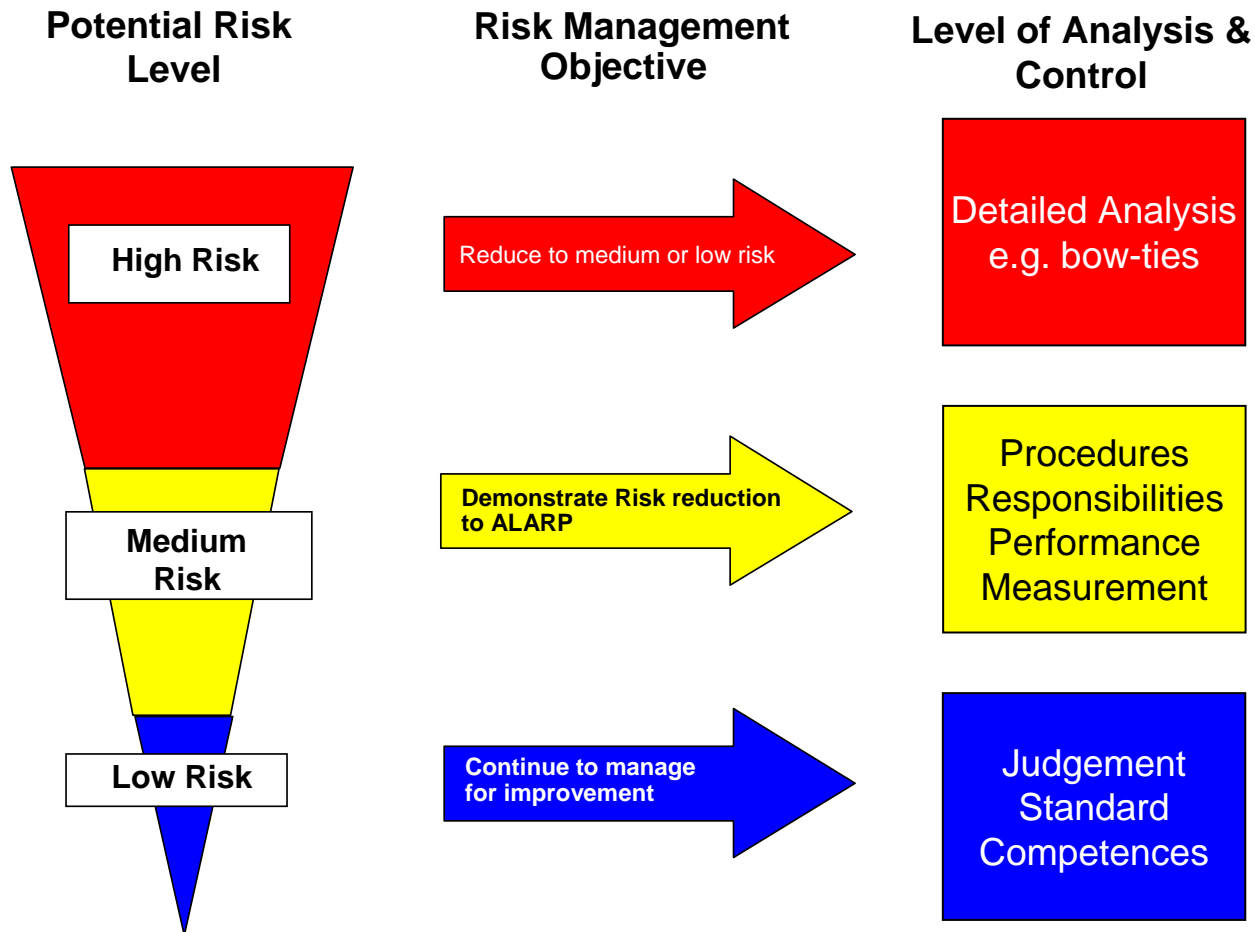
Bow-tie diagram



Bow-tie diagram



Typical application of bow-tie method



**But method is equally applicable to
routine risks as major risks**

Practical uses

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?

