Effective Safety Management - The tale of the Engineer, Safety Manager and Accountant

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Synopsis

In several recent naval ship building projects, Lloyd's Register has been looking at methods for integrating statutory compliance with the hazard and risk assessment mandated by some ship building contracts. The Authors have observed that standards are sometimes applied without due regard of operational context. Equally they have spent hours assessing risks for simple reliable equipment designed to rules, codes and standards.

As a result, we propose in this paper, an integrated approach for assessing the whole ship safety, with a focus on the safe to operate aspects, building a comprehensive safety argument founded on an agreed standards set which is augmented with a focused safety assessment delivering value and a proportionate risk assessment.

Keywords: Naval, Risk, Safety, Hazard, Management, MIL882E.

1. Introduction

An Engineer, Safety Manager and Accountant were told to make sure a ship was safe. The engineer said "fine I've got a great rule book with 200 years of experience". "No" scoffed the safety manager "that's old school, I've got a great technique to derive all the hazards and risks in great detail". The accountant said, "I can't afford all this, one of us will have to go". The engineer and safety manager smiled at each other.

In several recent naval ship building projects, Lloyd's Register has been looking at methods for integrating statutory compliance with the hazard and risk assessment mandated by the ship building contract. It has been observed that standards are sometimes applied without due regard of operational context. Equally we have seen hours spent assessing risks for simple, reliable equipment designed to codes and standards.

As a result, we have developed an integrated approach for assessing whole ship safety. The focus is on the "safe to operate" aspects, building an effective and comprehensive safety argument founded on an agreed set of standards, augmented by a targeted safety assessment delivering value and a proportionate risk assessment.

The Authors outline the process plus some of the techniques and tools employed to develop a cost effective, efficient and comprehensive safety argument which should be easy to maintain through the life of the ship. Thus ensuring the Engineer, Safety Manager and Accountant live "happily ever after".

2. Development of Hazard and risk assessment approaches

Hazard and risk assessment is embedded within the safety management processes of a number of navies around the world. UK DEFSTAN 00-56, ABR6306 Ch4, NZ DFO10 Ch3. A number of navies require a formal safety case or safety argument for new and existing platforms. This often involves environmental aspects too, but the focus for this paper will be safety.

Within the UK, the requirements developed following reports published in 1990 into the Piper Alpha offshore platform (DOE 1990, HSE 1992) and Clapham Rail disasters. These recommended a goal-setting and safety case regime for the Offshore industry. In 1991, the MoD Chalmers Report proposed the establishment of a Ship Safety Management Office and safety cases for ships alongside the existing three areas of key hazard certification. Hazard identification, risk assessment and safety cases have been a regular part of UK MoD procurement for the last 25 years.

Author's Biographies

Andrew Franks has nearly thirty years' experience in risk assessment and related areas, particularly with respect to high - hazard industries. He has experience working with contractors on major projects and for regulators such as the UK HSE. He is currently a principal consultant working with Lloyd's Register Consulting. Recently he has been extensively involved in safety studies and development of safety cases for naval ships.

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 http://doi.org/10.24868/issn.2515-818X.2018.050

Management of safety in the UK MoD applies to all stages of the project life cycle from Concept through to Disposal. Throughout a platform's life, the development, review and update of a "Safety Case" body of evidence is required together with safety management activities, described in the safety management plan. An integral part of today's safety case is certification of seven key hazards to agreed standards.

Separately, the merchant maritime industry have historically relied upon a prescriptive system of regulation through agreed standards and codes negotiated at international conferences and adopted by a number of seafaring nations, e.g. Loadline, Collision regulations and Safety Of Life At Sea (SOLAS). These provide comprehensive requirements for the platform, people and processes on-board, governing safety and environmental management. A number of the international conventions rely on compliance with classification society rules and the assurance processes therein. There are risk based elements of the conventions and newer conventions are goal based. Formal safety assessment has been proposed by IMO as a method for developing safety requirements, described as "a structured and systematic methodology, aimed at enhancing maritime safety, including protection of life, health, the marine environment and property, by using risk analysis and cost-benefit assessment." (IMO 2015). However, a formal safety case for a ship is not required.

Latterly these approaches have combined with rules utilising risk assessments and safety cases linking to rules. classification societies have published procedures for the assessment of novel technology using risk based design techniques (LR 2016), plus classification societies have published rules for Naval ships (James 2015). Some navies have also applied the international conventions with varying degrees of success and latterly the International Naval Safety Association INSA has published a goal based interpretation of the international conventions suited to the naval operational context. The Naval Ship Code. (Rudgley 2005).

