CASE STUDY IN RISK EVALUATION FOR A SMALL-SCALE SEA-BASED TRIAL TO SATISFY A NEW OPERATIONAL REQUIREMENT

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Abstract

The duty holder for corporate risk has the responsibility to manage the corporate residual risk portfolio based on the operational profile of the corporate entity. When a new operational requirement is placed on the company, a risk assessment is required to make the risk profile of the new operation explicit to the duty holder. The completeness and accuracy of the information to support his operational decision and the corporate risk exposure is critical to the duty holder.

This paper presents a real example of how the risk evaluation was actually done for a new operational requirement to carry out a series of sea-based trials using a small rigid inflatable vessel to evaluate prototype communication equipment. It proposes that corporate benefit balance was improved, since capability was extended with minimum potential for harm.

Rather than a hypothetical example, this paper will discuss a real operational requirement, with rich meta-information and will follow through from trial specification, hazard identification to presentation of residual risk profile and operational recommendations.

1 Introduction

As a component part of the performance demonstration for a short to medium range system for support to situational awareness when 'policing' at sea, a requirement for small-scale sea-based trials was placed on the manufacturer. This was a novel requirement on the manufacturer, and although there were recreational sailors within the project staff, there was no experience or equipment for undertaking planned sea-based trials. The project staff had to be prepared to operate in adverse weather conditions and in darkness.

As in any commercial venture, there is a duty of care on the employer to ensure the safety of its employees so far as is reasonably practicable. As such it was necessary to undertake a risk assessment for the planned suite of trials.

The remainder of this paper is organised as follows; section 2 will review recent historical incidents associated with marine craft as a guide to future risk assessment areas. Section 3 will summarise the nature and domains of risk in small-scale sea-based trials. Section 4 recounts the resources and planning used for the formal hazard identification process and presents the results of that process. Section 5 establishes descriptions of those at risk. Section 6 presents the hazard-to-risk numerical ranking for the sea trails, and identification of appropriate mitigations. Section 7 considers the corporate risk profile, and section 8 summarises the output used for decision support and future management of the risk structure.

2 Review of recent historical incidents

Web sites for the Maritime and Coastguard Agency (MCA) [2], Royal National Lifeboat Institution (RNLI) [3], and Royal Yachting Association (RYA) [4] were referred to. The following points are condensed from sources for commercial vessel accidents as well as for leisure craft.

- An important and recurrent element in incident sequences is slipping on wet/greasy surfaces
- Wearing of correct survival clothing, especially non-slip footwear, is always helpful and sometimes vital
- Correct positioning and securing of dense payloads, such as gas bottles, is important
- Openings in rails (and deck, if relevant) must be guarded
- Batteries always deserve respect - they combine dense movable items with potential chemical spill, energy dump/fire hazard, and subsequent propulsion starting failure
- Mooring forces can be high and unexpected and are frequently the first cause of an accident sequence
- The human dimension is fundamental to both cause and prevention of unwanted events
- Most human element shortcomings involve lack of situational awareness rather than lack of zeal

MCA Formal Safety Assessment (FSA) advice on risk management is distilled from knowledge and experience, summarized as follows:-

- Pay careful attention to identification of all hazards
- Take time to use formal tools such as Detailed Risk Assessment form, and to visualize scenarios
- Always consider human element contribution, for good and ill
- Establish scenarios to rank risk levels and to assist derivation of cost effective preventive measures
- Propose risk control measures and procedures

The RNLI Safety Digest is optimised for small leisure craft and small working boats such as fishing vessels:-

- Always wear life jacket
- Check state of vessel and systems before leaving, and during passage
- Inform shore agency of plans – and their completion
- When risk threatens, call for help in good time
- Maintain situational awareness of weather forecasts and tides
- Ensure crew capability and training is appropriate for task.

3 The nature and domains for risk in small scale sea trials

A manufacturer of civilian and military command and control devices wanted to extend their market opportunities by expanding their device capability to inshore and offshore environments. In order to demonstrate this capability, the manufacturer was asked to run a series of ship-to-shore communication scenarios based from a public marina. The manufacturer obtained the use of a rigid inflatable boat (RIB) and a land vehicle to carry out the series of range and positional trials. The trials involved moving both emitter and receiver around various truth points of an estuary environment, both by day and night. This paper concentrates on the risk assessment for the water-borne component of the trial.

Since we could devote only very limited resources to the study, we modelled it on the HSE 5-step risk assessment [1]. This method follows a logical path and encourages an uncomplicated approach. As set out in the HSE publication, it concentrates on safety of employees – since we were assessing operation of a fast vessel in open waters, we expanded the model to examine potential harm to the public, to private and public property and to the environment.

