add energy

Safety and Risk Engineering

HSE Case Implementation

Clive Rawson

IADC 75 YEARS

Asia Pacific HSE&T 2015

Purpose

- ALARP
- Risk Assessment
- Major Accident Events
- Bowties
- Safety Critical Systems
- Performance Standards
- Implementation
- Getting HSE Case accepted
- Gap Assessment and rig upgrades

Add energy HSE/Safety Case Experience

- Oracle Risk Consultants from 2001-2013
- Now part of ***add energy group***
- Over 150 HSE/Safety Cases
- Offices worldwide
- Members of IADC

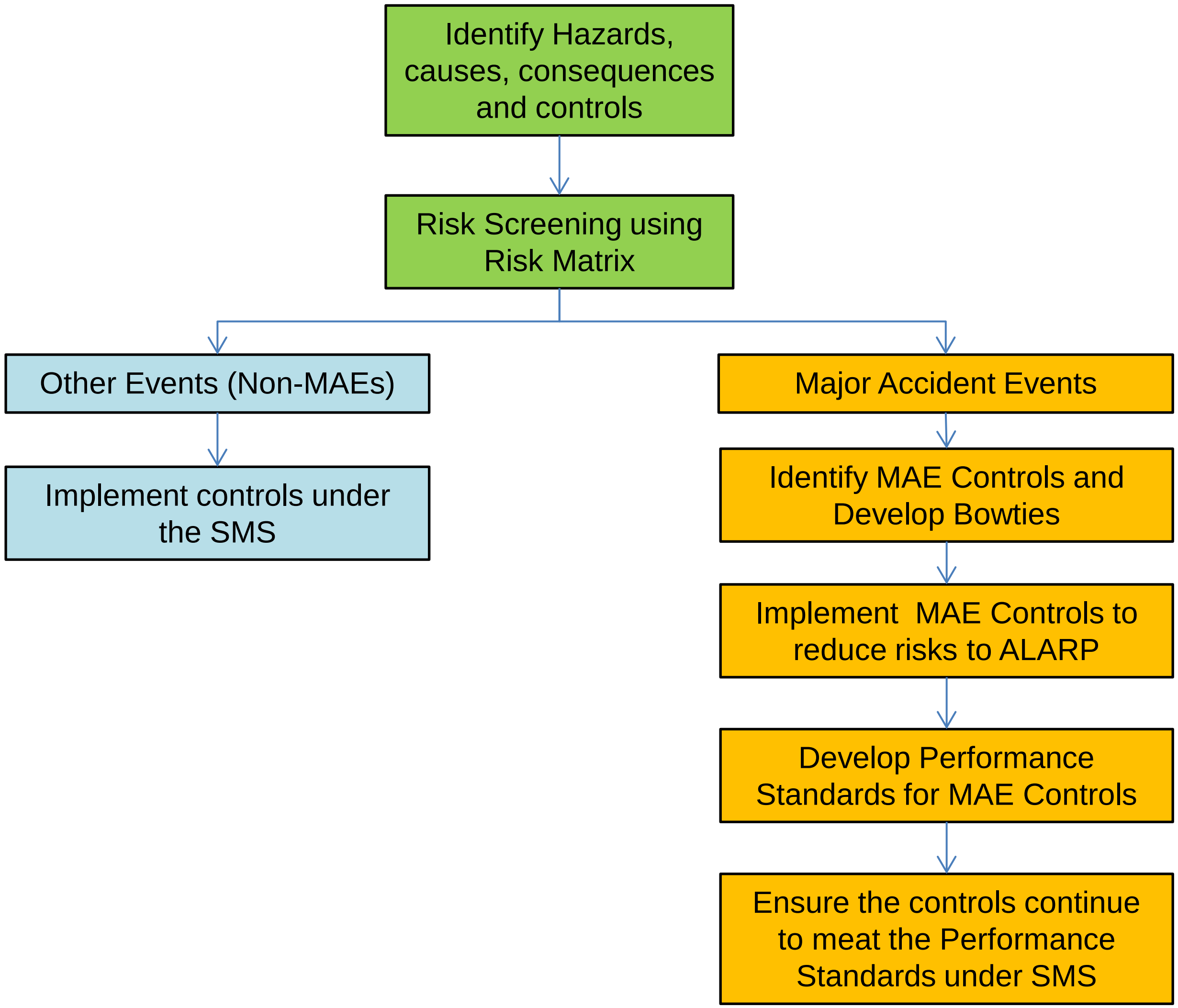
Definitions

- **ALARP** – Demonstrating that the safety Risks have been reduced to *As Low As Reasonably Practicable* (i.e. the operator can demonstrate that there are no practicable upgrades or changes that can be made to reduce risk further)
- **Major Accident Event** – one capable of multiple fatalities (e.g. blowout)
- **Control Measure** - any system, equipment or procedure that reduces risk
- **Risk Assessment** – Process for estimating the severity and likelihood of a Major Accident.
- **Safety Critical System** – one that has a benefit in preventing Major Accident Events
- **Performance Standard** – Specification of the performance required os a Safety System which is used as a basis for managing the risk

Key issues

- HSE Case produced by others but not followed (sits on shelf)
- No evidence of meeting the latest standards and gap assessment
- No performance standards produced
- No evidence of testing and maintenance of safety critical equipment
- No adequate demonstration of “ALARP”

Risk Assessment Process



Hazard Register

We use a bowtie format:

Threats / Causes	Prevention Controls (Physical) (SCEs)	Prevention Controls (Procedural) (SCPs)	Hazardous Event / Incident	Reactive Controls / Emergency Response (Physical) (SCEs)	Reactive Controls / Emergency Response (Procedural) (SCPs)	Potential Consequences / Outcomes	Risk Ranking C	Risk Ranking L	Risk Ranking R	Risk Ranking MAE?	Comments / Assumptions
• Dropped objects / crane or lifting equipment failure	• Crane Safety Systems • Basis of design, equipment specifications, material specifications • Dropped object / impact protection • Constant communication between crane driver, dogman, rigger and vessels (dedicated crane channel) • Lifting equipment rated for maximum lift weight • Redundant lifting lines • Lifting equipment designed and tested for specific lifting applications • SWL marked on equipment	• Crane Operations and Lifting Equipment (ALL/HSE/PRO/041), including engineered lift approval process and pre-use inspection of crane and lifting equipment • Working at Height and Scaffolding (ALL/HSE/PRO/019) • Adverse Weather Operating Conditions (ALL/HSE/PRO/024) • Training and competency (BU/TEC/PRC/001), including use of competent dogman • Risk Management Procedure (ALL/HSE/PRO/040), including JHA, pre-start meeting, StepBack 5x5, Four Quarters, fatigue management, fitness for work and Behavioural-based Safety Program • PTW / WI / EODs (ALL/HSE/PRO/053), including inspection prior to use • Maintenance and inspection strategy, procedures and schedules in line with manufacturer recommendations • Regular third party