Whilst both approaches are required for a naval ship (safety case plus compliance with prescriptive standards) to date, they have generally been undertaken as independent activities. Resulting, in some cases, a duplication of effort. The question posed by the authors is: Can they be combined effectively? How do we do this? and are there processes we can adopt to be more effective, more efficient and keep the Accountant happy?

3. Experience of hazard and risk assessment

Lloyd's Register has gained experience supporting a number of naval projects over the last 18 years, applying its own Naval Ship Rules to a wide variety of ships. Occasionally there has been interaction with the safety team. In a number of cases, this has required review of hazards and controls that utilise or draw upon the rules, codes and standards.

In one particular project, we were asked to review the hazards generated from a ship wide preliminary hazard assessment. The particular ship in question was being designed to Rules and IMO conventions. Of the 420 Hazards identified 80% were found to have adequate controls and barriers provide by requirements in the rules, codes and standards. Noting of course that the design controls would be supplemented by suitable operational and maintenance controls developed later in the project. The obvious question here was, why were we expending significant effort for very little improvement in safety?

It is not surprising that rules, codes and standards provide answers to hazards raised in safety studies. After all, a rule set is effectively a list of solutions to past problems derived from incidents which include the wisdom, knowledge and good suggestions of present and past engineers no longer with us.

On another project, we noted that the rationale behind the generation of hazards was not always clear. For example, Hazards such as "disposal of galley waste oil", "waste tank level detectors", were valid and required by the rules, codes and standards. However, a hazard such as "remote activation of pumps and valves", was not a safety issue and we suspect added as a safety requirement during a hazard study because it was convenient method of operation required by participants.

In other cases, controls had been identified which referred to rules, codes and standards but on further investigation proved not to be valid. In one case, the hazard "Hydraulic Machinery igniting local fuel source" was raised and the control specified as: Designed and certified in accordance with Lloyd's Register Rules for Lifting Appliances in a Marine Environment. This particular rule set does not contain requirements for hydraulic systems, so was an invalid control. The project did in fact have controls for this hazard which is specially mentioned in LR's Naval Rules, Vol2 pt7 ch5 s11.1.2.The rule requires protection for flammable liquid systems. In addition, the use of SOLAS in the project, meant that compartments containing such equipment required: fire detection, containment and fixed fire-fighting systems SOLAS II-2 Reg 10 s5 refers. In addition regular through life class survey and inspection would support any operational control required. The example also highlighted the need to cite chapter and verse in controls that use Rules, codes and standards.

It was clear from these examples that there was value in utilising rules, codes and standards to define controls and barriers but also that some management and standardisation was required to help safety engineers identify robust and effective controls.

However, we should not expect rules, codes and standards to be a panacea to solve all engineering problems. The have their limitations: if not updated, they may contain errors and omissions, missing hazards associated with new technology or modes of operation, in some cases, the rationale behind requirements in standards is lost in the midst of time. There is a particular requirement in all classification society rules for the design of tank scantlings which can be traced to 1890 but no further. There are also several examples of equipment correctly designed, appraised and certified, failing in use. In many cases this comes down to inadequate assumptions and understanding of equipment use. One example being that of the use of equipment on HMNZS Canterbury "From the outset of the project, there was insufficient appreciation of the constraints to the ship's operations imposed by the selection of a commercial Roll-on, Roll-off (Ro-Ro) design". (RNZN 2009).

So there are clearly benefits in reviewing and assessing the operation and function of a ship and its equipment to identify hazards and risks particularly when operating outside the normal assumed modes of operation. This should ensure key hazards are not missed by the uninformed application of standards.

Equally, the disregard of requirements in standards without and effective safety assessment is equally dangerous as highlighted by the Haddon Cave report.

"The Cross-Feed/SCP duct system represented a clear breach of good design standards and was contrary to design regulations applicable at the time."(Haddon Cave Part I Ch 7)

The need to undertake effective integration of the safety case work with rules, codes and standards has always been recognised by the authors, the challenge is how to do this efficiently. If we look at the number of hazards raised for typical ship projects, we can see that there can be a significant burden of hazards to manage. Table 1.

Table 1: Number of Hazards raised on Naval Projects

Year	*Vessel*	*Hazard Total*	*Hazard Category*			
			High	*Medium*	*Low*	*Very Low*
2003	Landing craft	73	0	0	44	29
2008	Major combatant	2200				
2015	Auxiliary ship	364	4	8	183	170
2017	Patrol vessel	194	0	3	103	80
2018	Auxiliary ship	1419	16	192	535	676
2017	Major combatant	695 796 arcived	0	1	86	608
2018	Auxiliary ship	2392	5	28	844	1515

Note: Figures represent safety assessments in progress, not all high category risks have been mitigated.
Numbers exclude equipment hazard log data.

