Linking critical competencies with major accident hazards

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The importance of competence in the management of major accident hazards has been recognised for some time. However, developing effective systems to support this has proved to be difficult. Often the underlying reason for this is that everything carried out at a facility handling major accident hazards could contribute to the risk, and so too many competencies are identified as critical and the system becomes unmanageable. Also, there has often been a narrow view of competence and systems described have been mostly focussed on administering existing training courses.

This paper describes a recent scope of work for a North Sea Duty Holder that aimed to develop an effective system for identifying critical competencies with a clear and transparent link to major accident hazards. The process used Bow-Tie Diagrams that had been developed for a group of offshore installations to demonstrate the link between barriers and competence of individuals at all levels in the organisation.

The conclusion of this paper is that a structured approach to identifying critical high-level competencies by mapping procedures to the Bow-Tie Diagrams can be beneficial because it provides an effective way of demonstrating how competency directly contributes to ensuring risks of major accident hazards are As Low As Reasonably Practicable (ALARP). It dispels the myth that competence can only be achieved by sending people on training courses and highlights that people at all levels of the organisation need to have competence in the management of major accident hazards. Arguably one of the greatest benefits of this approach is that it highlights the competencies required by Senior Managers.

Key Words: Competence, Competencies, Bow-Tie, Major Accident Hazard, ALARP

Introduction

The importance of competence in the management of major accident hazards has been recognised for some time. However, developing effective systems to support this has proved to be difficult. Often the underlying reason for this is that everything carried out at a facility handling major accident hazards could contribute to the risk, and so too many competencies are identified as critical and the system becomes unmanageable. Also, there has often been a narrow view of competence and systems described have been mostly focussed on administering existing training courses as these are relatively easy to administer.

As a result competence management systems tend to focus on operators / technicians and their immediate supervisors. The role and associated competencies of senior managers, including Technical Authorities, is often overlooked.

This paper describes a recent scope of work for a North Sea Duty Holder that aimed to develop an effective system for identifying critical high-level competencies across an organisation, with a clear and transparent link to major accident hazards.

Major Accident Hazards, Barriers and Supporting Safety Critical Procedures

The first steps in implementing a Competence Management System are to:

1. Identify the organisation specific hazards.
2. Identify the key roles linked to those hazards.
3. Identify the tasks linked to those key roles.

Well-drawn Bow-Tie Diagrams can be a useful hazard management tool for visualising hazard progression from cause to consequence. They provide an effective and visual means of communicating the hazard management barriers to the workforce. Bow-Tie Diagrams can be used to demonstrate the link between major accident hazards and the tasks that underpin the key barriers that manage these.

In the example that forms the basis of this paper, Bow-Tie Diagrams were developed for a North Sea Duty Holder's assets. The Bow-Tie Diagrams demonstrated, at a high-level, the management of major accident hazards in terms of the Safety and Environmental-Critical Elements (SECEs) and key operational controls. The relevant Duty Holder's procedures were mapped on to the Bow-Tie Diagrams to present the relevant procedures that underpin these barriers and thus demonstrate how barrier integrity, and ultimately the major accident hazards, are managed. An example of the application of this approach is shown in Figure 1 in relation to managing attendant (platform support vessels) in proximity to an offshore installation.