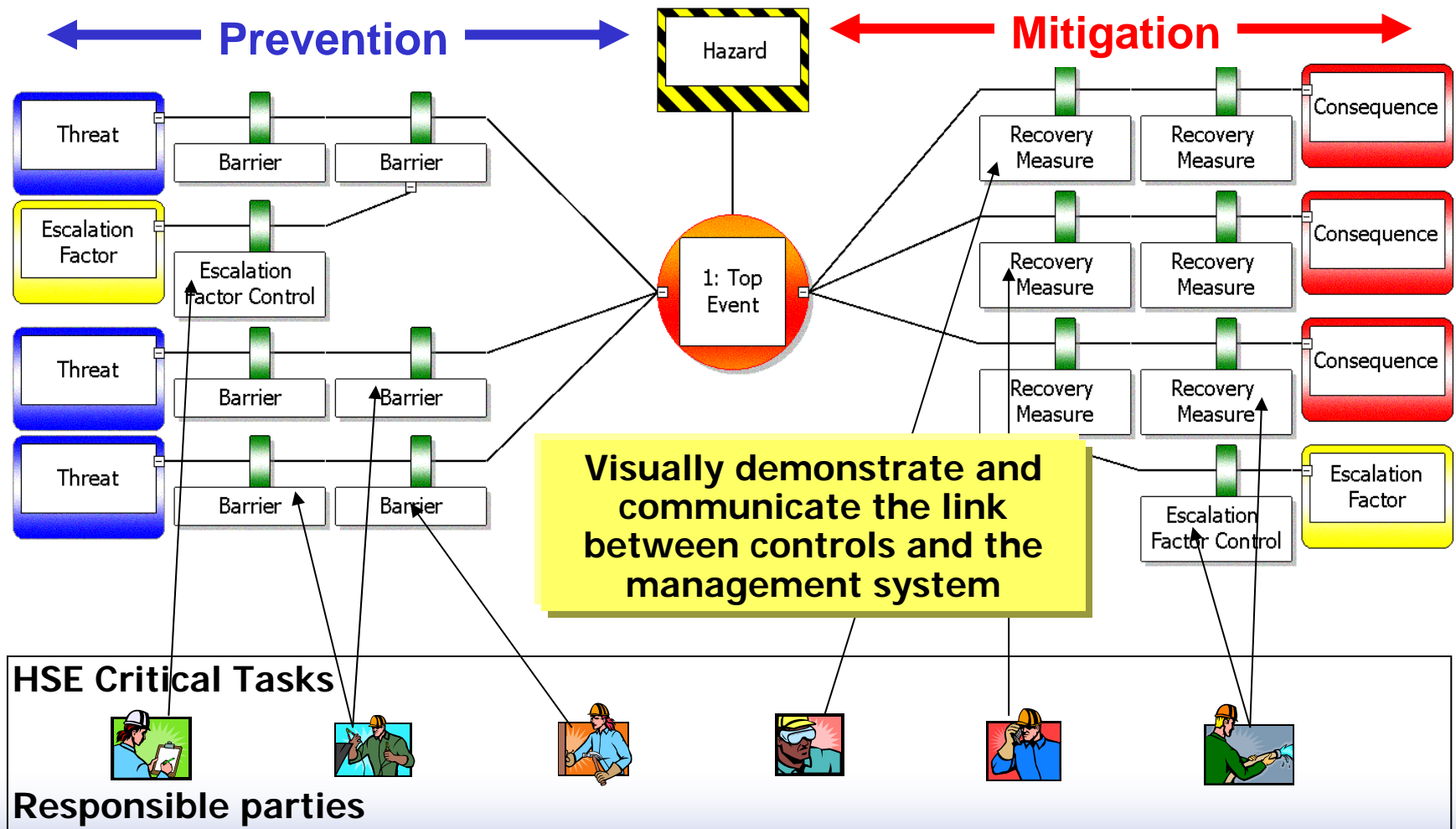
Auditing

How can we focus audits on what really matters?

Critical systems and performance standards

What are they?

Link between bow-ties & HSE-critical tasks



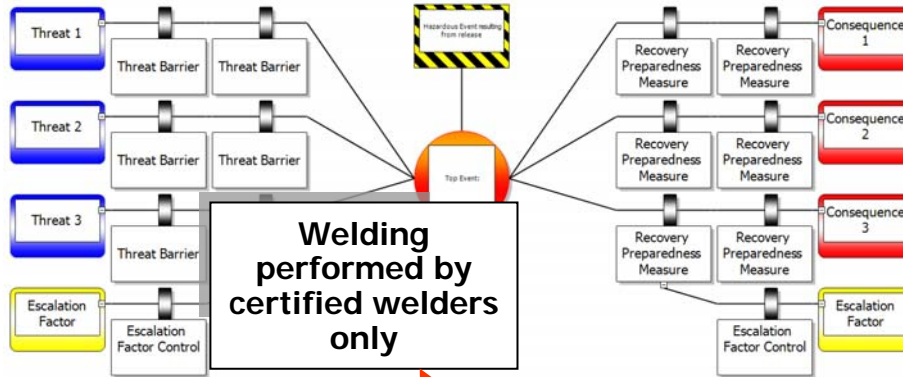
HSE-critical task catalogue

Client/Project Name		Senior Supervisor		HSE-Critical Role
Task 01.01	Making live and Closing of Hot Work Permits	Ensure that all permits are signed out 'made live' and closed by the Authorised Person	Permit register Records of Hot Works Safety Meetings	
Task 01.02	Ensure that Hot Work is in compliance with permit conditions	Ensure that permit is in compliance with MSN 102L and work is undertaken in safe manner	Permit register Walk round check/inspection of works Pre-job briefing sign off Safety meeting actions Daily records	
Task 02.04	Ensuring that lifting gear is tagged and colour	Ensure that lifting gear is coded as per procedure MSN 205L Ensure competence of certifying contractor	Audit and Inspection Sign off from certifying company.	Verification
Task 04.04	Confirm portable electrical equipment is fit for purpose and in possession of integrity certification	Ensure that external electrical equipment is tested on a 3 month cycle and internal equipment is tested on a 6 month cycle as per MSN 23L.	Visual check Audit of Portable appliances	

HSE-Critical task

HSE-critical procedure

Link between bow-ties and competence



Verify that competence and control requirements are aligned

Typical Competence Assurance System Job Profile

Job Title: Lead Production Operator (OPF)		JG: 7
Building Block	Skill Element	A K S M
Process System Description	Describe purpose of system	
	Provide sketch of product flow	
	Identify process parameters	
Equipment Identification	Identify subsurface completion equipment	
	Identify surface equipment	
	Identify facilities equipment	
	Identify safety systems	
Facilities (and Wells) Configuration	Identify line-up	
	Identify availability of production system	
	Take levels of production tanks	
	Calculate tank capacity	
Production Flow Regulation	Identify production capacity	
	Select well production	
	Produce wells and facilities	
Product Delivery Commitments	Communicate with marketing	
	Plan production	
	Produce at required rate	
Equipment Operation Description	Describe purpose of equipment	
	Identify pressures, temperatures, flow rates	
	Take readings	
	Analyse readings	
Equipment Readings	Report anomalies	
	Equipment Availability Optimisation	
	Execute maintenance	
Equipment Availability Optimisation	Control running hours	
	Analyse equipment failure	
	Rotating Equipment	
Rotating Equipment	Describe different rotating equipment	
	Perform rotating equipment maintenance	
	Analyse and correct machinery faults	
	Maintain equipment history	
	Test emergency equipment	
Static Equipment	Monitor rotating equipment	
	Describe different static equipment	
	Perform static equipment cleaning and maintenance	
Static Equipment	Maintain equipment history	
	Monitor static equipment condition	
	Failure Analysis	
	Apply condition monitoring techniques	
Failure Analysis	Analyse faults	
	Investigate possible shooting	
	Investigate possible shooting	

Accountability pack for each HSE-critical role

Accountability Sheet					
Role/Post :		Maintenance Supervisor			
Identified Safety Critical Role (Document OD-SA-03-46):		Yes, Level 1 and 2			
HSE Critical Task Specification Sheet					
Task Ref	Task Title	Input / Procedures		Task Verification	
BON-06.01.03	Maintain, test and inspect cargo and crude export pumps, meters and protection systems	<ul style="list-style-type: none"> OPRM-2003-0304 : POPM Volume 4 - Oil Storage Handling and Ballast OPRM-2003-0305 : POPM Volume 5 : Oil Metering and Export OPRM-2005-0057 : Maintenance and Inspection Management System Manual 		Maintenance plan, maintenance records, test results checked and verified by Operations Supervisor	
BON-06.01.08	Maintain, test and inspect the inert gas system	<ul style="list-style-type: none"> OPRM-2003-0319 : POPM Volume 19 - Inert Gas 		Maintenance Records. Reviewed by Ops Supervisor.	
Etc...					
Safety Critical Role Competencies (Document OD-SA-03-46)					
Competence Requirements	Prerequisites for Assessment	Assessment Format (Standard)	Assessor / Verifier	Re-Asses. Frequency	Maintenance of Competence
Skill at Validating PTW	Computer Based Training to Signatory standard	Computer Based Assessment	PTW Coordinator / Line Verifier	—	Maintained through ongoing daily activities and annual staff appraisal whilst in position
Skill at Supervising HSE	On the job exposure while completing OIM portfolio	Area Supervisor Competence Assessment Manual	Installation Manager / Line Verifier	—	Maintained through ongoing daily activities and annual staff appraisal whilst in position
Knowledge of the Nigerian Legislation (Mineral Oils (Safety) Regulations	Training Course	Demonstration of knowledge	Line Assessor / Line Verifier	—	Maintained through ongoing daily activities and annual staff appraisal whilst in position
Etc...					
I understand and accept the HSE Critical Tasks and Safety Critical Role Competencies assigned to me.					
Name			Signature		
Position			Date		