surveys / audits of all lifting equipment • HSE Auditing and Inspection Procedure (ALL/HSE/PRO/031) verifies adherence to the appropriate procedures • Weather report, wind data, wave data	CPP-FT04: Loss of containment of topsides process hydrocarbons	• Fire and gas detection • Bayu-Undan Electrical Equipment in Hazardous Areas (BU/TEC/GLN/027) • Design for fire / explosion resistance • Fire / blast wall barriers / PFP • Engineered design - grating, drainage, bunding • PSD • ESD • CCTV • Fire-rated valves • Emergency blowdown • PFP • Active fire protection • Platform MACs / alarms • PPE • ISVs in field can assist if required • Medical / first-aid facilities • ETRER facilities	• Emergency Response Plan (BU/HSE/PLN/001) • Ignition controls, including PTW (ALL/HSE/PRO/053) • BU Field Network Security Plan (BU/HSE/PLN/007) • Incident Reporting and Investigation Procedures (ALL/HSE/PRO/003) • Field Precautionary Down Manning Procedure (BU/OPS/EOD/838) - reduced manning for extreme weather conditions	• Fire / explosion • BLEVE • Multiple fatalities • Asphyxiation from hydrocarbon release	5*	3	Significant	Y	• **ACTION 1:** Proceduralise arrangements for inspecting worksite following an earthquake - Mike Gibson. • **ACTION 2:** Review the requirements for passive fire protection on critical piping, equipment and support structures (particularly the piping and support structure of the Second Stage Separator) - Derek Cross. **CLOSE-OUT:** Study being carried out by MMI to review PFP requirements.
• Corrosion of hydrocarbon containing equipment, including CUI	• Material Selection and protective coatings • Corrosion inhibitor injection • Engineered design (corrosion allowances, duplex flowlines)	• Maintenance and inspection strategy, procedures and schedules • Asset integrity management, including anomaly management, removal of external corrosion scale from pressurised piping and equipment, quantification of coating anomalies, engineering survey and inspection • Leak / pressure testing conducted prior to introduction of hydrocarbon into the process system									
• Erosion of hydrocarbon containing equipment	• Engineered design - duplex flowlines • Mechanical interlocks on valves • Level instrumentation (prevents gas blowby)	• Process Operating Guideline / EODs • Inspection procedures • Monitoring of sand impact • Onshore monitoring of flow rates • Training and competency (BU/TEC/PRC/001) - knowledge and awareness of design limitations									
• Mechanical failure / fatigue / vibration	• Basis of design, equipment specifications, material specifications • Vibration monitoring	• Process Operating Guideline / EODs - procedures to limit flare rate (limits vibration at surge drum headers) • QA / QC of materials and welding during construction, repairs, remediation • Leak / pressure testing conducted prior to introduction of hydrocarbons • Maintenance and inspection strategy, procedures and schedules in line with manufacturer recommendations • Training and competency (BU/TEC/PRC/001) - knowledge and awareness of design limitations • Training and competency (BU/TEC/GLN/003-089) - knowledge and awareness of design limitations									