Authors in other industries have noted the need for hazard assessment to be suitable, sufficient and effective so that we do not overload and obscure the key safety issues.

"The depth of the analysis in the operator's risk assessment should be proportionate to the hazards and risks presented by the establishment." (HSE 2015 section 5)

"The risk assessment methodology applied should be efficient (cost-effective) and of sufficient detail to enable the ranking of risks in order, for subsequent consideration of risk reduction. The rigour of assessment should be proportionate to the complexity of the problem and the magnitude of risk." (HSE 2006)

"To be acceptable a risk assessment must be suitable (that is, appropriate to the situation) and sufficient (that is, enough to manage the risk). Sufficiency should not be confused with size; more pages do not make an assessment more sufficient — and might make it unsuitable". (Leathley 2016)

Recent projects have provided an opportunity to develop an adaptable strategy which allows safety engineers to focus effort in areas where hazard and risk assessment will bring most value. However, this approach requires an iron will and discipline to avoid reverting to the norm, assessing everything in detail regardless of the associated risk and degree to which controls are already well defined.

It is important that we do this, because resources are precious on a naval project and we need to make effective use of them, the accountants do have a point. Typically the cost of the safety team to manage the safety process for a medium sized frigate will be £1.5m based on 2 people for 5 years plus engagement of the design team, though we have noted costs of £4-6m for a design safety case. Classification design assurance costs can be £300k to £1m.

It is not just the design cost, a large number of hazards will be impossible to manage through life and a more proportionate list will ensure they do get managed through life and not left on the shelf.

However before we fully bend to the Accountant's will, we should always carefully consider the balance of cost and technical risk noting the very sobering summary provided in the Haddon Cave report, one which we would not wish to be repeated:

> *Unfortunately, the Nimrod Safety Case was a lamentable job from start to finish. It was riddled with errors. It missed the key dangers. Its production is a story of incompetence, complacency and cynicism. (Haddon Cave Part III Intro)*

That said, we believe there is scope for savings to be made.

4. Proposed Approach

A staged approach is proposed in this paper, which follows elements of the system safety standard MIL882E. Whilst not used in the UK, the standard is used by several navies and provides a useful framework for this discussion. The approach is outlined in Figure 1.