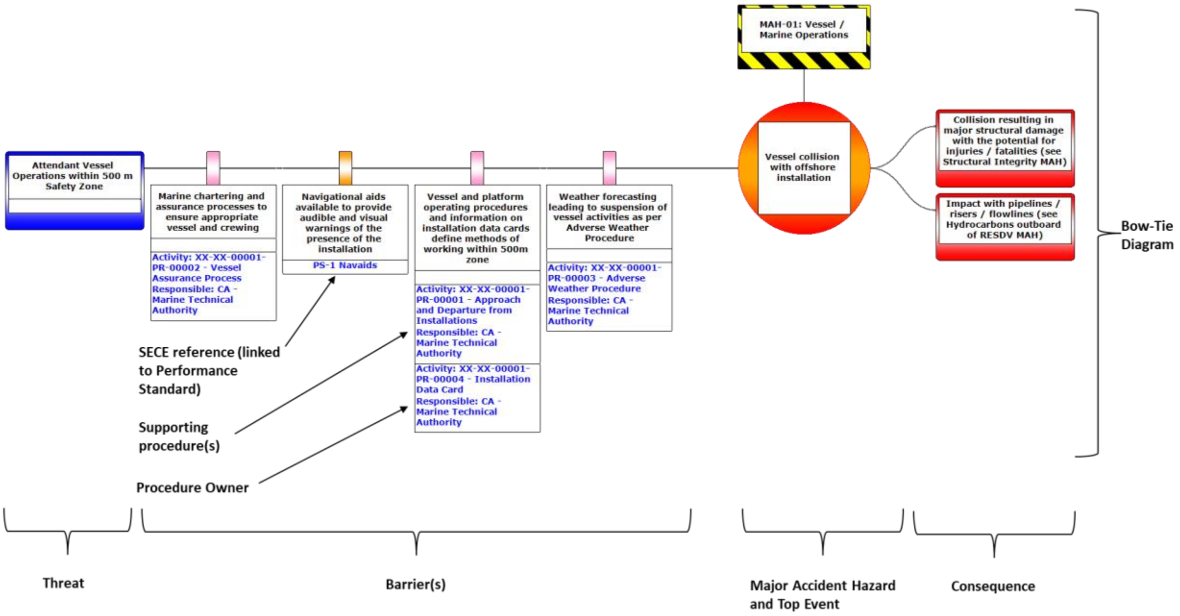

Figure 1. Simplified example Bow-Tie Diagram showing the identification of safety critical procedures – Marine Operations

The output from this exercise was a list of procedures that were considered to be critical because they were associated with a barrier on one or more Bow-Tie Diagrams. This list of procedures was supplemented by other safety critical 'pervasive procedures' which had not been specifically identified on the Bow-Tie Diagrams. Examples included, but were not limited to:

- Permit to Work procedure;
- Operational Risk Assessment procedure;
- Management of Engineering and Organisational Change procedures;
- Alarm management, etc.

Critical Competency Identification

Approach

Organisations have a legal duty in the United Kingdom (UK) to put in place suitable arrangements to manage health and safety. The UK Health and Safety Executive (HSE) have published a framework for managing health and safety called HSG65 (HSE 2013). HSG65 presents a so-called Plan-Do-Check-Act model as summarised below:

- Plan: Determine the policy / plan for implementation.
- Do: Profile risks / organise for health and safety / implement the plan.
- Check: Measure performance (monitor before events, investigate after events).
- Act: Review performance / act on lessons learned.

The methodology used to identify critical high-level competencies supporting the safety critical procedures involved applying the Plan-Do-Check-Act model to each identified procedure across a typical system lifecycle, which may include the following distinct stages:

- Design.
- Build.
- Operate.
- Planned Maintenance, Inspection and Testing (MIT).
- Maintain.
- Modify.
- Decommission.
- Degraded.
- Emergency.

A typical application of this approach is shown in Table 1.

Table 1. The Plan-Do-Check-Act model across a system lifecycle

Lifecycle	Element			
	Plan	**Do**	**Check**	**Act**
Design	Define requirements & resources	Design to meet requirements	Verify requirements achieved	Approve for construction
Build	Construction methods & resources	Construct according to design	Inspect construction	Pre-start-up safety review (PSSR) to allow operation to start
Operate	Operating procedures & resources	Start-up, operate & shutdown to fulfil operational requirements	Operating envelope	Respond to events (e.g. alarms)
Planned Maintenance, Inspection and Testing (MIT)	MIT plans & resources	Implement plan	Adherence to plan	Evaluate system reliability & adequacy of plan
Maintain	Maintenance plans & resources	Repair/ replace	Return to service checks (e.g. leak check)	Evaluate planned MIT strategy
Modify	Plan change via Management of Change (MOC) process	Make change	Verify change as agreed	Evaluate change & update records
Decommission	Decommission methods & resources	Decommission according to design	Inspect remaining items	PSSR to allow operation to restart
Degraded	Assess impact of degradation and develop strategy	Implement controls	Monitor system and controls	Continual review until degradation is rectified
Emergency	Emergency procedures & resources	Protect personnel, environment and assets	Risk & escalation	Continual review until standdown

Broadly two types of procedure were identified:

1. A procedure covering a management process such as Management of Change, Emergency Response, etc.
2. A procedure covering a physical process such as isolating and reinstating plant, operating procedures, etc.

