Bowtie Analysis focusing on Human Factors (Safety Critical Tasks)

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▪ Hazard identification ▪ Physical effects consequence modelling ▪ Qualitative risk assessment ▪ Bowtie risk management ▪ Quantitative risk assessment ▪ Functional safety ▪ ALARP assessment ▪ Reliability, availability & maintainability modelling	▪ Asset integrity management ▪ Process safety management ▪ HSSE management systems ▪ HSSE/ Safety cases ▪ Independent review & auditing ▪ Incident investigation ▪ Emergency planning & crisis management ▪ Business continuity management ▪ Security risk management ▪ Supply chain risk management	▪ Safety leadership ▪ Culture & behavioural safety ▪ Human factors ▪ Competence management ▪ Workplace safety ▪ Training & education ▪ Game based learning

Products (reseller) – BowTieXP, Investigator-3

! From small work packages to large, complex projects

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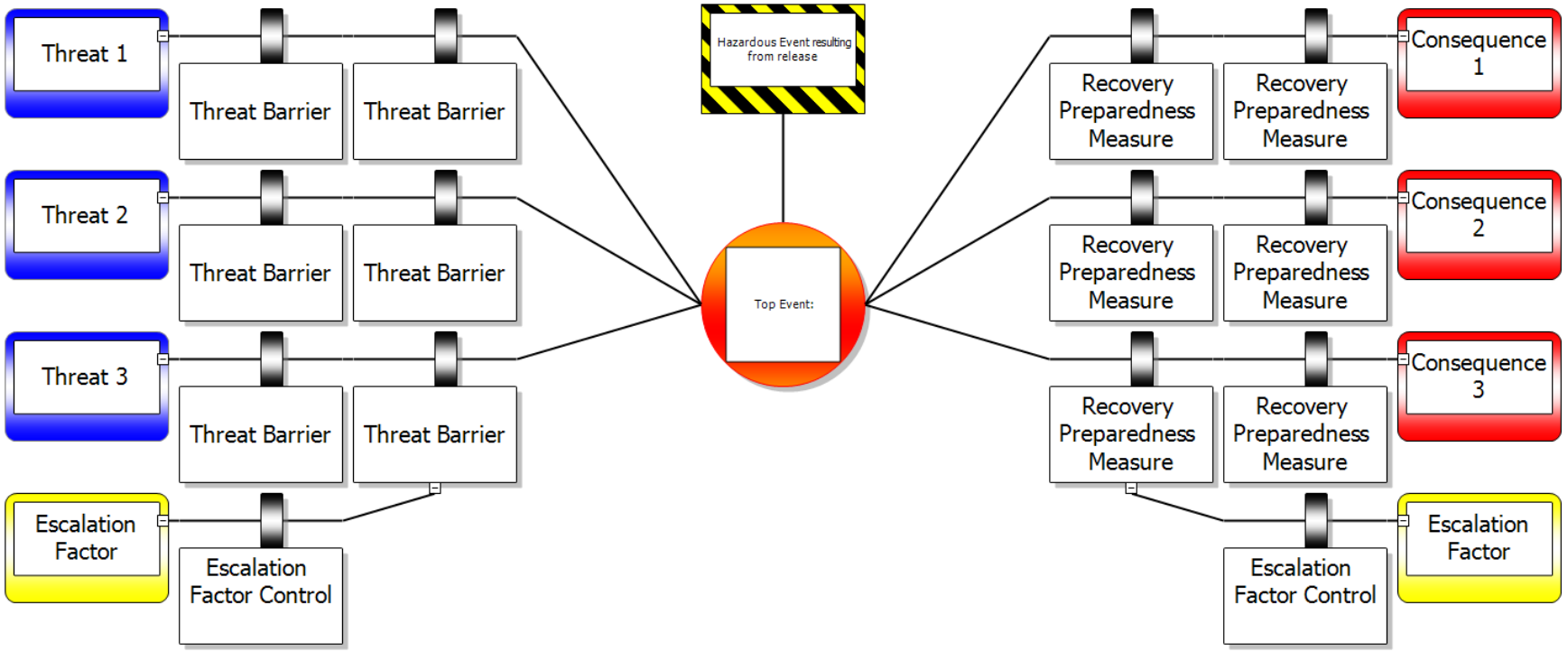
Bowties a generic hazard analysis framework



Graphical illustration of how hazard is managed.