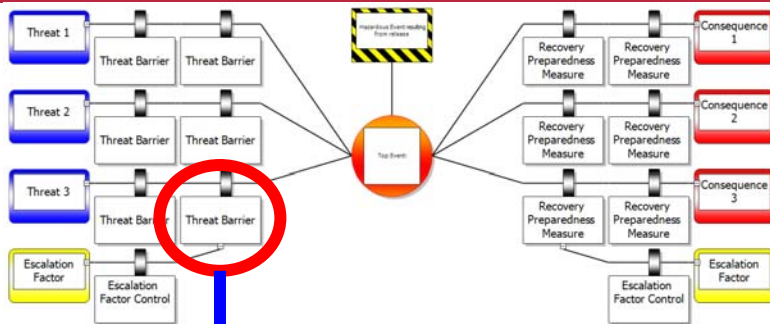
HSE-critical role

HSE-critical tasks, procedures & verification

HSE-critical competencies

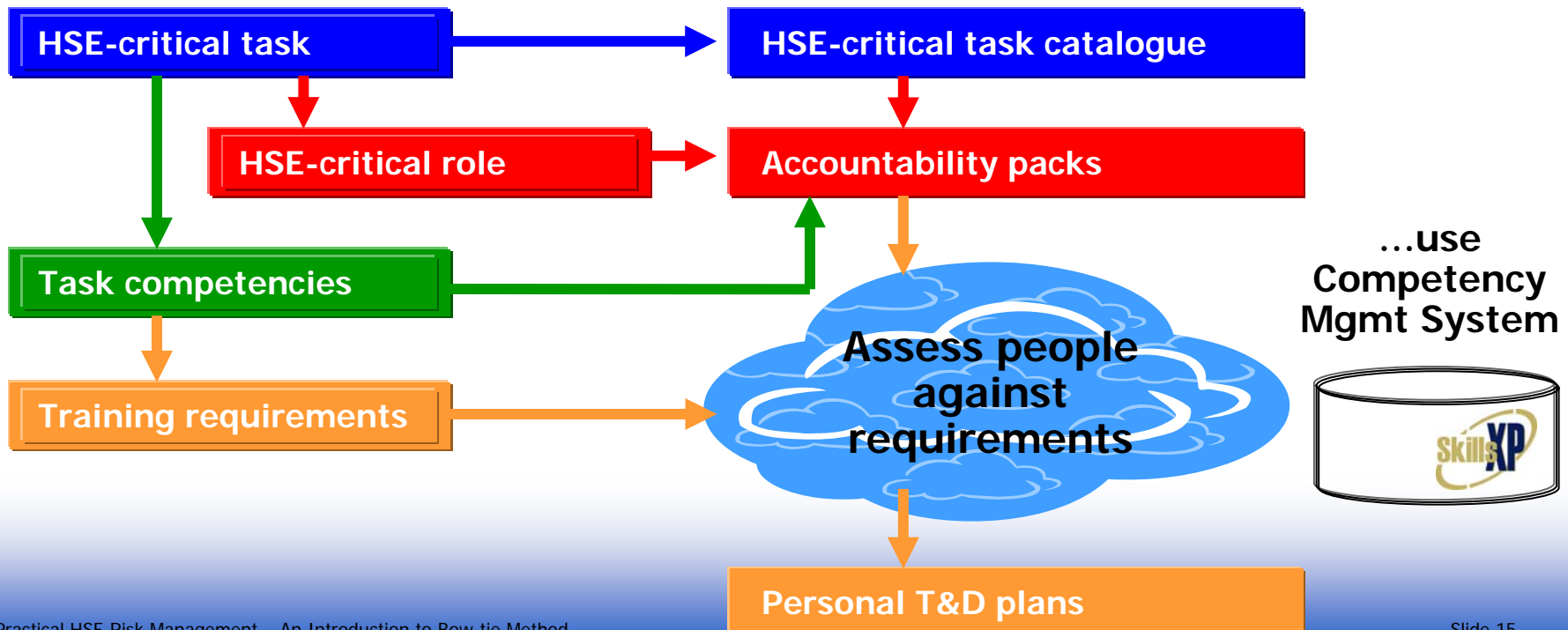
Sign-off

Link between bow-ties and training & development



Competent people provide resilience against major risks

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



Competency management system

CompetencyXP [Show Matrix]

File Add Records Security Maintenance Reporting Course Planning Tools Window About... Help

Select a Matrix

☐ Matrix from definition

☒ Dynamic matrix from role

Expiry date: 2/2/2006

Costs not calculated: ☒

Compiling: ☐

Department (incl. sub):

Find: 350 23.91 % 15.000.00

Expired: 10 0.68 % 25.201.00

Missing: 1.114 76.09 %

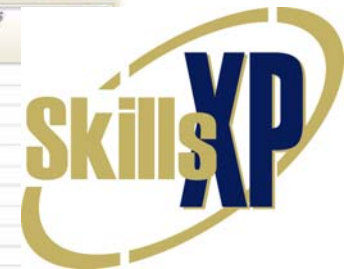
Valid
Expired
Planned date before selected expiry
Planned, in future