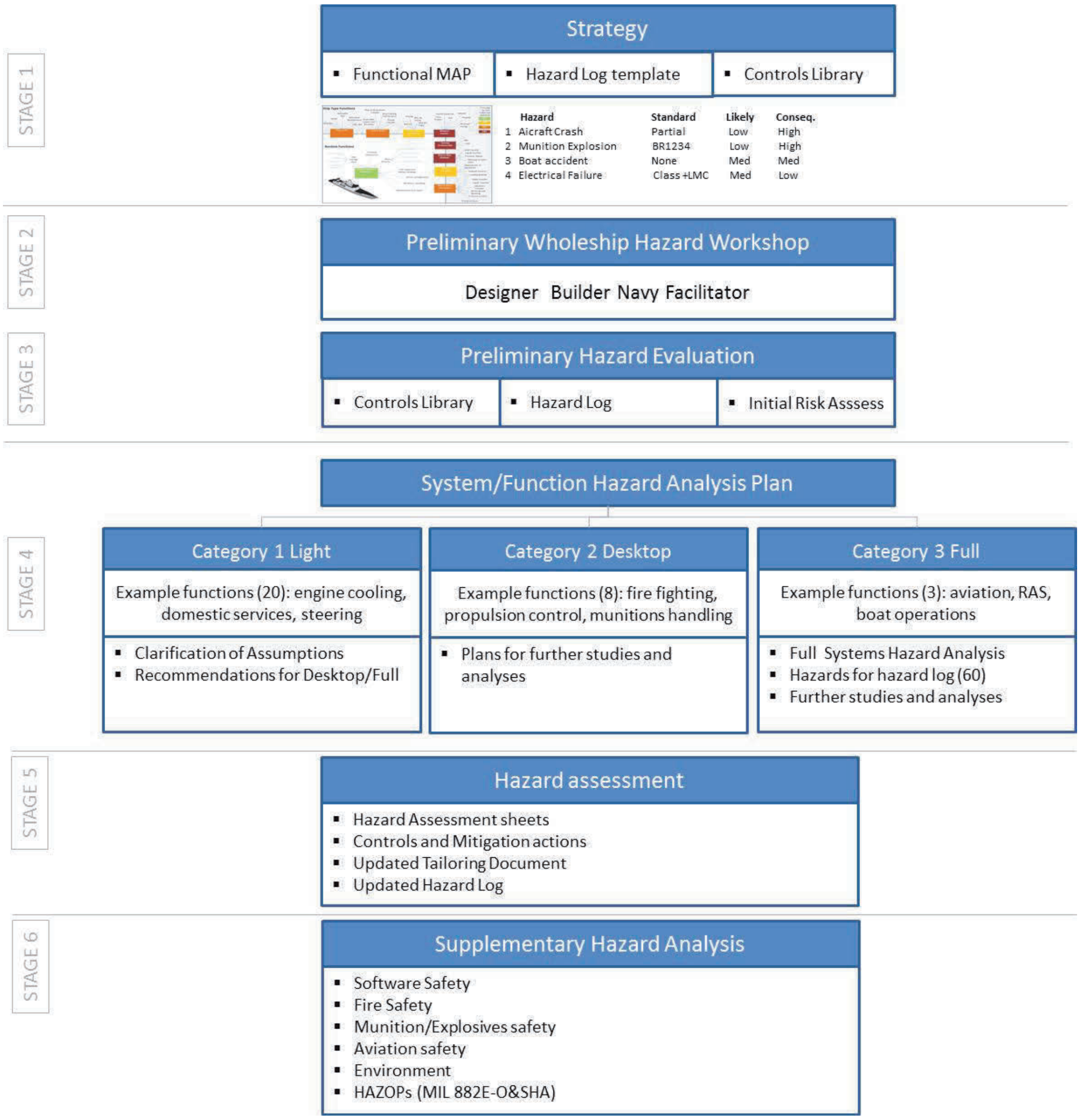

Figure 1: Safety Assurance Process

4.1. Stage 1 - Set the Strategy

The purpose of this stage is to set the direction for the safety case, to develop and populate initial hazard templates to facilitate the preliminary whole ship hazard assessment (PHA). The template is populated using a tailored list of ship functions and carefully selected guide words.

The important point here, is that we should make a conscious decision not to study certain aspects of the ship design in detail, those that are well managed by the selected rules, codes and standards. It is intended to guide the PHA towards major hazards and functions rather than ship equipment and systems. For example we should not use the weight group breakdown and start with item structure as this will waste time concentrating on something which typically has few unusual hazards and risks.

A useful tool we can develop is the Functional Map (Figure 2), this provides a pictorial representation of the ship functions and divides these into routine and special ship type functions, the map is intended to keep the PHA on track and identify areas of focus.

Risks associated with routine functions will for the most part be dealt with by assurance against rules, codes and standards (military, class society and statutory). Special ship type functions will require more detailed investigation and analysis. Some standard ship functions, for example lifting, may end up in the special ship type box if there are unusual or novel elements. The authors have developed a generic functional map for a naval ship type, grouping functions around none key operational modes:

1. Ship independent operation
2. Ship to Air
3. Ship to boat
4. Ship to ship (underway)
5. Weapon launch
6. Sensing environment
7. Ship to ship (rafting)
8. Payload Handling
9. Ship to shore (alongside)

These modes and their dependencies should be modified based on the roles declared in the ship operational concept or ship specification.