? How can we provide assurance that barriers remain effective over time

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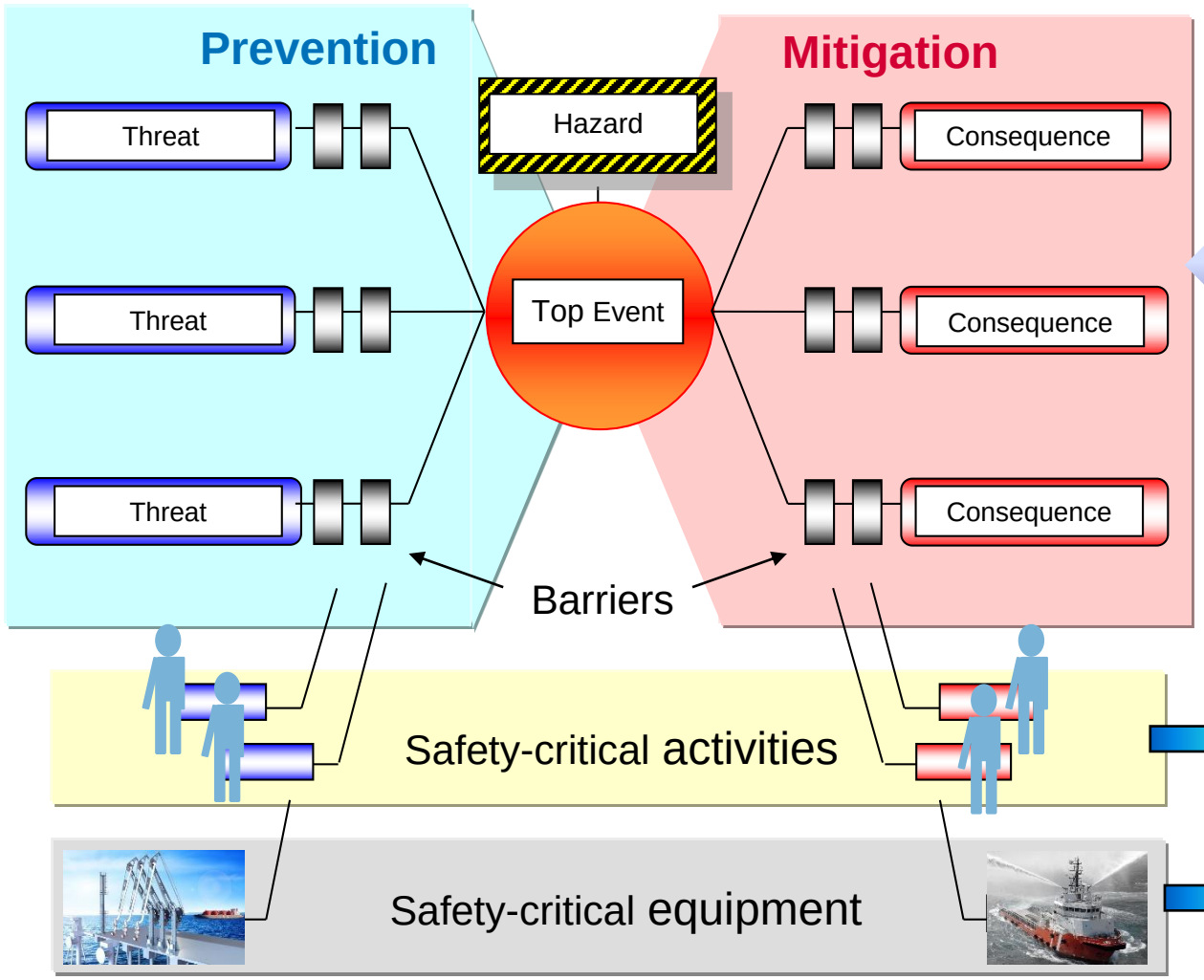
How controls are made effective in bowties?