Risk Matrix

LIKELIHOOD	0 Remote	1 Highly Unlikely	2 Unlikely	3 Possible	4 Quite Likely	5 Likely
Historical:	"Unheard of in the industry"	"Has occurred once or twice in the industry"	"Has occurred many times in the industry, but not in the Company"	"Has occurred once or twice in the the Company"	"Has occurred frequently in the Company"	"Has occurred frequently at the location"
Frequency: (Continuous Operation)	Less than once every 10,000-years at location	Once every 1,000-10,000 years at location	Once every 100-1,000 years at location	Once every 10-100 years at location	Once every 1-10 years at location	More than once a year at location or continuously
Probability: (Single activity)	1 in 100,000-1,000,000"	1 in 10,000-100,000	1 in 1,000-10,000	1 in 100-1,000	1 in 10-100	>1 in 10

CONSEQUENCE	People	Environment	Value	Reputation			0 Remote	1 Highly Unlikely	2 Unlikely	3 Possible	4 Quite Likely	5 Likely
	Multiple Fatalities (MAE)	Permanent impact	> $1000M	International concern. Major ventures terminated. Company at stake.	5	Catastrophic	5	6	7	8	9	10
	Single Fatality or Permanent Total Disability	Long term (years) impact	$100M-$1000M	Persistent national concern. Long term 'brand' impact. Major venture/asset Operations severely restricted.	4	Massive	4	5	6	7	8	9
	Major Injury/illness, Permanent Partial Disability or Lost Work Case >4days	Medium term (months) impact	$10M-$100M	Medium term national concern. Minor venture or minor asset operations restricted or curtailed.	3	Major	3	4	5	6	7	8
	Minor Injury/illness. Restricted Work Case or Lost Work Case <4 days.	Short term (weeks) impact	$1M-$10M	National bad mention. Short term regional concern. Close scrutiny of Asset level operations/future proposals.	2	Moderate	2	3	4	5	6	7
	Slight Injury/illness. First Aid or Medical Treatment Case	Localised (Immediate area) Temporary impact (days)	<$1M	Short term local concern. Some impact on asset level non-production activities.	1	Minor	1	2	3	4	5	6