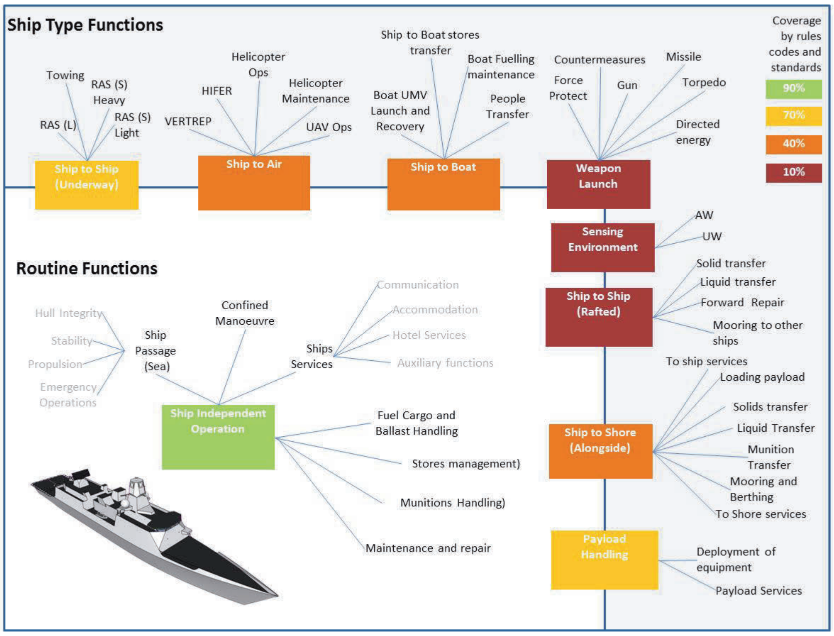

Figure 2: Functional map

Guidance on these operational modes and the extent to which they may be addressed by Rules, codes and standards is provided in Annexe A. It is interesting to note that it is the interfaces with other platforms and infrastructure that are least addressed in the rules, codes and standards. These should therefore be the areas of focus for the PHA and subsequent studies.

Output from this stage should include the completed functional map and outline safety argument along with the normal PHA terms of reference and scene setting information. The customised controls library discussed in the next section should also be modified to reflect the project standards. We could also provide an initial hazard log part populated by common hazards and standard controls.

4.2. Stage 2 – Preliminary Whole ship Hazard Workshop

This is the initial engagement between the designer and operator in hazard analysis and risk assessment. Traditionally this started with blank sheet of paper and the facilitator would determine the direction and scope. It is anticipated that the strategy setting and template development in stage 1 will set the direction and course for the PHA to follow. Over a number of projects, this should result in a consistent and familiar output with routine hazards pre or part populated. For simple ships, the PHA may be a validation and questioning rather than a brainstorm. The role of the PHA should change from identification to asking the important question "is there anything else". The purpose being to identify the unusual or irregular, rather than generating the same generic hazards such as: grounding or propulsion failure. This will produce output of significantly greater value and quality than the traditional approach.

Where normal ship operating hazards are raised they should be parked during the PHA and later cross referenced to the rules, codes and standards. This can be greatly facilitated by the use of a controls library which we will discuss later.

If properly implemented, this should generate around 70 or so new hazards particular to the ship operation rather than the 500 standard hazards which often get generated.

It is important that the proposed approach is discussed and agreed with the Navy and the shipyard to ensure that the prescribed approach can be followed during the PHA. The natural tendency will be to focus on the easy areas and known common hazards based on the bias of participants. It is also important that the navy project team agree this more focussed and efficient approach with their regulator so that the end results will be accepted.

Output from this stage will be a draft hazard log and PHA report.

4.3. Stage 3 – Preliminary Hazard Evaluation

Hazards output from the PHA should be subject to risk assessment and evaluation, with suitable controls being identified. Those controls should be reviewed to identify if the rules, codes and standards provide sufficient safety requirements to address the control. To facilitate this review, the authors have been developing a controls library which lists the common controls identified from a number of hazard assessments.

Common controls are grouped based on common ship operating hazards and accident causes. The current controls library contains 210 controls linked to 91 common hazards. (Table 2)

Table 2: Summary of Controls Library

Common Hazards		*Common Controls*	
Navigation	5	Accommodation	5
Structure and Watertight Integrity	9	Aviation	2
Fire and explosion	25	Cargo	10
Machinery	23	Deck	20
Deck Operations	12	Machinery	85
Cargo Operations	12	Navigation	14
Environment	7	Power Generation	6
Cold weather	10	Ship Design	68

Over time, the controls library will continue to be developed and maintained by LR. Links to rules, codes and standards are at section level to ensure requirements can be pinpointed, but not a paragraph level to reduce maintenance effort when sources are updated. An example is provided below. The controls library will need to be customised for each project because different standards and rule notations will be used, in some cases, the same requirement exists in a variety of standards e.g. SOLAS, ANEP or the Rules.

Table 3: Example Library Entry

Typical Hazard/ Cause	*ID*	*Nota tion*	*Control Prevention*	*ID*	*Nota tion*	*Control Mitigation*	*ID*	*Control On Going*
Crank Case explosion	M40	LMC	Oil Mist Detection [NSR v2 p2 c1 s6.7]	M06	LMC	Crank case relief Devices required [NSR v2 p2 c1 s6.2]	O01	In service Inspection and maintenance [NSR v1 c1 s3]
				M23	FIRE	Requirements for fire boundaries [NSR FIRE Notation SOLAS II-2 Reg 9]		
				M10	FIRE	Fire detection, containment and fixed fire-fighting [NSR FIRE Notation SOLAS II-2 Reg 8]		

If appropriate, an initial set of common hazards can be used to pre-populate the PHA hazard template. Risk categorisation of these initial hazards (and functions) can also be undertaken in advance using the Navy's risk matrix. These initial assumptions can then be validated at the workshop. There is always a danger in using generic approaches to risk assessment but the authors believe that with the correct balance between rigour and efficiency you get better quality assessment and visibility of the things that matter.