Audit and Inspection

To:

- Check accuracy and currency
- Verify performance

- Job descriptions
- Competency requirements
- Required documentation

- Performance criteria
- Performance standards

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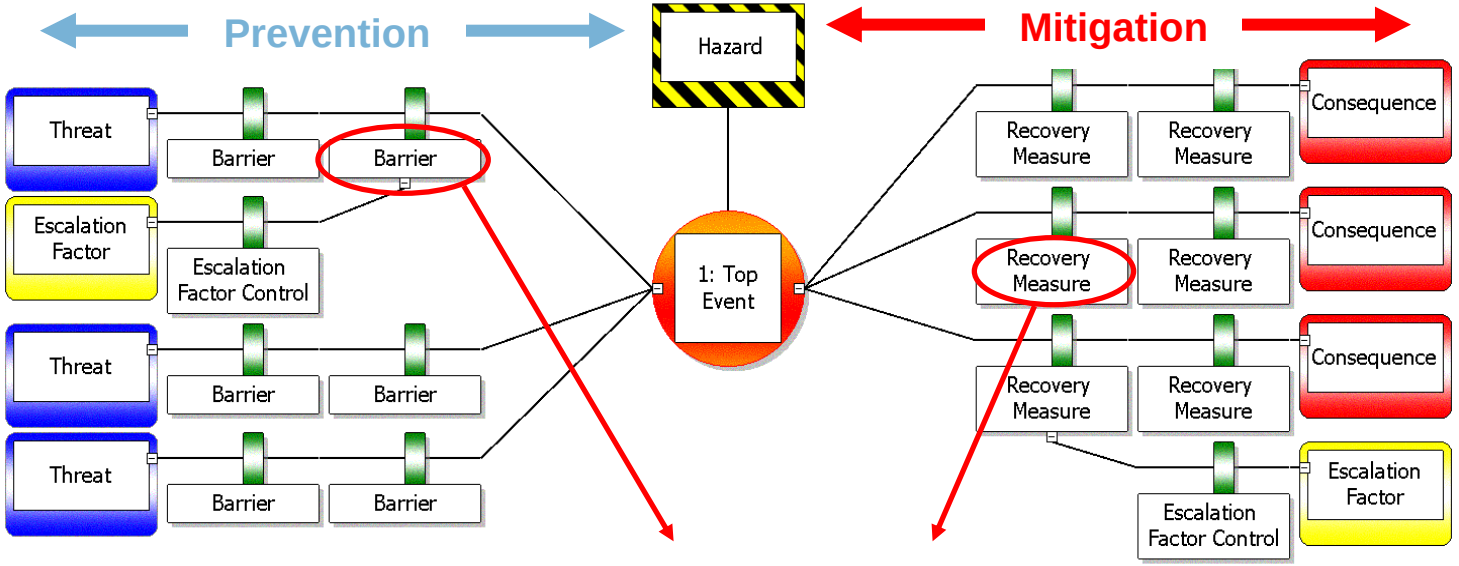
Safety Critical Elements

A Safety Critical Element can be defined as *"parts of an installation and such of its plant, or any part thereof:*

- *the failure of which could cause or contribute substantially to; or*
- *a purpose of which is to prevent or limit the effect of, a major accident"*



Examples:

- Hydrocarbon containment
- Fire and Gas Detection System
- Emergency Shutdown System
- Cranes and lifting equipment
- Vessel Hull
- Evacuation equipment

Engineered systems as barriers on major accident hazard bowtie diagrams are SCEs

More information in Energy Institute, Guidelines for the management of safety critical elements