INTOLERABLE

ALARP REGION (TOLERABLE IF REDUCED TO ALARP)

BROADLY ACCEPTABLE

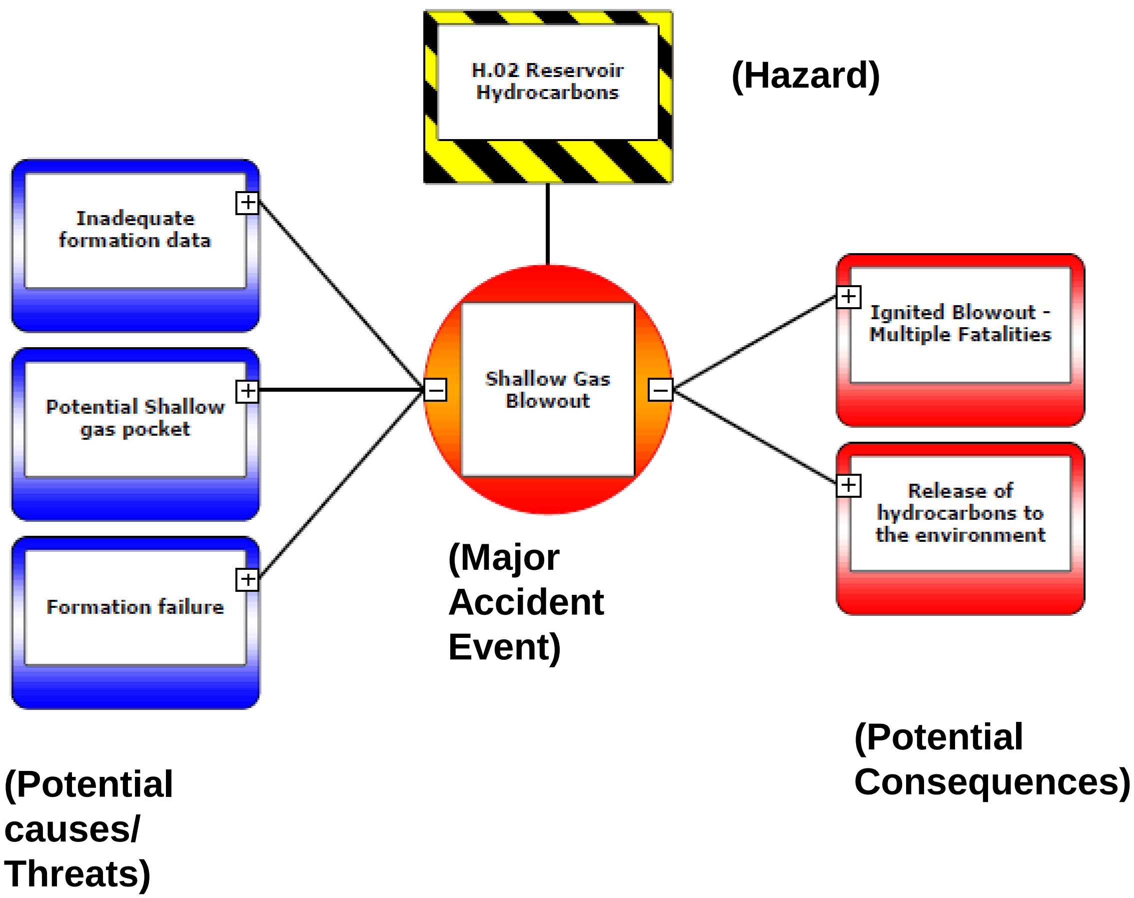
Potential Major Accidents

The definition of a ***Major Accident Event (MAE)*** is an accident with the potential for ***multiple fatalities, eg.***