Where additional design or inspection controls are identified, these can be added to the classification society's scope by including them in a rule tailoring document to modify the standard scope of work. This will enable the classification process to be used to provide robust assurance for the hazard controls through design, build and future operation. The verification activities (survey, inspection, test) required to assure these controls should be defined.

Output from this stage will be an updated and revised hazard log and an updated tailoring document.

4.4. Stage 4 – System or Function Hazard analysis

This stage is key to the rationalisation future of safety work on the project by again utilising the assurance provided by rules, codes and standards but at the system rather than ship level. The first step is to develop a plan to categorise the top level elements of the functional map, e.g. Propulsion, RAS, lifesaving, based on two criteria, consequence and residual risk after application of the hazard controls provided by rules, codes and standards. Three categories of system hazard analysis are proposed.

Category 1 Light
Category 2 Desktop
Category 3 Full

The functions in the Map are to be placed into one of the assessment categories. This will then inform the System hazard analysis (SHA) plan, the purpose of which is to rationalise and focus the safety assessment process on the important and unusual aspects of the design.

4.4.1. Light.

These are systems or functions whose safe design is adequately covered by the chosen rules, codes and standards. For this to be a valid safety argument, it should be confirmed that there are no unusual modes of operation, system interactions or unusual design features that warrant further investigation. Examples of systems or functions to which this applies, are: engine cooling, domestic services or steering system.

The proposal is to review these quickly en-masse to test the above assumption and to ask the so far as reasonably practical SFARP question "is there anything else we should do". It is assumed that this will involve a single study covering around 20 systems or functions. In some cases, it may be appropriate to add additional controls or indeed recommend rule changes to address common hazards.

Output will be actions to clarify the contribution or influence of systems and functions on each other (interfaces) and recommendations to perhaps add a system or functions to one of the subsequent more rigorous steps. Such a recommendation must be made on the basis of a clearly different method of operation or a novel feature. If it is felt that the hazard should be addressed by rules and standards, proposals should be made to update the standards for the benefit of future projects.

4.4.2. Desktop.

This is applied to systems or functions that are identified as relatively high residual risk and high consequence. Even if they are adequately covered by the chosen rules, codes and standards, a system hazard analysis (SHA) in some form is still required. However, this might not be a HAZID but rather a discussion on and agreement on additional studies and analysis required to verify that the systems or functions are undertaken safely. Examples might include recommendations for: escape simulation, fire simulation, FMECA, task analysis or operability study. Examples of systems or functions to which this applies might be: Propulsion or munitions handling.

The system hazard analysis review will be undertaken separately on each system or function identified with specialists from the designer and navy.

Output will be a list of studies and investigations to be undertaken. A few additional hazards may be raised for further investigation.

4.4.3. Full.

This is applied to systems which have unusual operating requirements, complex interactions or novel design features. In these cases, a full system hazard analysis as prescribed by the standards such as MIL882E will be applied.

The assessment will consist of a full HAZID workshop with contributions from the shipyard, owner and operator, taking place over several days for each system. The review should step through all aspects of the operation of the function or system and identify all system interactions. It is anticipated that this may be 3-4 systems or functions depending on the complexity of the ship. For a simple ship type e.g. patrol boat, there may be no systems or functions that require this level of assessment. That said, experience suggests that boat operations should always be studied. Examples of systems or functions to which this applies might be: Aviation, RAS, boat handling, Antarctic operation, carriage of low flash fuel.

Where required, an ALARP/SFARP (as low or so far as reasonably practical) exercise should be held for each system to determine where additional controls can be added.

Output will be a list of hazards that require review and assessment plus recommendations for future study or detailed analysis including quantative risk analysis.

The Navy operator will be required to support all three studies as the operational use is one of the key considerations for the safety analysis.

4.5. Stage 5 – Hazard assessment

This stage is the formal categorisation, assessment and mitigation of the hazards in the hazard log. It is a fairly standard process undertaken in all risk assessment studies. However, the aim is again to link hazards to the controls and mitigation provided by the chosen rules, codes and standards. At this stage, it is anticipated that many of the mitigation actions will be provided by people and processes. However, where the opportunity exists, the hazard should be eliminated through good design.

The hazard log will have been populated by the PHA and SHA activities. We would expect around 100 hazards will require this level of assessment; if it is more than this the previous steps are not being effective.

As part of this review, the controls library will be used and updated. Similarly controls can be added to the classification society's scope.

The shipyard will be required to review and agree the mitigation actions and controls particularly if they involve design change.