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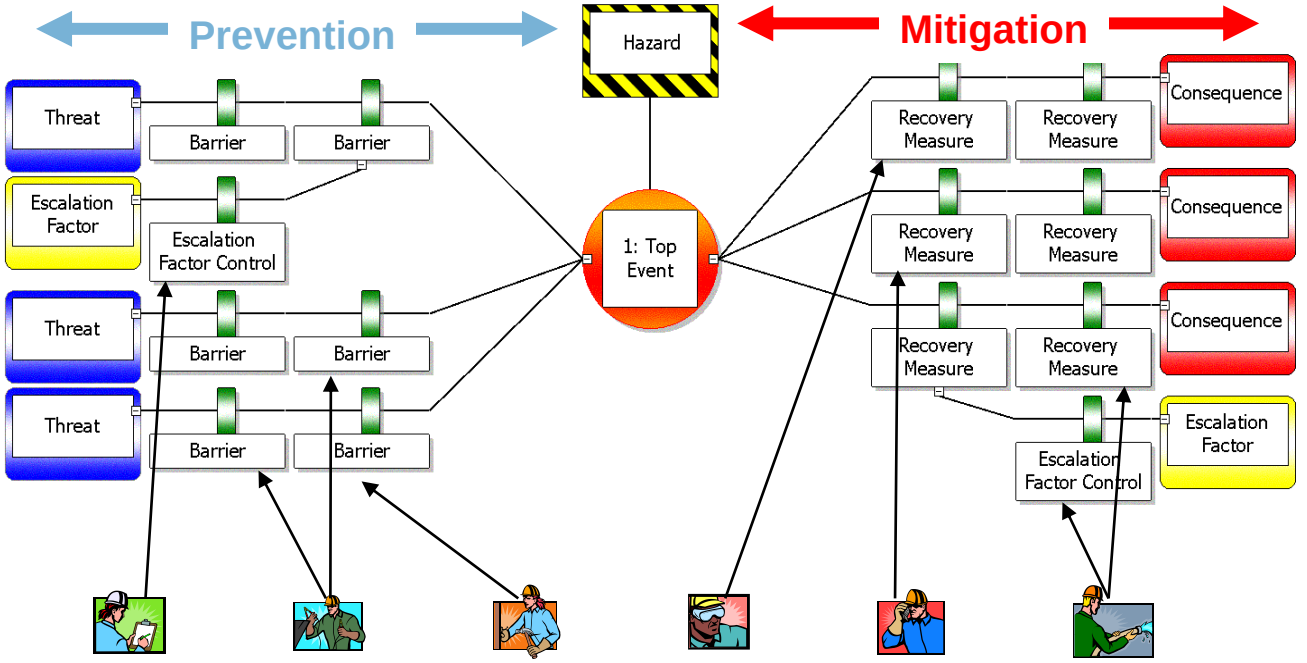
Safety Critical Tasks

Safety critical tasks are the things that people do to make sure barriers continue to work.



A barrier may be supported by several critical activities. A single critical activity may support several bowtie barriers, across several major hazards.

Human intervention examples:

- Responding to alarm
- Managing ramp up/ down rates during transfer
- Providing information to crane operator during lift

Management system examples:

- Evacuation equipment certification
- Managing crew training
- Maintaining procedures