Reload

Name	Role	H2S Training	JSA	NIOS EPI	GVF	Rigging and Lifting	Scaffolding	SITP Method 3-step Management	HSEET	Survival	ISM Induction	Permit To Work	SEMS
CORREA DE LIMA, EVERTON	Floatabout								12/7/2007	11/23/2009			
CORREA GUEDES, WESLEY	Floatabout								10/14/2007	5/14/2007			
CORREIA DOS SANTOS, LUIZ ANTONIO	Floatabout			12/31/9999	12/31/9999			12/31/9999	6/24/2006			12/31/9999	
COUTINHO DE OLIVEIRA, RITA DE CASSIA	Floatabout					8/23/2007		12/31/9999	10/28/2007	10/27/2008			
CRUZ DO NASCIMENTO, MARCOS	Floatabout		12/31/9999		12/31/9999	12/31/9999		12/31/9999	8/25/2006	7/7/2006			12/31/9999
DA COSTA MONTEIRO, RONALDO	Floatabout					8/5/2007			4/7/2006	8/26/2007			
DA CUNHA SILVA, FABIANO	Floatabout				12/31/9999	12/31/9999			12/12/2007	1/6/2008			12/31/9999
DA CUNHA SILVA, FABIO	Floatabout				12/31/9999	12/31/9999		4/7/2006	2/7/2007		12/31/9999		
DA RORA, JOSE LAELDO	Floatabout				12/31/9999	7/22/2007		10/22/2006	3/31/2006	11/18/2009			
DA SILVA CORREA, ADILDO	Floatabout								12/19/2007	12/19/2009			
DA SILVA CORREA, CARLOS	Floatabout							12/31/9999	2/2/2007	2/15/2006			
DA SILVA CORREA, JOSE PAULO	Floatabout								4/28/2007	6/11/2006			
DA SILVA CORTES, JOAO MARCIO	Floatabout	12/31/9999	12/31/9999			12/31/9999		2/13/2006	5/14/2006	11/23/2008		12/31/9999	
DA SILVA ESTEVAO, ANSELMO	Floatabout					11/11/2007			11/12/2006	2/22/2006			
DA SILVA OLIVEIRA, JOSE EDUARDO	Floatabout	12/31/9999	12/31/9999			12/31/9999		10/11/2006	3/31/2006	3/2/2006			
DE ALENCAR SANTOS DA SILVA, HUMBERTO	Floatabout								12/21/2007	3/18/2007			
DE ALMEIDA COIMBRA, PAULO CESAR	Floatabout					12/31/9999		12/31/9999	11/18/2007	8/27/2006			
DE ALMEIDA RANGEL, MANOEL	Floatabout	12/31/9999	12/31/9999			12/31/9999		12/31/9999	2/23/2007	8/15/2009			
DE JESUS, DANIEL LUCIANO	Floatabout					12/31/9999			10/13/2007	10/13/2008			
DE LEMOS CASADO, SIDNEI	Floatabout									3/28/2009			
DE OLIVEIRA FREITAS, JERISON ROGERS	Floatabout									2/15/2006			
DE OLIVEIRA TALINA, CLAUDIO	Floatabout									8/36/2007			
DE PAULA DA SILVA, PAULO SERRAO	Floatabout	12/31/9999	12/31/9999					12/31/9999	1/13/2007	1/21/2009			
DE SA SANTOS, ALEXANDER	Floatabout								12/5/2007	8/4/2008			
DE SENA, ADILTON CATARINO	Floatabout		12/31/9999				12/31/9999		8/18/2006	4/6/2008			
DE SOUZA CALDAS, ROGERIO	Floatabout							12/31/9999	10/14/2007	2/25/2007		12/31/9999	
DE SOUZA MELO, PAULO ADRIANO	Floatabout					8/5/2007			4/26/2006	6/18/2006			
DE SOUZA PEREIRA, CRISTIANO	Floatabout							4/13/2006	12/3/2006	4/20/2007			
DE SOUZA PESSANHA, REGINA MARCIA	Floatabout								11/26/2006	12/1/2010			
DE SOUZA SILVA, JOAO BATISTA	Floatabout			12/31/9999	12/31/9999				12/12/2007	7/22/2007		12/31/9999	
DE SOUZA TAVARES, CARLOS AUGUSTO	Floatabout									12/15/2006			
DIAS GUEDES, ROSSON	Floatabout									7/22/2009			
DOS ANJOS, WAGNER JORGE	Floatabout								10/14/2007	10/13/2008			
DOS REIS CORREA, FERRANDO ANTONIO	Floatabout								10/7/2007	10/3/2009			
DOS SANTOS ARAUJO DA SILVA, ANDERSON	Floatabout					3/13/2007			8/18/2006	8/20/2008			
DOS SANTOS, JOSUE LUIZ	Floatabout		12/31/9999			12/31/9999		3/24/2006		3/20/2006			
DOW, WILLIAM MICHAEL	Floatabout					8/5/2007			4/7/2006	7/29/2009			
DUARTE DA SILVA, EDUARDO	Floatabout									1/10/2009			
FARIA MACIADO, MARCOS ANTONIO	Floatabout								3/24/2006	3/29/2009			
FELKDA SILVA, FRANCISCO CARLOS	Floatabout			12/31/9999		12/31/9999		12/31/9999		5/23/2007			
FERRERIA BARBOSA, ELY CARLOS	Floatabout					12/31/9999			4/23/2006	12/23/2007			
FERNANDES, ROBERTO	Floatabout									12/15/2006			

Show report Export Close

Sample training matrix



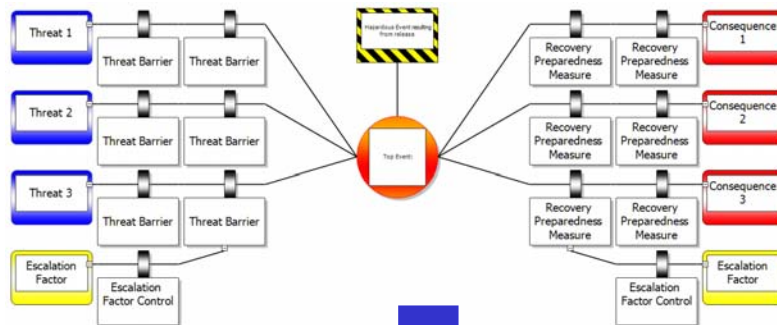
- Personnel information
- Training management
- Competency management
- Document management
- Reporting

Link between bow-ties and procedures

Task	Responsible Person/Task Description	Inputs/Documents	Verification
ABC-22.05	Area Supervisor – Maintain Safety Signage	Ensure safety related signs are maintained up-to -date and in good order <ul style="list-style-type: none"> - escape routes - exit signs - fire equipment signs - life saving appliance signs 	- Inspection and Audit
ABC-12.03	HSE – Manager – Management of Hazardous Materials	Ensure correct storage and handling of hazardous materials in accordance with the requirements identified in the MSDS <ul style="list-style-type: none"> - secure storage - segregation of incompatible chemicals - use of PPE - appropriate means of transport- inventory management 	<ul style="list-style-type: none"> - HSE audit - area inspections - manifests - non compliance reports
ABC-06.03	Site foreman – Weekly area Inspections of process facilities	Carry out weekly inspections of all site areas: <ul style="list-style-type: none"> - housekeep - general co - general co - condition c - availability 	<ul style="list-style-type: none"> - Inspection checklist - " " reports - " " reports