4 Methodology for hazard identification and tabulation of associated hazards

Hazards were identified in 4 areas of key accidents, either as vessel condition or potential accident sequence initiators:-

- loss of stability and sinking
- collision with another vessel, or person, or object
- fire and explosion
- crew member falling overboard.

Each of the assessed hazards was considered as an unwanted event and then expanded to list all associated hazards and potential impacts – see example below:-

Unwanted event	Assessed impact	Severity index	Probability index	RISK INDEX
Collision with swimmer	3rd party death, injury	5 (5 = most severe)	4 (1=least probable)	5*4=20
Mitigation	a) Crew C&T b) Safety kit, deployable ladder c) VHF d) Caged propeller e) Observe exclusion zones			

Table 1:- Derivation of Risk Index and Mitigations

5 Establish at-risk entities

This section will establish the at-risk entities and the scope of unwanted events for small vessels in the maritime environment, assuming that adverse conditions and poor visibility will sometimes be encountered in open waters, by day and by night.

A safe operation is one which reduces all unwanted events to an acceptably low level of risk, where 'risk' is the combination of hazard impact and probability. Three areas will be examined:- death and injury to humans, loss of corporate reputation and corporate assets, and degradation of the natural environment. In general, an operation which is safe for humans is safe for the other 2 areas, but there are exceptions eg chafe of RIB buoyancy chamber at moorings, or fuel spillage.

Humans are examined as 2 groups:

- Own employees, trained to recognize and mitigate risks and rewarded for managing them as part of their job,
- 3rd parties and public who must have an order better risk mitigation than employees and who will be removed from risk as far as possible.

Similarly property is examined in the 2 categories of own property, and 3rd party and public property. Own property is to be assessed under 2 distinct headings:

- Company investment in RIB and associated systems to deliver a capability
- Public perception of organization – reputation, goodwill, share price.

3rd party and public property consists of all items of value which are not 'own property' and which are associated with RIB operation. The environment is clearly always a public asset, and commercial shipping is now addressing environmental impact at all levels.

Domains for risk have been designated at 3 levels:

The first (highest) level domain defines those risks which may have serious accident outcomes combined with relatively high frequency, and which have potential to cause significant business disruption, loss of reputation and share value, prosecution and damages.

The second (medium) level domain are risks which are judged to have medium probability of severity and frequency, to be potential first events in an accident sequence, and which will disrupt company business to a significant degree.

The third (lowest) level domain are risks which offer some disruption to company business but are susceptible to internal management measures.

6 Derivation of risk index and relevant mitigations

The risk index numerical ranking is the product of assessed hazard impact index, and probability, where the hazard index ranges from 5 (most severe) down to 1. The assessed probability index also ranges from 5 (most likely) down to 1. The risk index numerical value is simply a guide to the areas which deserve most detailed management attention. They do not offer exact weightings and are not designed to contribute towards complex logic tree analysis. This type of numerical analysis would not refine risk ranking information and would be unlikely to be numerically accurate in the longer term.

The purpose of the risk ranking index is to assist categorisation/sentencing of operating risks. This will be done in 3 stages:-

- Identification of all relevant mitigations against the hazards associated with each unwanted event
- Collation of multiple benefit cost-effective mitigations, which cover a wide range of hazards and are of benefit for protection of humans, property, and environment
- Matching of cost-effective multiple mitigations to most exacting risk domains

Two examples of cost-effective safety mitigation measures are given below:-

6.1 RIB Design for Safety

- Engine installation to high standard, acceptable vibration and noise levels, well routed exhaust, reliable water cooling supply, fuel system with ON/OFF tap, fire extinguisher port into engine compartment, engine kill switch with crew attachment,
- Well engineered double battery installation, 1 battery dedicated to engine starting,
- Hand starting handle (optional if battery installation satisfactory),
- Caged propeller,
- Alternative propulsion systems – outboard, paddles,
- Alternative tiller installation for directional control of engine thrust after steering failure,
- Ballast secured, bilge drains,
- Anchor, warps, fenders, boathook

6.2 VHF Radio Communications

- Physically secure installation with GMDSS if going offshore, antenna firmly secured at highest convenient point.
- Able to operate from both batteries,
- Back up comms system and spare antenna,
- Emergency Positioning Identification Radio Beacon if operating offshore.