Outputs from this stage will be: an updated hazard log, hazard assessment sheets, mitigation actions and controls, an updated Tailoring Document.

4.6. Stage 6 – Supplementary Hazard Analysis

This stage is for detailed hazard analyses and studies which may be required from the above system hazard analysis or specifically requested in the ship specification. These subjects will have been raised in the earlier PHA and SHA stages but may require further detailed investigation against prescribed processes. Examples include:

1. Software Safety
2. Fire Safety
3. Munition/Explosives Safety
4. Aviation. Safety
5. Environment

 http://doi.org/10.24868/issn.2515-818X.2018.050

6. HAZOPs hazard and operability studies with a focus on identifying system instructions and operating procedures based around maintenance and operation of the systems (MIL 882E-O&SHA)

These usually have prescribed processes, defined in a navy's standards or procedures which will be followed. In some cases, it may be useful to follow a version of the above process particularly where prescriptive standards cover the majority of the hazards. A template has been developed by the authors for fire safety studies based on standard SOLAS Hazards and consequences.

5. Conclusion

The authors have presented a method for producing a proportionate safety case built upon and integrated with the rules, codes and standards specified for the ship. The aim of the process is to use the engineer's knowledge of hazards addressed by these documents to refine the safety assessment. This should result in a reduced number of hazard studies which are more focused and produce more valuable output.

Two standard tools are proposed to help in this process. The functional map, which shows where hazard and risk assessment effort should be targeted, and the standard hazard and controls library which allows commonly raised hazards to be quickly mitigated and resolved.

The main challenge with this process is keeping it on track, to enforce discipline on the safety engineer to follow the process and focus on the key areas which are usually going to be operational issues.

It will also be necessary to limit discussion on areas which are familiar, safe territory where it is easy to produce a large number of hazards which add plenty of work but little value to the safety assessment.

The designer, owner and regulator will need to be confident in the integrity of the process and not measure the success of a safety case by the volume of detailed assessment or number of hazards.

Learning from the assessments and adding controls to rules and standards which are subject to third party verification will ensure roust verification of controls. If not in the rules today, there are methods for adding these items to the scope of a classification societies work on the project.

If successfully implemented, it could lead to savings in excess of £1m in the cost of developing a safety case for a project. The resulting output will be more focussed, proportionate and relevant for the in service team to pick up after the delivery of the ship.

The measure of success will be in the quality rather than quantity of the hazards raised and whether they have a positive impact on the ship design. They should result in real safety improvement for ship operations and the personnel engaged in those activities. We can all agreed that the real beneficiaries of this approach should be those serving on board rather than the workload of the engineer, safety manager or indeed purse of the accountant.

6. Acknowledgements

The author would like to thank their team in Bristol, Manchester and Korea for their support in developing this paper. The views expressed in this paper are that of the author and do not necessarily represent the views and opinions of Lloyd's Register.

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Annexe A Suggested functions or modes to be considered during PHA

The following list is a set of generic modes to be considered for the PHA, the list should be filtered and reviewed before issue so it is appropriate for the ship being assessed. They Navy may have their own approach, but the key is to make sure is it function based not System based. The order of approach is up to the facilitator but it is recommended to avoid starting with ship deployment because this is adequately covered by rules, codes and standards. The column "Stds Cover" is a subjective judgement of how well the rules codes and standards cover the hazards, it is intended to indicate that less time should be spent on these areas.