Verify procedures for conducting HSE-critical tasks are complete and effective

Link between bow-ties and auditing

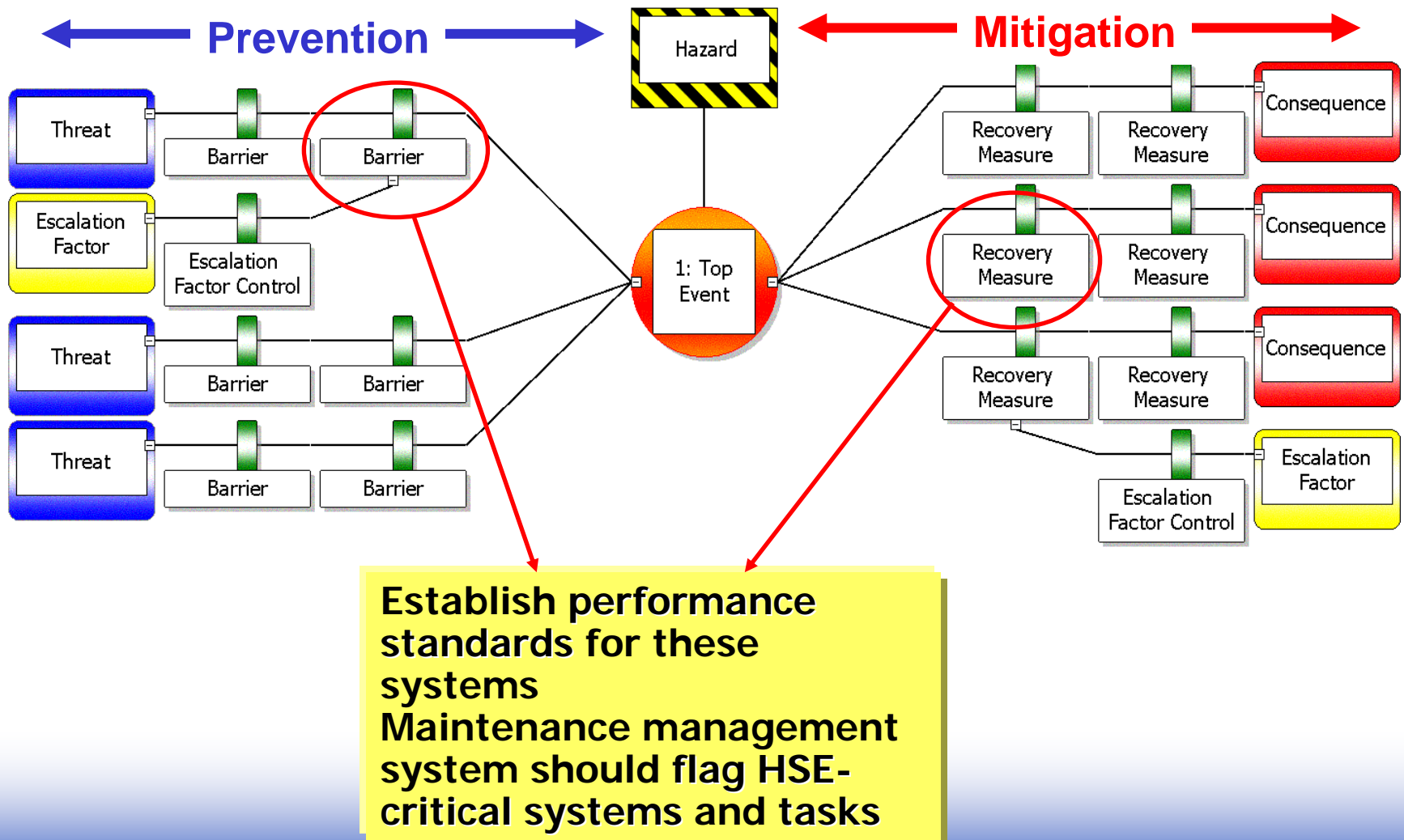


HSE -CRITICAL TASK LIST	
Responsible Person:	Supervisor
Task 1:	
Task 2:	
Task 3:	

AUDIT CHECKLIST	
Supervisor	
Task 1	<input checked="" type="checkbox"/>
Task 3	<input checked="" type="checkbox"/>
Foreman	
Task 5	<input checked="" type="checkbox"/>
Task 9	<input checked="" type="checkbox"/>
Task 11	<input checked="" type="checkbox"/>

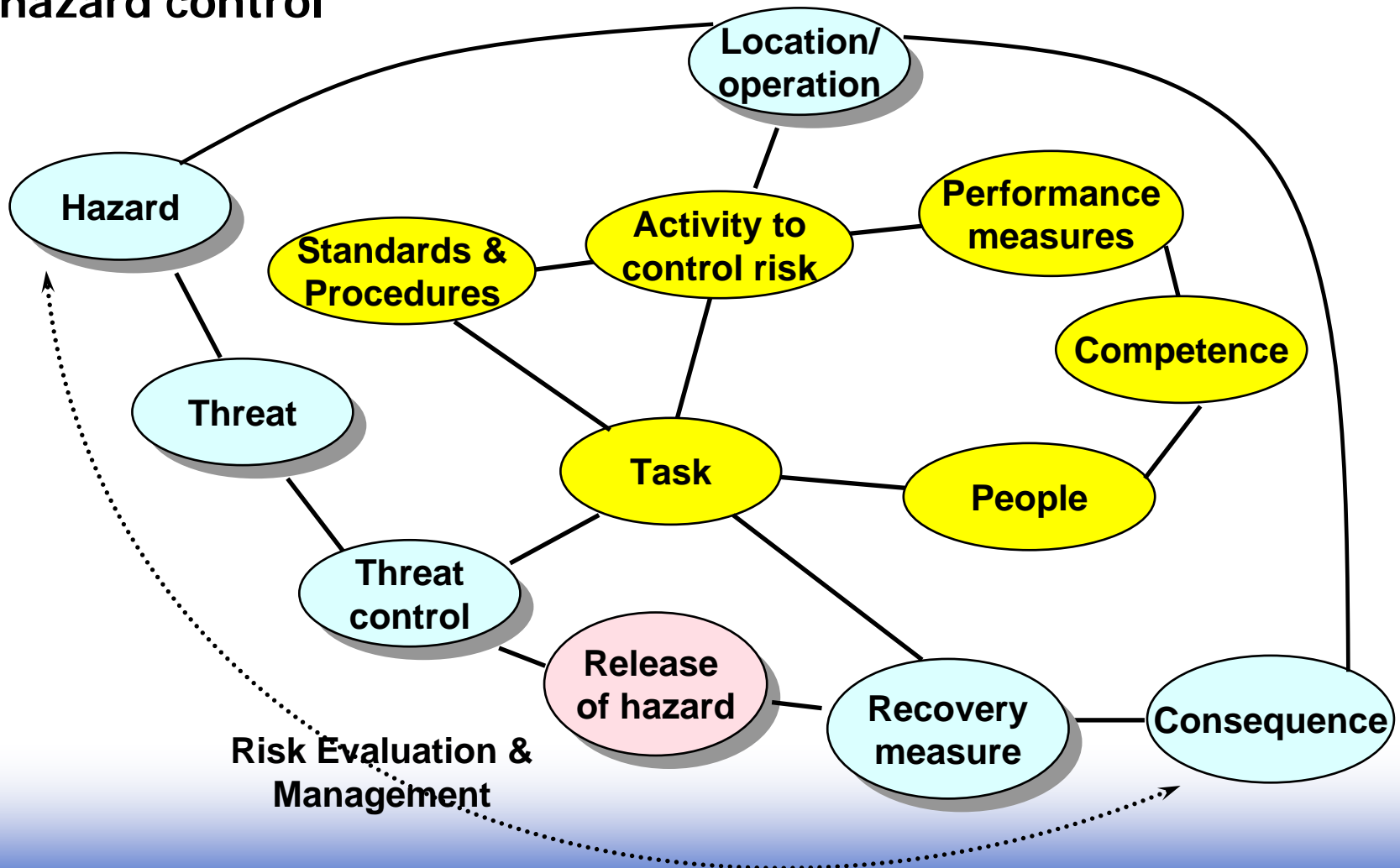
Audits can be focused on what really matters