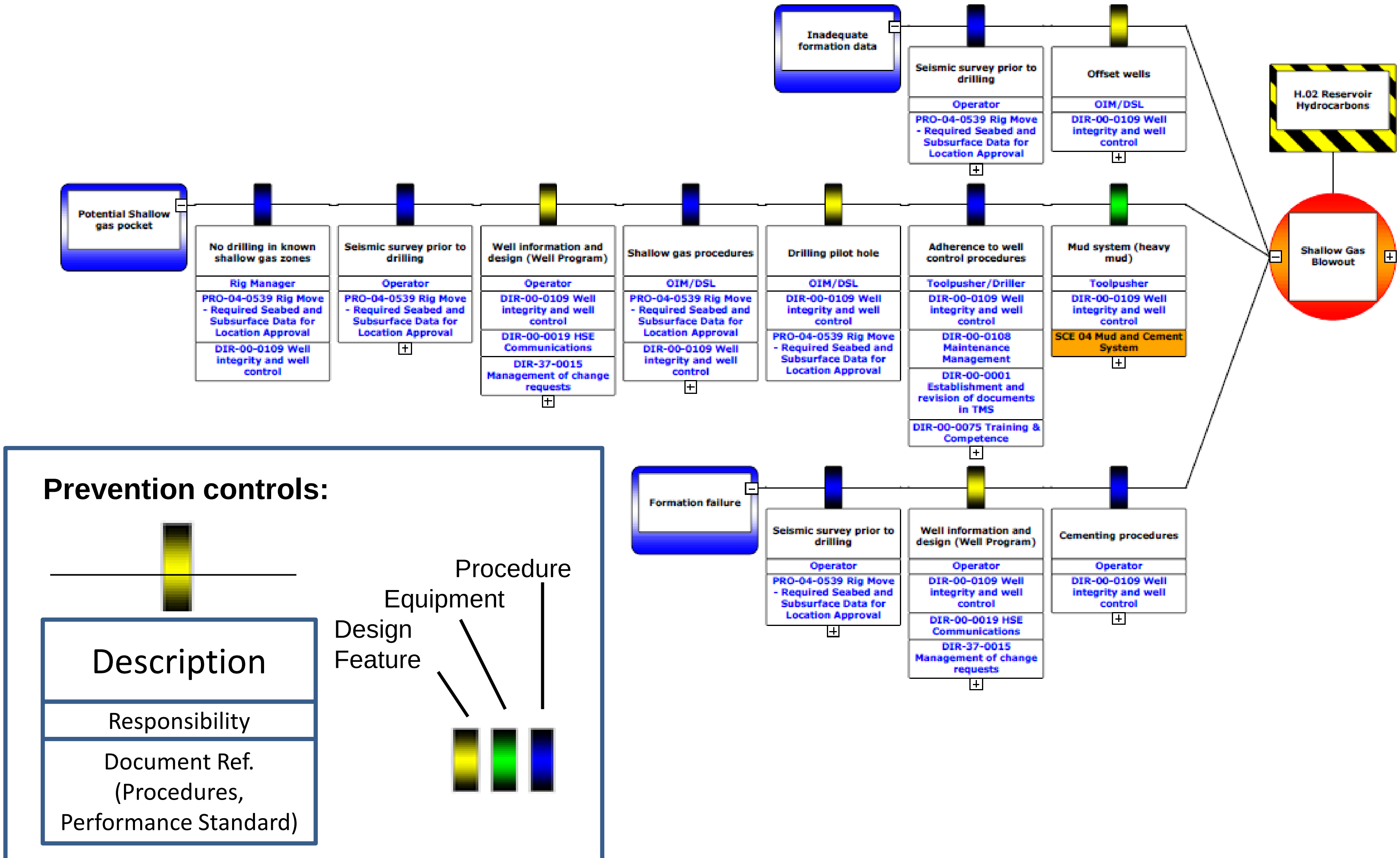
- Blowouts
- Shallow Gas
- H_2S
- Fire in Machinery Space
- Fire/explosion in mud return area
- Fire in well test area
- Fire in Accommodation
- Loss of stability
- helicopter crash
- H_2S
- Dropped objects
- Ship collisions
- Loss of position
- lifeboat/billy pugh accident