For those procedures that covered a management process, the lifecycle was interpreted as follows:

- Design: Write the procedure.
- Build: Implement the procedure.
- Operate: Use the procedure.
- Planned Maintenance, Inspection and Testing: Check the procedure, as written, works.
- Maintain: Update the procedure to follow latest good practice.
- Modify: Change the procedure.
- Decommission: Largely not applicable.
- Degraded: Respond to situations that mean the procedure cannot be followed.
- Emergency: Plan for failures occurring whilst following the procedure.

For those procedures that covered a physical process, the lifecycle was applied to the process covered by the procedure.

The approach involved populating Table 1 for each procedure. The role responsible for each entry (i.e. task) in the table could be identified, and then the associated high-level competencies associated with the different roles listed.

Roles

Competencies were defined for six broad roles in order to cover the areas that procedures are used:

- Senior management: accountable for major accident hazard management.
- Technical Authority: typically, although not always, the procedure owner.
- Discipline Engineer (office based work): typically the procedure author.

- Discipline Engineer (site based work): examples include Responsible Person Electrical, Integrity Engineer, Health and Safety Advisor, etc.
- Site Supervision: the person responsible for supervising the task.
- Technician: the person responsible for carrying out the task.

Example Output

As an example, and continuing the Marine Operations major accident hazard shown in Figure 1, Table 2 shows the application of the method to a procedure covering the approach and departure of vessels from an offshore installations safety zone. Marine operations are classed as a major accident hazard and improper management can lead to a loss of structural integrity of the installation. Periodically vessels are required to enter the installation 500 metre safety zone and this process needs to be managed in order to reduce the risk of a vessel collision to as low as reasonably practicable. The resultant high-level competencies are shown below the table by broad role. Finally, Figure 2 summarises the identified competencies for the Marine TA on a Bow-Tie Diagram.

Table 2. The Plan-Do-Check-Act model – Approach and Departure from Installations

Lifecycle	Element			
	Plan	**Do**	**Check**	**Act**
Design	Define scope of Approach to and Departure from Installations procedure	Write the Approach to and Departure from Installations procedure	Confirm Approach to and Departure from Installations procedure is practical and effective	Endorse Approach to and Departure from Installations procedure
Build	Identify supporting organisation (resources required)	Train in-house personnel and specify contractor training as part of contracts (Platform Support Vessels, Dive Support Vessels, Heavy Lift Vessels, etc.)	Check resources in place	Issue Approach to and Departure from Installations procedure
Operate	Recognise when the Approach to and Departure from Installations procedure shall be used - any vessel entry to the 500 metre Safety Zone	Follow Approach to and Departure from Installations procedure	Review and approve pre-entry checklist and monitor limits for operations (working location, heading, significant wave height, wind speed, visibility, etc.)	Troubleshoot, rectify, refuse entry
Planned Maintenance, Inspection and Testing (MIT)	Plan audits to test all elements of the Approach to and Departure from Installations procedure	Carry out audits and reviews	Confirm Approach to and Departure from Installations procedure has been implemented and is covering all aspects	Update Approach to and Departure from Installations procedure
Maintain	Plan reviews to check information is up to date and procedure is keeping up with industry good practice (e.g. Procedure for Offshore Marine Operations (GOMO))	Review	Audit to confirm reviews are taking place and are effective	Update details if not current (following audit).
Modify	Ensure all changes to the procedure follow MoC	Update Approach to and Departure from Installations procedure	Complete MoC	Issue updated Approach to and Departure from Installations procedure

Lifecycle	Element			
	Plan	**Do**	**Check**	**Act**
Decommission	Recognise changes may be required when facilities are decommissioned, de-manned etc.	Implement changes as part of decommissioning	Confirm new arrangements in place and effective	Update arrangements as required
Degraded	Recognise that situations may exist where it is necessary for the vessel to operate on the windward side of the installation. Additionally, a failure may be revealed within the approach and departure checklist. In such situations a risk assessment shall be performed	Vessel Master and OIM approve risk assessment	Confirm mitigation measures are good enough	Continual review
Emergency	Recognise an emergency situation whilst vessel is approaching or departing (e.g. engine or DP failure)	Assess risk of the event and initiate response	Review effectiveness of response	Stand-down after the incident

Note: this procedure does not consider competencies associated with vessel crew or the vessel service provider.