Link between bow-ties and HSE-critical equipment & systems

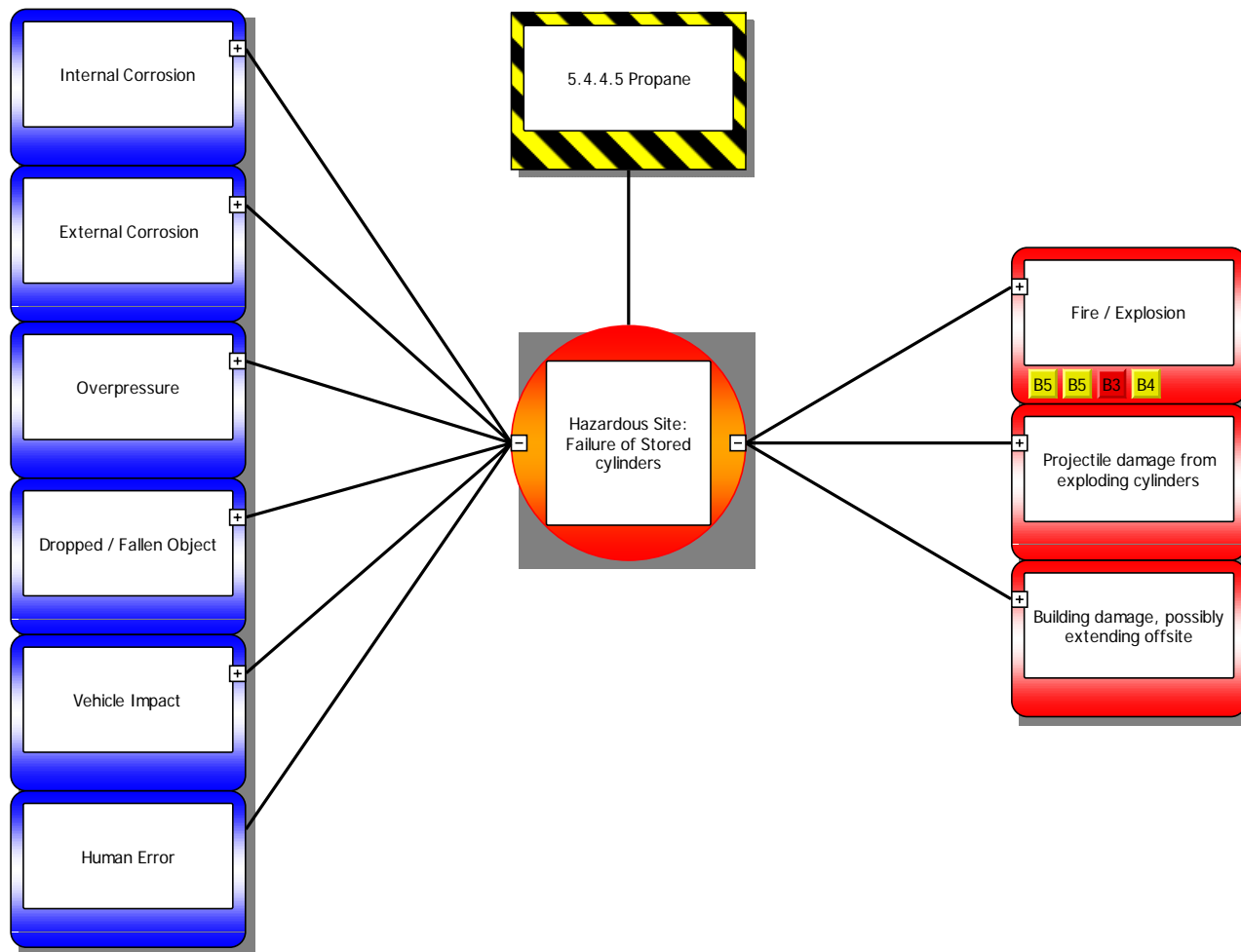


Total hazard control

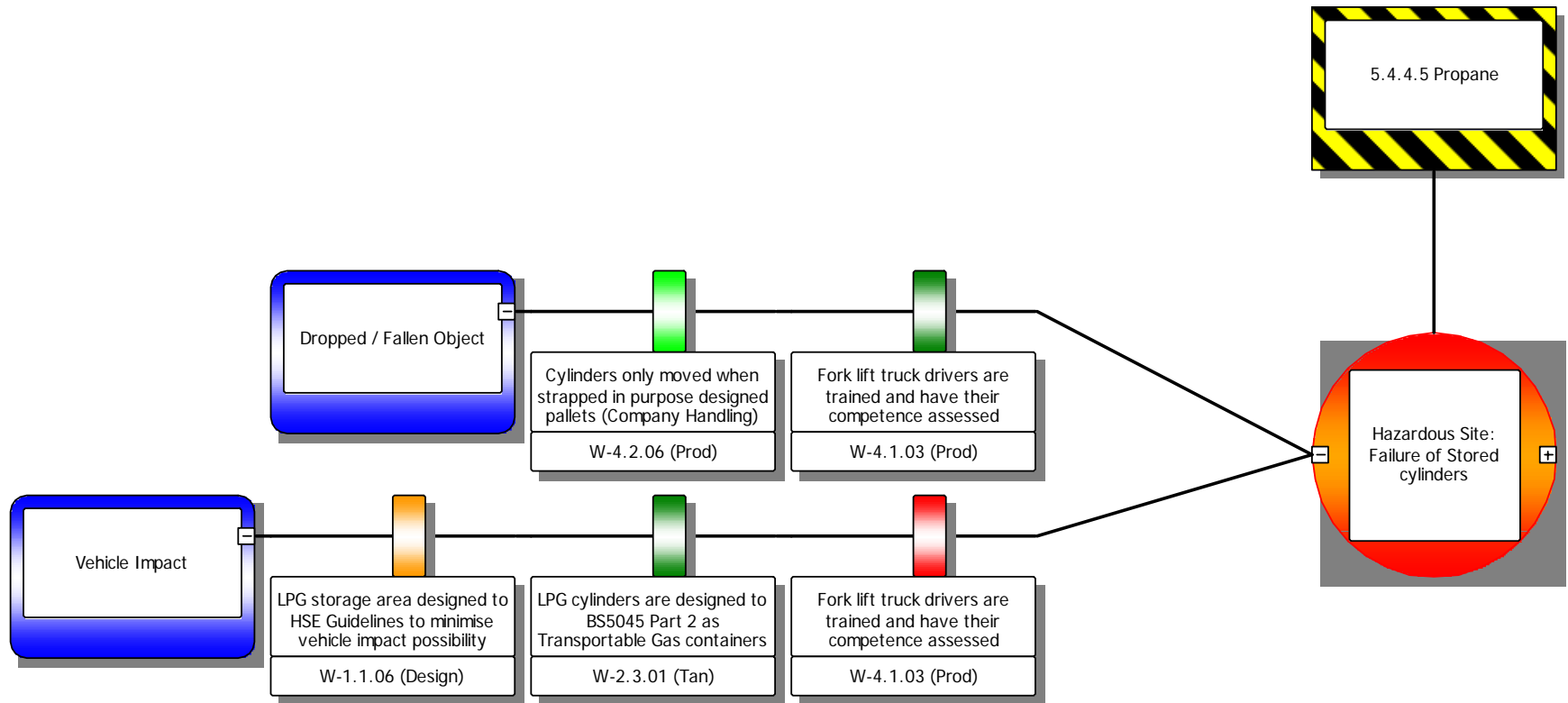
In the end you must have all connections in place for effective hazard control