Bowtie Example

A “bowtie diagram” is simply a pictorial representation of a Major Accident.

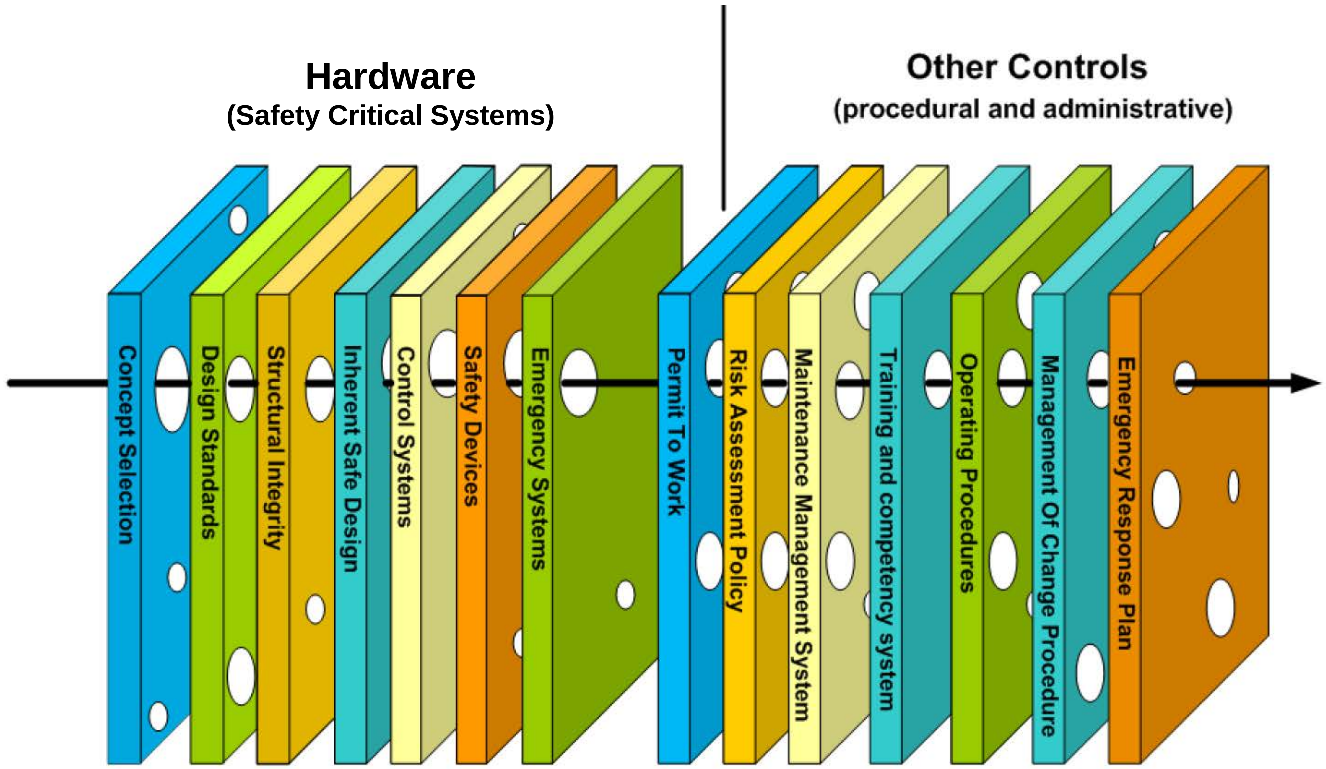


Bowtie Example



Do we have enough Controls?