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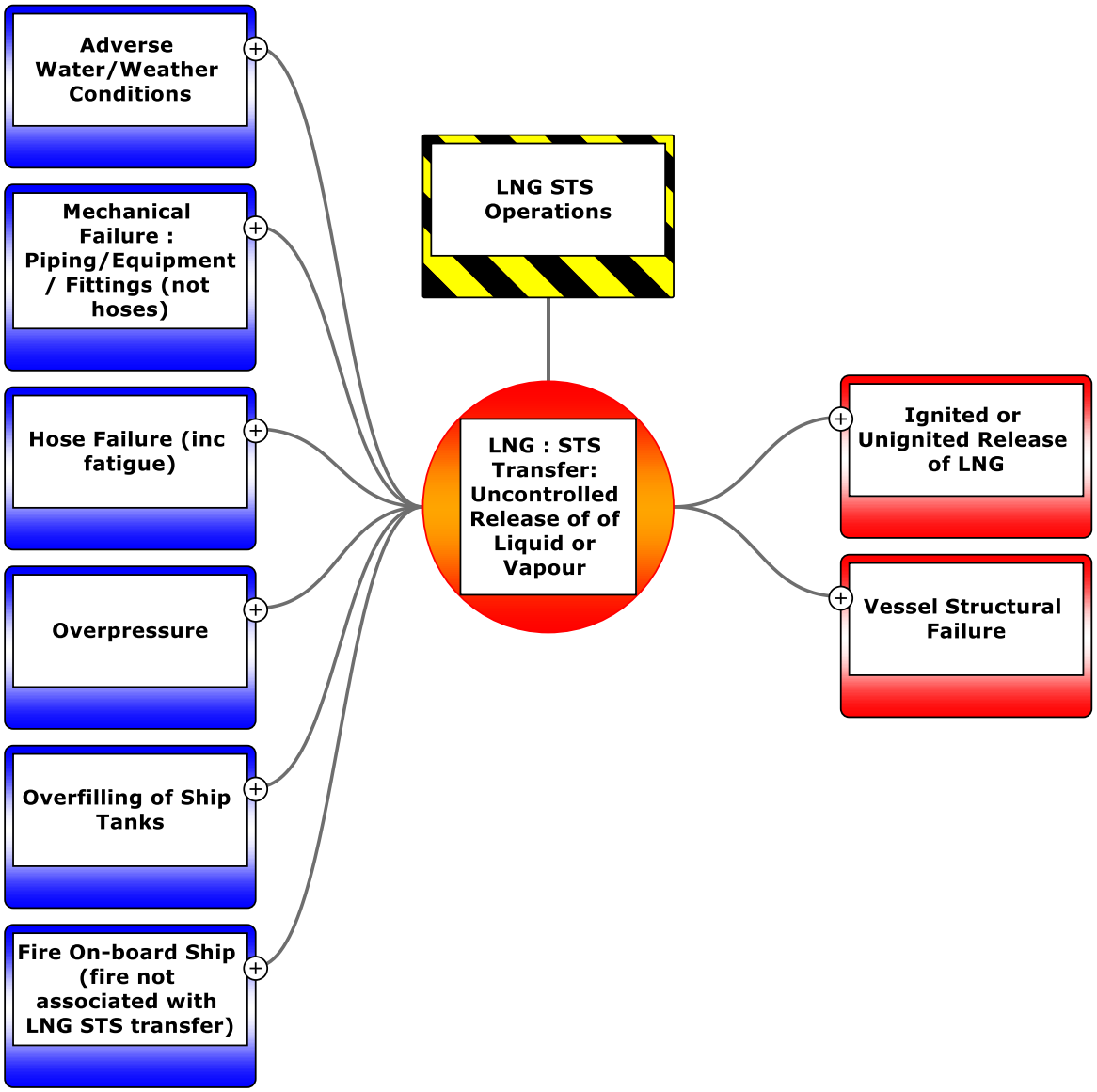
Critical tasks: minimum information

- WHO does the tasks?
  - aim to set tasks that may be verified at supervisor level
- WHAT do they do?
  - brief description of task
  - how does the person know what to do?
- WHY is the task done?
  - what prompts the task?
  - how does the person know when to do it?
- HOW do we know it's been done?
  - what assures us that the task was performed correctly?

Example – portion of LNG ship to ship transfer bowtie



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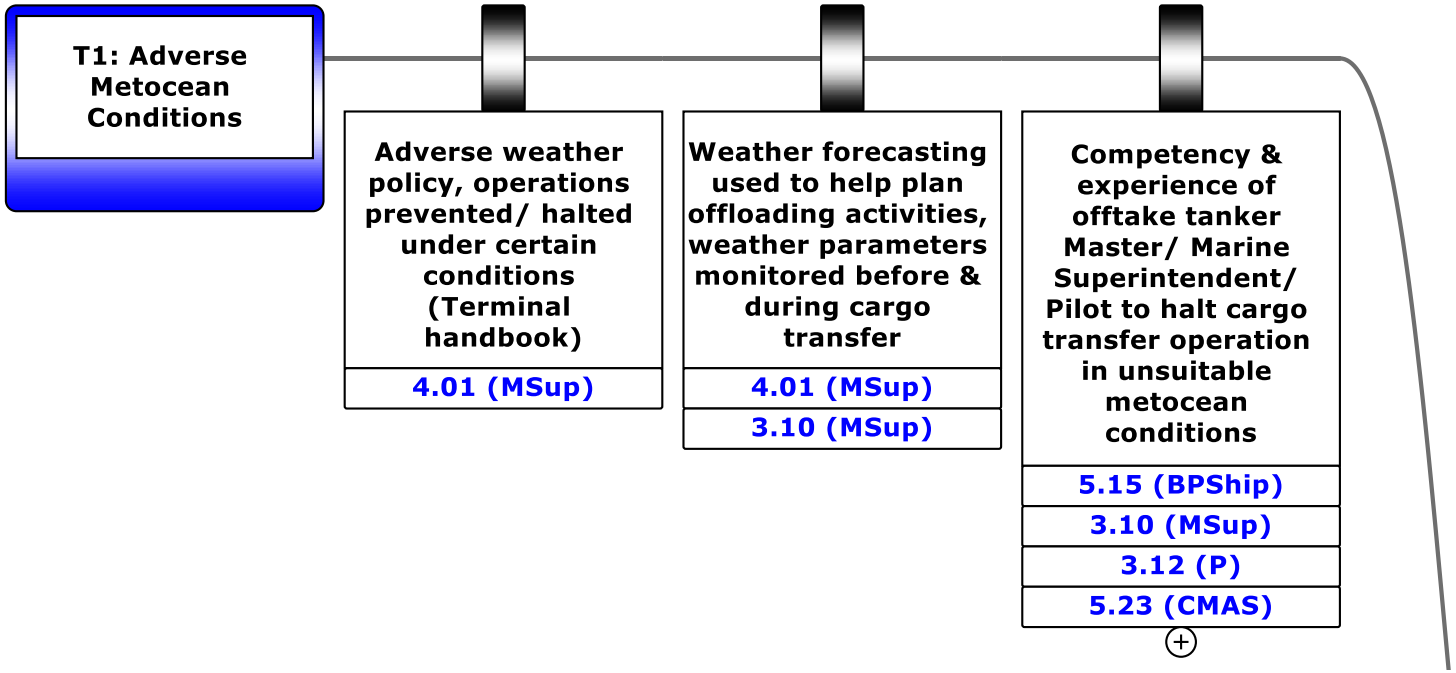
SCTs related to adverse metocean conditions barriers