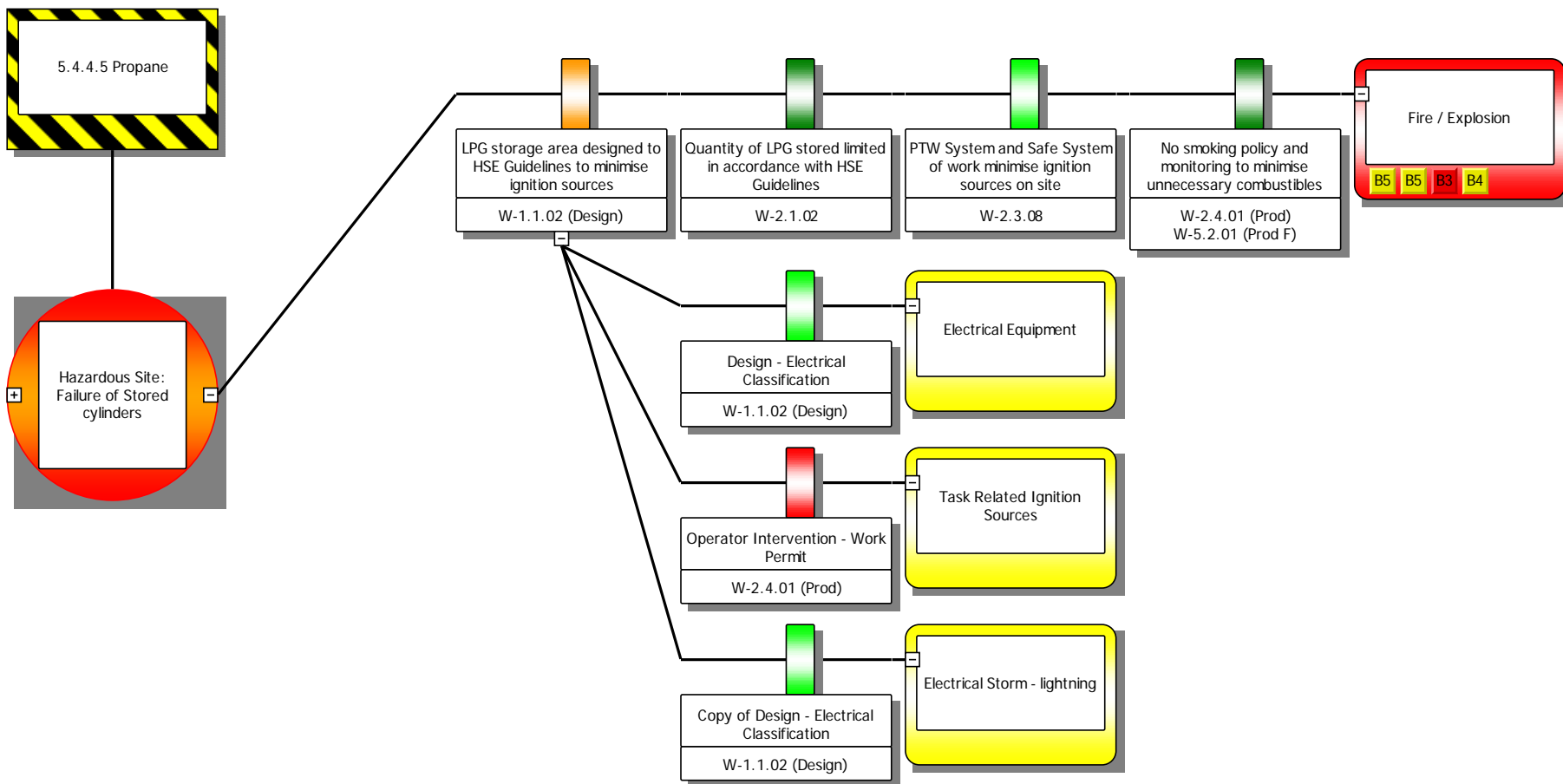
Example bow-tie



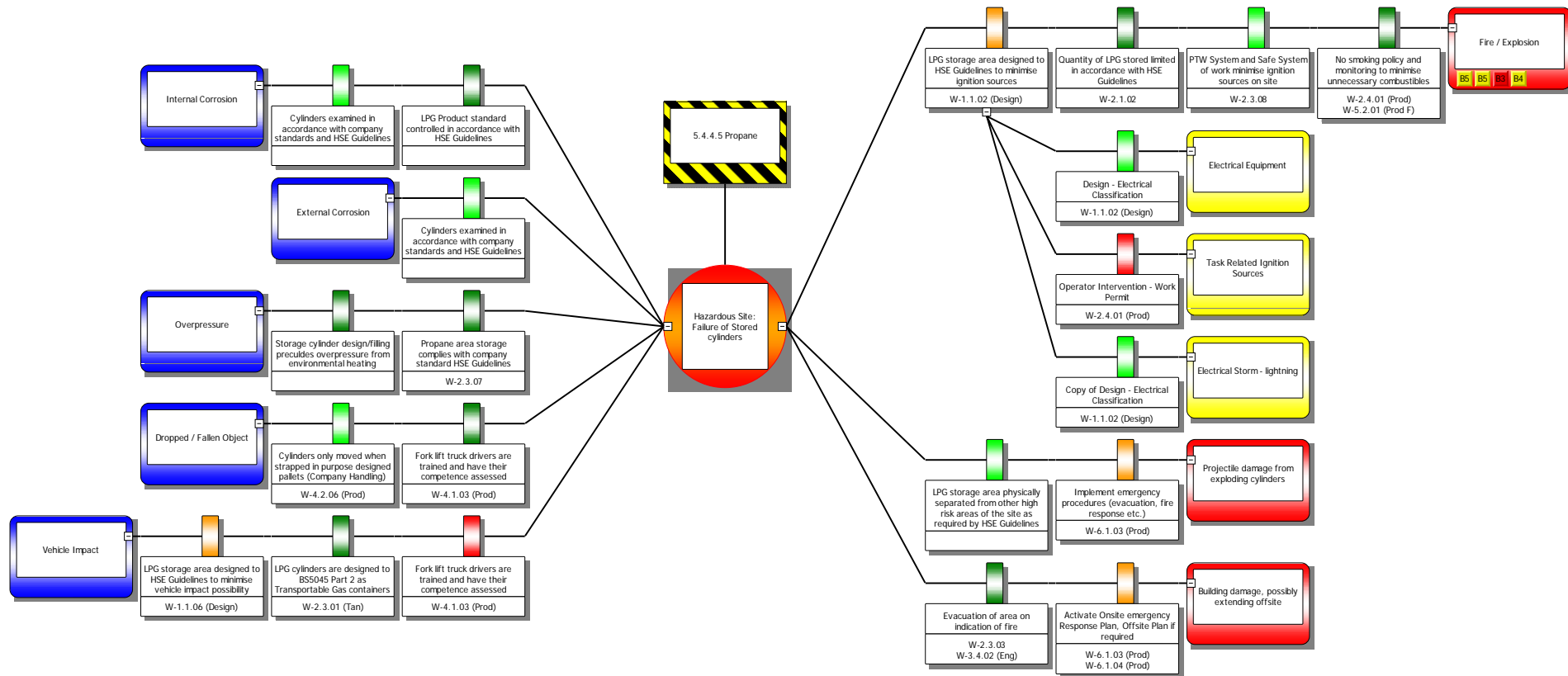
Example bow-tie: threats



Example bow-tie: consequence

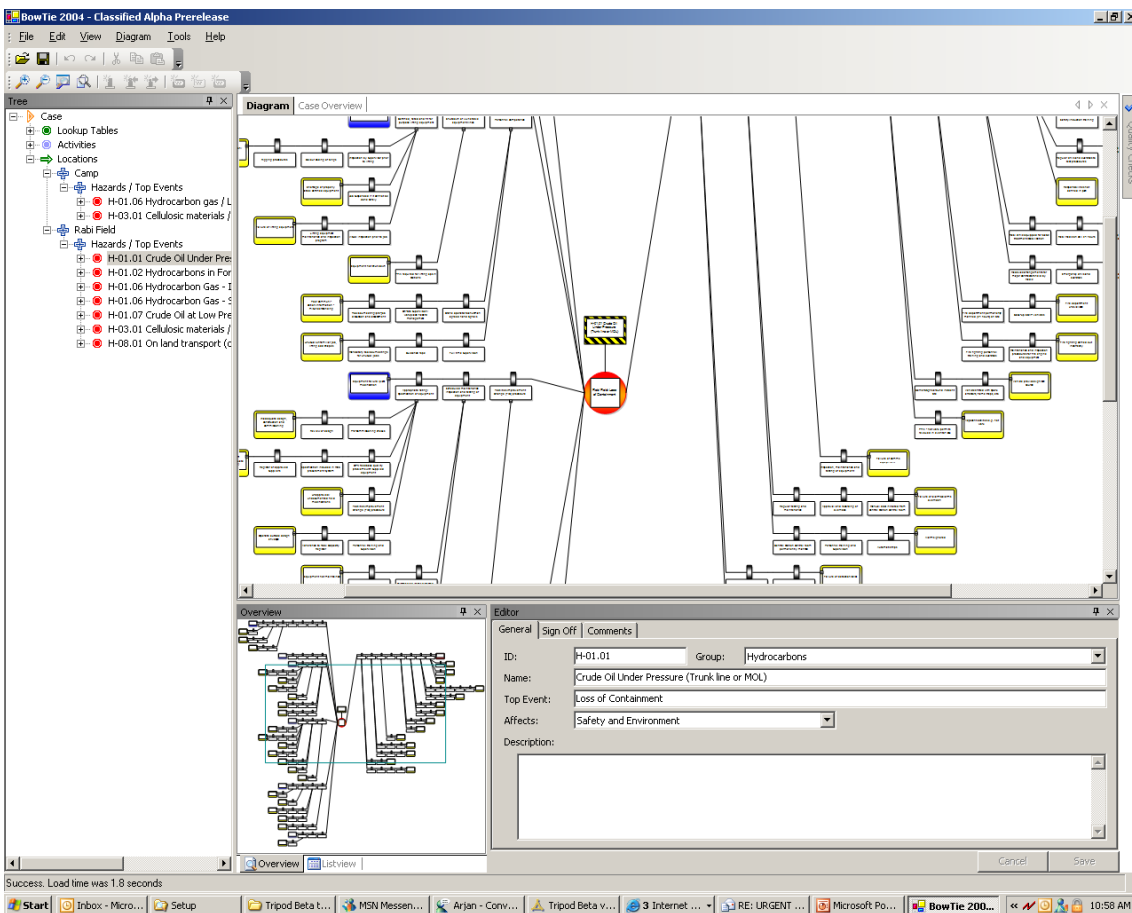


Example bow-tie: complete



Building bow-ties

Software helps but don't
get hung up on it!
**Benefits are from
approach and involving
workforce**



 **BowTieXP**

Benefits of bow-tie method

- **Communication** – “a picture paints a thousand words”
- **Ownership** – involves people, gains buy-in, practical approach
- **International application** – overcomes language difficulties
- **All risks** – not just HSE
- **Risk reduction** - identifies where resources should be focussed for risk reduction, i.e. prevention or mitigation

Benefits cont...

- **Fit for Purpose MS** – Links elements of the organisation's MS to specific control
- **Auditable Trail** – the diagrams and critical tasks provide protocol around which auditing by internal depts focuses on what people are actually doing rather than physical systems

Limitations

- Entirely qualitative
- Does not replace other techniques (JSA, method statements, etc.) – is complementary to them
- Depends on experience of personnel and active workforce involvement
- Ensure controls in bowtie are truly independent

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 bow-ties

Tips for success

- 1. Keep end objective in mind - pitch at the right level**
- 2. Involve the right people**
- 3. Avoid barrier counting**
- 4. Use method to full potential**
- 5. Verify controls and tasks**

Summary

- The **Bow-tie Diagram** is a user-friendly, graphical illustration of how hazards are controlled
- Effective risk management is only possible if people are assigned responsibilities for controls via **HSE-Critical Tasks**
- Visible links are made to **HSE-critical systems** and **competencies** and **auditing**
- The total methodology demonstrates not only what controls are in place **today**, but why they will still be there **tomorrow**