- Driller rule of thumb: *two independent tested barriers*
- But the more barriers the lower the risk
- Some controls are more effective at reducing risk than others – but all are important



Output from Bowtie

Outputs from the “Bowtie” include:

- List of Control Measures that can be divided into:
  - Safety critical systems (Equipment)
  - Safety critical procedures
  - Safety critical competencies
- List of responsibilities for each key person regarding control measures
- Checklists for use prior to starting a task or regularly checked during task

“Implementation of the HSE Case involves ensuring that all control measures are in place and remain effective (maintained and tested) – not just documented in the HSE Case”

Typical Safety Critical Systems

- Blowout Preventer, well control and diverter system
- HP mud and cement systems
- Choke and Kill systems
- The hull and primary structure
- Watertight integrity
- Ballast and Bilge systems
- Propulsion and station keeping (DP)
- Anchors & winches
- Towing system
- Fire & Gas Detection
- Emergency Shutdown
- Emergency power and lighting
- Ventilation system, including shutdown to prevent gas/smoke ingress
- Fuel and Lube oil system
- Hazardous Area Zoning and Ignition prevention
- Active and Passive Fire Protection
- Escape, Temporary Refuge, Evacuation and Rescue Systems
- Helideck and helicopter refuelling
- Navigation and communications systems
- Lifting systems including cranes, derrick and tubular handling
- Hydraulic and Pneumatic systems including Heave compensation

Performance Standards

- Design basis/ specification for each system
- They define the parameters against which the control measures for MAEs can be measured and tested to ensure risk are managed to ALARP.
- They specify function, survival requirements (e.g. fire resistance) and reliability/sparing requirements (e.g. 2 x 100% fire pumps required)
- Based on Codes, Standards, operations experience or risk assessment.
- ***Implementation is via the Preventative Maintenance System (PMS) which should contain*** maintenance and testing procedures which align with the Performance Standards.
- Performance standards contain both design and operational requirements:
  - 2 x 100% fire pumps (at least one fire pump always available)
  - Minimum delivery pressure at helideck = 5bar
  - Minimum survival time of ring main = 1 hour
  - Minimum blast resistance = 1 bar
  - Minimum coverage rate = 10 litres/m2/min
  - Maximum time to deliver water 15 sec

Typical Safety Critical Procedures

- Operating and Maintenance Procedures
- Well control procedures
- Training and Competency
- Permit to Work/Isolation procedures
- Integrity Management
- Technical Change Management
- Emergency Response
- Audit and review

SMS Performance Standard example

Example for Preventative Management system:

- All Safety Critical Equipment identified in the HSE Case to be flagged as Safety Critical in the PMS;
- All maintenance and testing of SCEs is logged within the PMS;
- The maintenance and testing procedures for SCEs are aligned with the Performance Standards and refer to them;
- No operations have been performed that rely on SCEs have not been confirmed to meet the Performance Standards (e.g. due to a backlog of maintenance tasks or a failed function test) unless a risk assessment has been performed to verify that the risks are acceptable.
- All personnel responsible for operations maintenance activities have the necessary competence and training in the concept of SCEs and Performance Standards and the importance of ensuring that the safety critical equipment is regularly tested in compliance with the Performance Standards.

How difficult is it to get Case Accepted?

Not all counties have a Regulatory regime that requires a HSE Case, however, many operating companies also require a HSE/Safety Case to be submitted for approval as part of the contract/selection process.

- **New rigs** – relatively straight forward since the MODU generally built to latest Codes & Standards

- **Older rigs** - come under particular scrutiny, particularly if built prior to the '89 MODU Code. This is because Codes are continuously updated in response to accidents or new technology.