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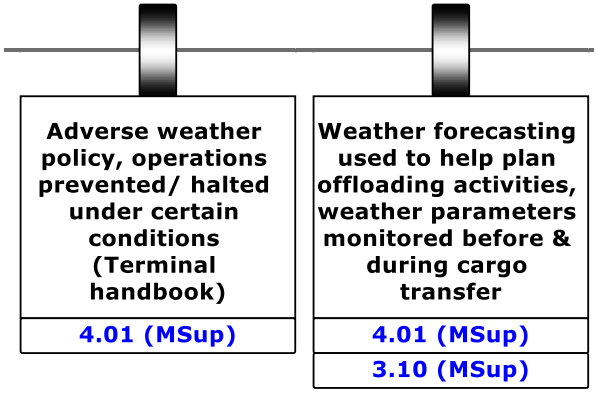
Example Marine Superintendent tasks

Responsible Person	Marine Superintendent
Procedures	Operations Manual
Verification	Loading/ discharge plans, Daily logs, Tank level measurement records, Pre-loading and unloading checklists
Activity No.	3.10
Activity	Manage Cargo Loading/ Unloading
Description of Activity	
Manage cargo loading/ unloading operations and other bulk fluid loading, in particular ensure that: - Suitable procedures are prepared, updated and used to control loading/ unloading including offtake rates, check sheets etc. - Formal loading/ discharge plans are prepared. - Ensure that visual inspection of hose carried out prior to cargo transfer. - Offloading hose inspection, testing, handling and changeout procedures are followed. - Filling rates and tank levels/ pressures are constantly monitored during operations and that appropriate action is taken on deviation from loading/ discharge plan and alarms (e.g. load limits reached, HH level). ……	

Responsible Person	Marine Superintendent
Procedures	Marine Manual
Verification	Weather records, Daily report
Activity No.	4.01
Activity	Monitor Weather and adhere to Operational Limits
Description of Activity	
On a regular basis obtain independent weather forecasts for the vessel location, also review data from on-board meteorological monitoring systems. Inform relevant personnel (e.g. Captain, HLO, Crane Operator, FRC Coxswain) of expected bad weather and when actual conditions exceed operational limits (e.g. for Tanker loading, Helicopter, and FROG transfer) as detailed in Procedure. For different storm conditions ensure that actions prescribed in the Marine Manual are followed. Suspend operations if required. Ensure that appropriate ship lighting, fog signals etc. are displayed/ sounded as necessary.	