Mode Group	*Function/ Modes*	*Description*	*Stds Cover*	*Primary standards*
Ship Deployment	Ship passage at sea	The ship underway operating up to 16 knots conducting routine maritime activities.	Most	NSR LMC
	Confined Manoeuvring and berthing	Ship independently navigating in confined waters, manoeuvring and berthing / unberthing alongside or to anchor.	Most	NSR LMC
	Ship own services	The ship mission supporting functions of providing water, power, sewage, heating ventilation air conditioning, to the crew messing, accommodation, and administration compartments.	Most	NSR LMC
	Fuel, Cargo and Ballast Handling	Routine internal transfer of liquids to support normal ship operations	Most	NSR LMC
	Stores Management	Routine internal transfer of solids to support normal ship operations	Limited	Navy Policy and standards
	Munitions Handling	Routine internal transfer of ammunition to weapon systems	Limited	Navy Policy and standards
	Maintenance and repair	Equipment and activities to support maintenance and repair of ships own equipment	Limited	Navy and Support org Policy
Ship to Air	VERTREP	Ship supplying / receiving palletised cargo as an under slung load to a helicopter and /or conducting deck winching of personnel.	Some	Navy Std NSR RAS
	Helicopter In Flight Refuelling	Ship supplying pressurised aviation fuel to a helicopter hovering adjacent to the flight deck.	Limited	Navy Policy and standards
	UAV operations	Ship controlling, launching / recovering, deck re-fuelling, and handling of Unmanned Arial Vehicle	Limited	Navy Policy and standards
	Helicopter operations	Ship controlling, launching / recovering, deck re-fuelling, and handling of helicopters.	Some	Navy Std NSR
	Helicopter maintenance and repair	Equipment and activities to support maintenance and repair of helicopters on-board	Limited	Navy Policy
Ship to Boat	Boat and UMV Launch and recovery	Launching and recovering ships sea boats and Unmanned Marine Vehicle.	Some	Navy Policy NSR LA
	Ship to boat cargo and stores transfer	Loading and off loading non-bulk cargo and stores using ships lifting systems.	Some	Navy Policy NSR LA
	Ship to boat personnel transfer	Transferring personnel either through accommodation ladder or pilot ladder.	Limited	Navy Policy and standards
	Boat alongside ship	Receiving and securing boats alongside the ship.	Limited	Navy Policy and standards
Ship to Ship Sailing	RAS – Liquid	Ship supplying and receiving bulk liquid fuel and fresh water while underway.	Some	Navy Std NSR RAS
	RAS – Solid heavy 2T/5T	Ship receiving palletised cargo / stores while underway.	Some	Navy Std NSR RAS
	RAS – Solid light 250kg	Ship receiving palletised cargo / stores while underway. Excluding people.	Some	Navy Std NSR RAS
	Emergency towing	Ship towing or being towed by another ship.	Some	Navy Std NSR RAS

Ship to Ship Rafted	Solid cargo transfer	Ship loading / off loading containers and palletised cargo / stores while rafted to another ship or submarine..	Some	Navy Policy NSR LA
	Liquid cargo transfer	Ship loading / off loading liquid cargo while rafted to another ship or submarine..	Limited	Navy Policy
	Forward repair	Ship loading / off loading equipment and people for repairs while rafted to another ship or submarine.	Limited	Navy Policy NSR LA
	Mooring to other ships	Mooring via bollards to another ship	Limited	Navy Policy
Weapon operations	Force protection	Operation of ships own weapons, failure in systems, protection, safe to fire, safe arcs	Limited	Navy Policy and standards
	Gounter measure	Operation of ships own weapons, failure in systems, protection, safe to fire, safe arcs	Limited	Navy Policy and standards
	Gun	Operation of ships own weapons, failure in systems, protection, safe to fire, safe arcs	Limited	Navy Policy and standards
	Missile	Operation of ships own weapons, failure in systems, protection, safe to fire, safe arcs	Limited	Navy Policy and standards
	Torpedo	Operation of ships own weapons, failure in systems, protection, safe to fire, safe arcs	Limited	Navy Policy and standards
	Directed engergy	Operation of ships own weapons, failure in systems, protection, safe to fire, safe arcs	Limited	Navy Policy and standards
Sensing Environment	Above Water	Above water sensors, Radar, Infra Red, Optical, Electro magnetic	Limited	Navy Policy and standards
	Under water	Underwater sensors, noise, sonar		Navy Policy and standards
Payload handling	Deployment of equipment	Launching and recovery of ship equipment, RoRo equipment, Landing craft	Limited	Navy Policy and standards
	Payload services	Provision of Fresh Water, Sea Water, Electrical power, Fuel to the pay load.	Limited	Navy Policy and standards
Ship to Shore	Alongside liquid transfer	Ship alongside loading / off loading Fuel, FW and Ballast from the port, base or refinery.	Most	NSR LMC FIRE
	Alongside stores transfer	Ship alongside, supplying / receiving containerised and palletised stores directly to the wharf using ships or port lifting systems.	Most	NSR LA
	Loading or payload	Loading of payload directly to the wharf using ships or port lifting systems. Lifting or RoRo.	Some	Navy Policy and standards
	Alongside explosive items transfer	Ship alongside, supplying / receiving ammunition directly to the wharf using ships or port lifting systems.	Limited	Navy Policy NSR LA
	Ship to shore services	Provision of ship services with the addition of exporting power, water, air to shore facilities.	Limited	Navy Policy and standards
	Shore to ship services	The ship alongside at its homeport integrated into the provided shore services (remote central alarm monitoring and access control system, data, telephone, power, water, sewage and compressed working air).	Limited	Navy Policy NSR LMC

NSR Lloyd's register Naval Ship Rules and associated notations.