Each item identified in Table 2 was assigned to a role as a required competence as follows:

Senior Management

Support the business in providing suitable resources to manage offshore vessel operations. Competence required:

- Understand that marine operations within the 500 metre Safety Zone are a Major Accident Hazard and understand how they are controlled in practice.
- Recognise where procedures sit within the hierarchy of risk controls (reliance of personnel to follow the procedure).

Technical Authority

The Marine Technical Authority is the owner of the Approach to and Departure from Installations procedure. Should a safety zone infringement occur, then the Marine Technical Authority is responsible for leading the subsequent investigation. Competence required:

- Understand that marine operations within the 500 metre safety zone is a major accident hazard. In particular, knowledge is required of the installation's collision risk study.
- Knowledge of the implementation of the Approach to and Departure from Installations procedure – subject matter expert.
- Knowledge of applicable good practice regarding marine operations within the 500 metre safety zone, including relevant information to include within a marine data card.
- Conducting of audits of Approach to and Departure from Installations procedure.
- Incident investigation.
- Able to review and interpret marine related Failure Mode and Effect Analyses and Dynamic Positioning operational windows.
- Maintaining controls during decommissioning.

Supervision

Within the 500 metre safety zone the Offshore Installation Manager (OIM) has the overall responsibility for the safety of the Installation; as such vessels within the 500 metre safety zone come under the operational control of the OIM. Competence required:

- Knowledge of the implementation of the Approach to and Departure from Installations procedure.
- Knowledge of risk assessment - understand that there may be periods when a vessel may have to work on the windward side of the installation or may suffer an equipment failure.
- Knowledge of the weather related trigger points within the Approach to and Departure from Installations procedure.
- Understand the criticality of installation based positioning reference aids, in particular that obstruction or movement could result in a loss of position.
- How to respond in an emergency situation when a vessel is approaching or departing.

Technician

In this context, this is the person(s) responsible for monitoring the prevailing weather and the weather forecast. Competence required:

- Able to monitor and interpret weather data (wind speed, visibility, significant wave height, etc.).
- Knowledge of the trigger points within the Approach to and Departure from Installations procedure.
- How to respond in an emergency situation when a vessel is approaching or departing.

As can be seen, whilst some of the high-level competencies could be achieved by attending training courses (e.g. competencies such as auditing and incident investigation), others may be best achieved by a combination approach of training, local underpinning knowledge achieved over a period of time, and supervisor assessment.

Common Competencies

During the process, a number of common, or basic, competencies were identified. These were grouped in order to avoid unnecessary repetition. As an illustration, a list of common competencies is provided below for the Technical Authority role:

- Knowledge of the major accident hazards and barrier management.
- Able to conduct effective audits.
- Knowledge of Management of Change.
- Recognise where procedures sit within the hierarchy of risk controls (i.e. a reliance of personnel to follow the procedure).
- Knowledge of risk assessment and application of the ALARP principle.
- Able to conduct effective incident investigations.
- Knowledge of document control systems to ensure latest version of procedures and supporting documents are used.
- Aware of relevant UK legislative requirements associated with offshore operations including OSCR 2015, PFEER 1995, HSWA 1974, etc.

As can be seen, the above competencies are generic in nature and are not specific to any one procedure. They are nevertheless key competencies required by a Technical Authority.