- A ***"Gap assessment"*** against the latest codes (MODU Code, Class, API, etc) is generally required for older rigs as part of demonstrating ***ALARP.***

- Generally Operating Companies are less stringent than Regulators!

Examples of Updates to Codes and Standards

- Introduction of MODU Code in 1979, plus major updates in 1989 and 2009
- Replacement of API RP 53 with API Std 53 covering BOP systems post the Macondo incident. Now requires dead-man and auto-shear systems on all subsea BOPS, including semis

*subject to risk assessment

Gap Assessment

- Use ***checklists*** to identify the differences between the design codes and the latest versions;
- Determine the ***practicability*** of upgrading the rig to comply with the latest requirements (i.e. cost versus benefit)
- Select upgrades which give most ***"bang for the buck*"**
- Identify alternative measures in lieu of code compliance which would have a similar risk reduction (e.g. procedural controls)
- Produce an implementation plan for the upgrades and agree with Regulator/Company

Note: - it may not be practicable to upgrade an older rig to the latest standards, but at least understand the reasoning between the latest codes and its impact on reducing safety risk.

Note: - Gap assessment is not the same as a Modu-spec Survey

Gap Assessment

Examples of some key changes introduced in the '89 MODU Code:

- central ballast control room provided and located above damaged water line
- no windows or port-lights below deck
- chain lockers to be fitted with remote detection of flooding and means of dewatering to prevent flooding
- all essential equipment including evacuation systems and bilge system designed to operate under maximum inclined angle
- ability to de-ballast semi to survival draft within 3 hours
- 2 x 100% ballast pumps available, both powered via the emergency generator
- ballast system designed to prevent inadvertence transfer of ballast water from one compartment to another resulting in stability problem
- - ability to monitor wind conditions and anchor tensions for the control room
- A60 fire rating for accommodation walls facing the drill centre wand within 30m with any windows also A60 rated or protected by water curtain or steel shutters
- smoke detectors in all cabins
- remote shutdown of fuel supply from safe location
- 00% capacity lifeboats each side.end of unit plus 100% liferafts (total)
- at least 2 widely separated stairs or ladders from deck to sea level
- additional life jackets provided in suitable locations for persons on duty
- on load lifeboat hooks with hydrostatic release

BOP System Design

There are several differences of opinion:

National Archives and Records Administration
code of federal regulations

energy API

Oil & Gas UK
Guidelines on BOP Systems for Offshore Wells
Issue 2
May 2014

Item	**30 CFR 250.442 (July 2012)**	**API Std 53 (Nov 2012)**	**UK WLCPF (May 2014)**
Deadman/Autoshear	DP rigs only	All rigs	DP rigs only
Annular Preventers:	1	1	2
Pipe Rams:	2	2	3
Shear Rams: *DP Rigs:*	1	2	2
Moored Rigs with Riser Margin:	1	1*	1
Moored rigs: without a riser margin:	1	1*	1*

*subject to risk assessment

Is it practicable to upgrade the BOP to comply with API S53?


Typical 5-ram with subsea accumulator (DP Rig)


Typical 4-ram without subsea accumulator (Moored Rig)

Summary

Implementation of the HSE Case involves:

- Making sure we have ***sufficient controls*** in place to prevent and mitigate Major Accident Events
- Developing ***Performance Standards*** for Safety Critical Controls and ***aligning the PMS procedures*** with the Performance Standards
- ***Maintaining and testing*** safety critical equipment to the Performance Standards
- ***Ensuring all controls are effective*** before commencing tasks and regularly during the task
- For older rigs - performing a ***gap assessment*** against the latest Codes and Standards and identifying safety critical upgrades
- Incorporation of ***lessons learned*** from previous incidents
- Brainstorming and discussion of potential ***risk reduction measures*** by project/crew and implementation where practicable
- Producing ***Implementation plan*** for upgrades that are cost effective

Questions?