7 Communication of corporate risk profile, decision support, and operations management

Risk domains are discussed above. The first and most serious domain levels have higher index scores and are a potential threat to public safety. These relatively high frequency serious accidents may lead to serious business disruption, loss of reputation and share value, prosecution and damages. There are 4 such risks:-

- Collision with swimmer
- Collision with another vessel
- Causing traffic confliction leading to large vessel emergency,
- RIB capsizes, floods/sinks, suffers structural failure

The middle domain level risks score in the median part of the index, are judged to be potential first events in an accident sequence, and will disrupt company business to a significant degree. There are 5 such risks:-

- Position uncertain
- Collision with fixed object, entanglement with floating debris
- Propulsion failure
- Electrical and radio failure
- Crew member overboard

The lower domain risks score in the lower range, offer some disruption to company business but are susceptible to internal management measures. Note that some of these have very high impacts, but also very low probabilities. There are 7 such risks:-

- Fire
- Explosion
- Adverse weather

- Vibration, noise
- Damage from wash energy
- Fuel/oil spills, contamination
- Mishaps during departure and docking manoeuvres

The next stage is to match mitigations to risk domains. Certain mitigation measures are repeated for many risks, and are also effective in minimizing death and injury, 3rd party exposure, property, and environment. These safety mitigation measures are most important and most cost effective. They comprise:-

- Crew composition and training, supported by rigorous procedures
- RIB design/certification for safety
- VHF radio communications, ship-to-shore and ship-to-ship
- Safety equipment and clothing
- Navigation/positioning equipment, charts and information
- RIB/system maintenance, supported by current log books.

This analysis has been used to derive proposed procedures for RIB operation – see examples below:-

7.1 Engine Pre-Start Checks

- Bilge ventilator ON
- Fuel contents, visual check,
- Fuel tap checked ON
- Fuel water trap bowl clear, drain if needed,
- Lubricant levels check – engine, gearbox, stern gland,
- Coolant and hydraulic fluid levels check,
- Raw water sea cock OPEN and water filter checked
- Battery switch to START battery,
- Check instrument/warning lights, fuel gauge,
- Out of gear, throttle to START setting,
- Check no trailing lines near propeller,
- Initiate START sequence, do after start checks.

7.2 Rescue of Man Overboard or Swimmer

- Shout to other crew members, throw safety MOB kit,
- Name crew member to keep sight and point continuously at casualty, use searchlight at night,
- Reduce speed, approach casualty, deploy rescue ladder, engine NEUTRAL or STOP
- Assist casualty aboard, treat for shock/exposure, make radio call, take ashore to shelter/medical,
- Operate unconscious casualty recovery procedure if required,
- Call for assistance if casualty lost to sight, stay in area, carry out search pattern at low speed, engine STOP at intervals to listen

8 Management of a Risk Ranking Structure

During derivation of safety mitigation measures the pattern of risk management for a small RIB emerged. This pattern is discussed at this stage since it may assist management to ensure that their safety culture allows safety focus at the optimum place and time, and is not diluted into general lip service.

Many low level hazards will be encountered which have a high probability of occurrence. Typical examples are the crew vibration environment, fuel spillage into the sea during refuelling, and chafing of the hull inflatable collar during mooring at pontoon. Such hazards are best managed on the assumption that they are ubiquitous. Since they are always present, the environmental component of the interacting system of vessel/crew/environment should be managed to offer permanent mitigation of the resulting risks, for example:-

- Crew vibration environment can be improved by use of vibration absorbent flooring,
- Refuelling operations should always use a generous funnel around the pressure fill hose,
- Pontoons should be fitted with permanent low-abrasion fenders to supplement the vessel fenders deployed by the crew.

For high level hazards with a very low frequency of occurrence, the potentially catastrophic outcomes require management measures which may seem disproportionate on simple evaluation of risk index. The sequence of RIB capsize/flood and sink/crew injury or death has an extremely low frequency of occurrence. Operation of RIBs is an inherently safe process but the vessels are high acceleration/high speed vehicles which represent a significant store of potential energy. Mishandling and excessive speed in rough conditions can have fatal consequences. Helmsmen and crews must be trained so that they understand the control envelope of the vessel, and the warning signals that the envelope limits are being approached. This observation reinforces the first rule of safe operation – crew to be correctly constituted and trained, and supported by rigorous procedures.

9 Conclusions

- A risk ranking structure is proposed for operation of a small RIB vessel used as a corporate asset to support a communications trial,

- The risk ranking proposed is designed to rationalize priorities for management of consequent risk to humans, corporate property and the environment during RIB operation,

- Mitigation measures are proposed which concentrate on most threatening and prevalent risks in a cost-effective way,

- Effect on corporate risk profile is assessed,
- Routine recording of operating events, and vessel condition, is proposed to assist corporate learning from experience,
- Generic procedures can be derived as guidance notes for operation of small RIB vessels.

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Biographies

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