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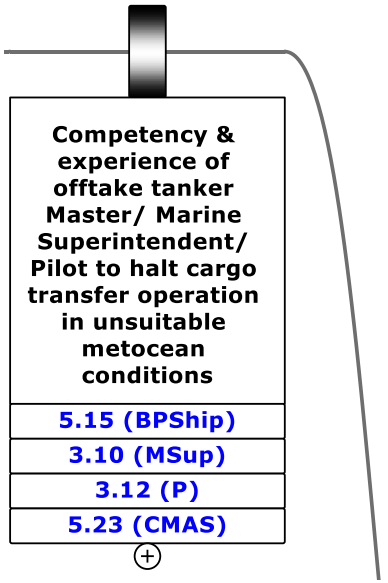
Example non-crew tasks

Responsible Person	Pilot
Procedures	
Verification	
Activity No.	3.12
Activity	Marine Pilots Responsibilities
Description of Activity	
In accordance International Procedures and Standards perform Marine Pilotage duties to bring in offtake tanker safely, including: - Confirm compliance with pre-mooring checklist. - Halt offloading operations if metocean conditions make them unsafe. - Use telemetry system to shutdown offtake tanker loading if it's position approaches unacceptable limits or an emergency develops on offtake tanker e.g. overfilling COT, fire etc. - When not on duty, ensure that watch on offtake tanker understands how and when to use telemetry shutdown. If telemetry system fails, request that Tanker initiate shutdown.	

Responsible Person	Shipping Dept.
Procedures	Marine Vetting Procedure
Verification	Vetting and approval records
Activity No.	5.15
Activity	Vet Offtake Tankers
Description of Activity	
Perform vetting activities and give approval for offtake tankers who will load from Tanker.	

Responsible Person	CMAS Team Leader
Procedures	Competency Assurance Program
Verification	Personnel Training Records, Competency Assurance Program Records, Site Annual Safety Training Plan, Audits
Activity No.	5.23
Activity	Competency Management
Description of Activity	
Ensure that all members of the crew, including contractors, are suitably experienced, trained and competent to carry out all the routine and non-routine duties expected of them. Maintain records of required training, review records to identify where individuals require refresher and/or additional training. All personnel should have undergone the relevant formal training (eg fire team, HLO, coxswains, crane operator, Marine Superintendent, deck crew etc.) appropriate for their position and duty. Specifically ensure that:- All offshore personnel receive BOSIET survival training.- Crane Operators are competent to perform man lifts.	



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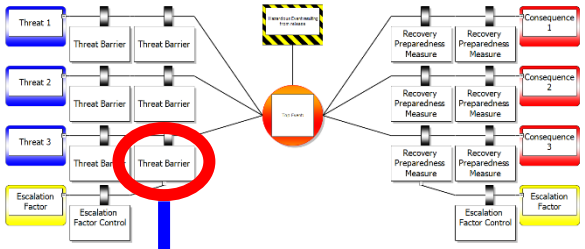
Bowtie and Training & Competence



Competent people provide resilience against major risks

…to ensure each risk control works…

HSE-critical task

HSE-critical task catalogue

HSE-critical role

Accountability packs

Task competencies

Assess people against requirements

…use Competency Mgmt System

SkillsXP

Training requirements

Personal T&D plans

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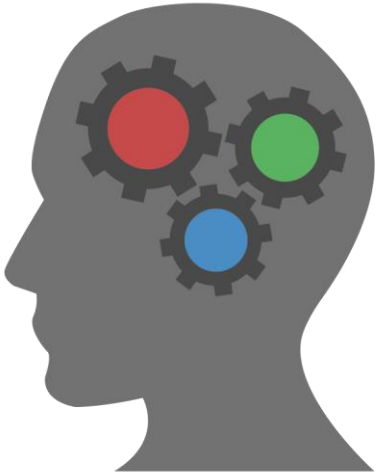
Using SCTs to ask Human Factors questions

- Do the procedures give sufficient information in a concise and understandable way to carry out task?

- Does anyone check SCT verification? How often?

- What Potential human errors are there? including:
  - Errors in performing actions, undertaking checking tasks, information retrieval, and communication.
  - Performance influencing factors that combine with basic human error tendencies to create error-likely situations, e.g. time stress, usability of equipment, environmental conditions, degree of training.