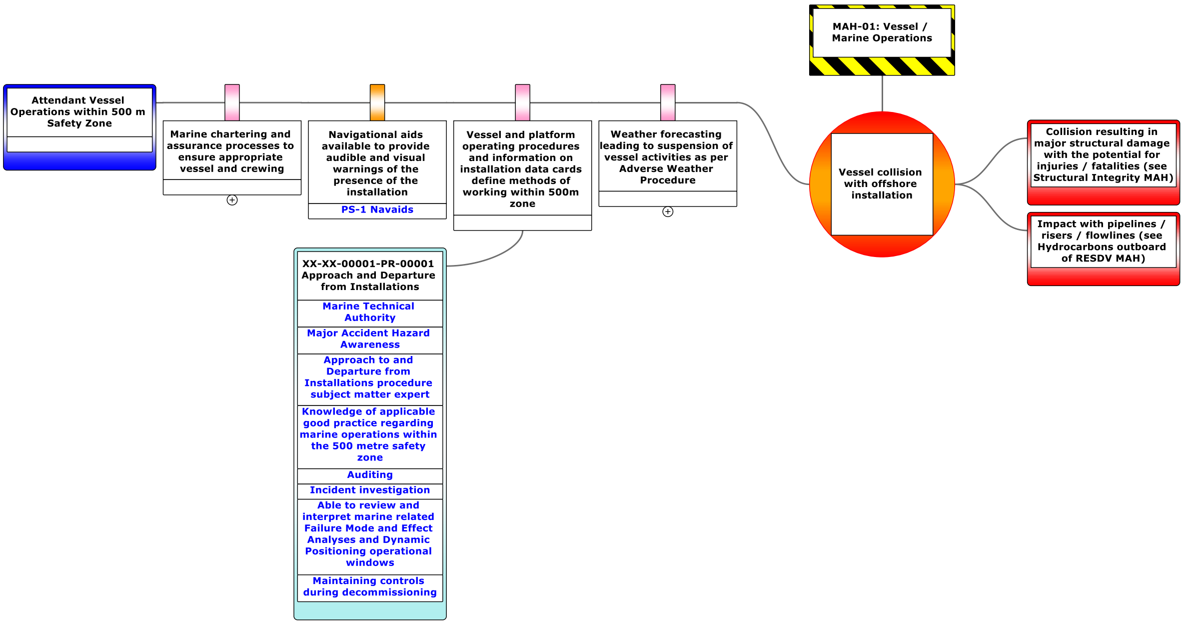

Figure 2. Bow-Tie Diagram showing the identification of critical high-level competencies – Marine Technical Authority (single procedure shown for clarity)

Limitations of the Approach

The exercise to map procedures to the major accident hazard Bow-Tie Diagrams involves a review of the Duty Holder's Safety and Environmental Management System. If sufficient time and resource is not allocated at the beginning of the process to allow the identification of all safety critical procedures then there could be a number of relevant procedures omitted from the mapping exercise. Consequently, competencies associated with those procedures would also be omitted.

Application of the Plan-Do-Check-Act lifecycle model requires knowledge of the activities covered by the procedure in the context of the major accident hazards.

The effectiveness of this exercise and resources required to complete it will depend on the quality of the Bow-Tie Diagrams and the procedures identified as safety critical. Bow-Tie Diagrams can often be poorly structured and include barriers that cannot be relied on, and procedures may not always be fully comprehensive, up to date or reflect industry good practice. As a result of this exercise, the ability to review and update procedures; and staying up to date with industry good practice were identified as critical competencies.

Finally, as an indication of the level of effort involved in this process, one application involved:

- Developing the Bow-Tie Diagrams for approximately ten major accident hazards - required a two day workshop for a team of Duty Holder personnel, in addition to preparation beforehand and finalisation after the workshop.
- Mapping the safety-critical procedures - required several days of effort.
- Application of the Plan-Do-Check-Act lifecycle model - required two to three hours of work per procedure.

This approach therefore involves a concerted effort by the Duty Holder.

Conclusions

In terms of a proof of concept, the approach summarised in this paper serves two main purposes:

1. The Plan-Do-Check-Act model applied to each procedure across a typical system lifecycle informed the derivation of competencies. The Plan-Do-Check-Act model may also serve as a useful prompt to the procedure author when procedures are created or updated.
2. It provides a systematic and transparent methodology for the identification of high-level competencies linked to the identified major accident hazards and is thus the basis for developing a competence management system.

The conclusion is that a structured approach to identifying critical high-level competencies by mapping procedures to the Bow-Tie Diagrams can be beneficial because it provides an effective way of demonstrating how competency directly contributes to ensuring risks of MAHs are As Low As Reasonably Practicable (ALARP). It dispels the myth that competence can only be achieved by sending people on training courses and highlights that people at all levels of the organisation need to have competence in the management of MAH. Arguably one of the greatest benefits of this approach is that it highlights the high-level competencies required by Senior Managers. Also, Technical Authorities and others in similar roles should take personal responsibility for making sure they keep up to date with latest guidance and good practice.

References

UK Health and Safety Executive, 2013, Managing for health and safety, HSG65 Third Edition.