- For example, if an operator has to respond to an alarm:
  - How do they know if the alarm is not working?
  - Can they see the alarm clearly and will it attract attention?
  - Is the alarm enunciation as expected?
  - Could they have too many alarms to respond to?
  - Is it clear what action should be taken on alarm?
  - Is it ignored because it always goes off?



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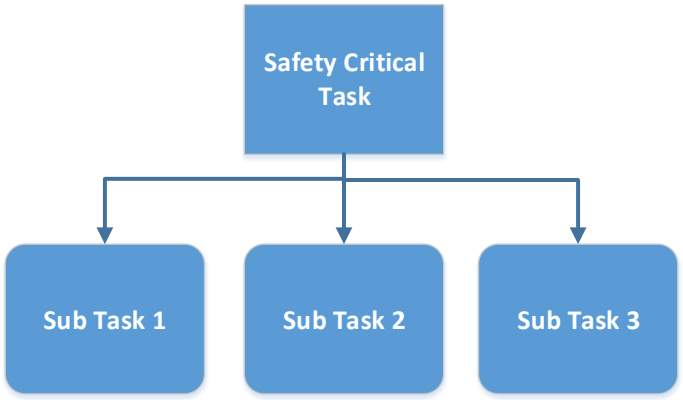
Task Analysis with identified SCTs

- Apply a systematic, rigorous HF task analysis (HF HAZOP) to identified Safety Critical Tasks



Guide Word	Meaning/ Usage
Missed Step	The step or operation is not performed at all
More Done/ Higher	Quantitatively, more is performed than is specified or required by the step or procedure (e.g. a vessel is supposed to be filled to the midpoint and is filled to the high point)
Less Done/ Lower	Quantitatively, less is performed than is specified or required by the step or procedure (e.g. a line is supposed to be flushed for 30 minutes and is only flushed for 10 minutes)
As Well As	Qualitatively, more is performed than is specified or required by the step or procedure (e.g. the block valves to two vessels are opened instead of the block valve to only one of the vessels)
Partially Done	Qualitatively, less is performed than is specified or required by the step or procedure (e.g. a valve is supposed to be shut off completely and is only half closed)
Reverse	The opposite of what is specified or required happens (e.g. a valve is opened instead of being shut)
Other Than	Something completely different to what is specified or required happens. (e.g. instead of isolating pump A, pump B is isolated)
How Done	How is the step to be accomplished? Is the operator physically able to perform the step as specified? Are the necessary facilities available?
Why Done	Why is this step included? Is there a logical reason for the step? Is the step or operation really needed?
When Done	Is it important when the step or operation is performed?
Where Done	Is it important that the step or operation is performed in a particular place/spot?
Who Does	Who is to perform this step or operation? Is it clear who is responsible?
Verification	How is it checked/verified that this step has been properly completed?
Sequence	Is it important that the steps are performed in the order/sequence specified?

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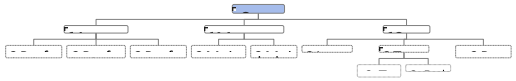
Example task analysis – chemical supply/ storage (offshore)



Task Step/ Action Required	Possible Errors	Consequence of Error	Task Support Measures (Design / Organisation)	Error Recovery	Comments & Recommendations
2.2.1 Maintain minimum required stock levels	Check omitted or mis-timed Supply route interrupted – (error by supplier)	Insufficient or no stock of CI available to support production – potential subsea corrosion. Insufficient or no stock of CI available to support production – potential subsea corrosion.	Supplier responsible for tracking minimum/ maximum levels at XXX base. Their system triggers requirement for order at specified stock levels. Audits of supplier system. Suppliers must provide detail of supply routes to XXX. Secondary supply route must be identified and detailed to XXX in case of problems with primary route.	Can source material from other suppliers to meet short term demand FPSO can shut-down production within 6 hrs	<u>Recommendation 2</u> Consider reviewing arrangements under XXXs control for maintaining a buffer of stock (on board and at XXX base)

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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.

- MAH Bowtie barriers provide Safety Critical Tasks that can be used to:
  - Make SCT responsibility clear to al staff.
  - Inform competency and training processes.
  - As a starting point for more detailed Human Factors Task Analysis

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Thank you for your attention

Any Questions?

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